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Inflation dynamics in South Africa: The role of public debt

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Orientation: Inflation targeting requires prudent fiscal policy to achieve desired results.

Motivation for the study: Since the 2007–2008 financial crisis, fiscal authorities in South Africa have implemented an aggressive fiscal stimulus that has resulted in an acceleration of public debt, accompanied by a sustained government deficit. At the same time, the economy has continued to struggle with achieving significant growth to assist the government with its ever-growing expenditure obligations.

Research Purpose: This study set out to investigate the relationship between inflation dynamics and the stance of fiscal policy, with a focus on public debt, in South Africa.

Method: This study employs a New Keynesian dynamic stochastic general equilibrium (NKDSGE) model with financial frictions calibrated on South African data.

Main Findings: The results of this study showed that when fiscal authorities put a relatively small weight on the control of public debt, inflation significantly increases in response to economic shocks. As a result, the cost channel of monetary policy transmission dominates the demand channel even if the loan rate pass-through is complete.

Practical/Managerial Implications: The results of this study highlight the importance of fiscal discipline and its potential adverse effects on monetary authorities' ability to achieve price stability as set out in their monetary framework.

Contribution/Value added: To the best of our knowledge, this is the first study to analyse inflation dynamics and public debt in South Africa using modular experiments in a structural model derived from micro-economic foundations of constrained decision-making.

Keywords: Inflation; inflation target; public debt; price stability; fiscal discipline; monetary policy; fiscal policy; policy coordination.

Introduction

In the Seventies and Eighties, South Africa experienced a period of high and volatile inflation. The rate of inflation rose from 5.3% in 1970 to 18.7% in 1986. Following the recommendations of the De Cock Commission, a number of reforms were implemented in the country's monetary systems and monetary policy. The rate of inflation declined in the Nineties, reaching 5.1% in 1999. Keen on keeping inflation low, South Africa adopted inflation targeting as a monetary policy framework in February 2000. Presently, the country is targeting between 3% and 6% inflation. However, since the adoption of the framework, monetary authorities have struggled to contain inflation within its targeted band, rendering the policy dynamically inconsistent (see Ngalawa & Komba 2020). During the period 2000–2016, annual inflation in the country was recorded outside the targeted band in 10 out of the 17 years. According to Blinder (1999), a credible central bank is one that says it will do something and people believe that it will do exactly the same thing. Any failure to achieve a stated goal or objective undermines the credibility of the central bank and hence heightens the expectations about future inflation.

Since the 2007–2008 financial crisis, fiscal authorities in South Africa have implemented an aggressive fiscal stimulus that has resulted in an acceleration of public debt accompanied by a sustained government deficit. In 2018, the country's debt to gross domestic product (GDP) ratio was recorded at 55.8%, effectively doubling the figure in just a decade, compared to 27.8% of 2008. This ratio is expected to top 70% in the next 3 years because of the propounding state-owned enterprises (SOEs) problems faced by the government. At the same time, the economy continues to struggle with achieving significant growth to assist the government with its ever-growing expenditure obligations.

During this period of countercyclical fiscal policy, the public debt to GDP ratio has been growing, while the rate of inflation has remained relatively high, around the upper target band and even surpassing it. The primary objective of this study, therefore, is to investigate how the stance of fiscal policy in South Africa affects inflation dynamics. This study focuses on the role of public debt in a New Keynesian dynamic stochastic general equilibrium (NKDSGE) model with financial frictions, calibrated on South African data.

Since the Eighties, there has been increasing interest on the interaction between fiscal policy and monetary policy, with particular attention to price level determination. Sargent and Wallace (1981) and Aiyagari and Gertler (1985) argued that disregarding the fiscal–monetary policy interactions may lead to policy errors and that theories which ignore fiscal policy are incomplete. Inflation is considered a monetary phenomenon, meaning its control is subject to the conduct of monetary policy. The quantity theory of money posits that inflation is solely determined by changes in the relative money supply and goods. Hence, policies aimed at containing inflation have focused on constraining monetary expansion. Nevertheless, a growing literature has since put forward the role of fiscal policy in the matter of price level determination (Aiyagari & Gertler 1985; Leeper 1991; Sargent & Wallace 1981). The argument is that money demand also depends on inflation expectations; thus, any monetary efforts at containing inflation may not be the only factor worth considering.

The seminal work of Sargent and Wallace (1981) argued that the effectiveness of monetary policy in controlling inflation is subject to its coordination with fiscal policy. This assertion holds even when the traditional link between money and the price level holds, but nevertheless, tight monetary actions could still lead to an increase in inflation. Based on Sargent and Wallace (1981), this is inevitable given the demand for government bonds in the absence of adjustments in future fiscal policy; a share of government obligations would have to be recovered through seigniorage at some point in the future, thus impacting inflation dynamics.

A similar school of thought rests on the so-called fiscal theory of the price level (FTPL). The FTPL, in addition, incorporates the traditional analysis of the Keynesian aggregate demand type factors such as public sector wage spill-overs to the private sector and taxes affecting private consumption and marginal costs (Elmendor & Mankiw 1999). In addition, the FTPL identifies the 'wealth effect' of government debt as an additional channel of fiscal influence on the price level. The FTPL posits that an increase in government debt adds to household wealth and, therefore, to the demand for goods and services, leading to price pressures (Christiano & Fitzgerald 2000; Cochrane 2001, 2005; Gordon & Leeper 2002; Sims 1994; Woodford 1994, 2001). Furthermore, the higher the size of the government debt, the higher the sovereign risk premiums being charged by creditors, inducing higher interest rates in the economy, thus leading to the well-known crowding-out effect with its accompanying impact on macro-economic stability.

To enrich this study, we incorporate financial frictions for our monetary policy analysis. There are several studies that have discussed the role of financial frictions in monetary policy analysis. Bernanke, Gertler and Gilchrist (1999) introduced financial market frictions in the standard New Keynesian model and argued for the existence of a financial accelerator effect. They maintained that a change in the external financial premium has a persistent effect on the real economy, while Ravenna and Walsh (2006) showed that a cost channel, which implies a rise in working capital induced by a monetary contraction, can cause inflation. According to Ravenna and Walsh (2006), this consequently generates a wedge between stabilising inflation and stabilising the output gap in the case of optimal monetary policy. Chowdhury, Hoffman and Schabert (2006) found that a cost channel plays a significant role in the New Keynesian Phillips curve (NKPC) in developed countries. These studies imply that the role of financial frictions is not negligible when the central bank conducts monetary policy.

The rest of the article is structured as follows. Section 2 is a brief overview of monetary policy, inflation and public debt–GDP ratio in South Africa. Section 3 reviews related literature. Section 4 constructs a baseline New Keynesian general equilibrium framework representative of the South African economy. Section 5 discusses the findings of this study. Section 6 presents a summary, draws conclusions and outlines policy recommendations from the study results.

Monetary policy, inflation and public debt–gross domestic product ratio in South Africa

Between 1960 and 1998, the country's monetary policy framework included exchange rate targeting, discretionary monetary policy, monetary aggregate targeting and an eclectic approach (Van der Merwe 2004). During the Seventies, direct controls from monetary authorities were less effective in controlling money supply growth, which led to the acceleration of inflation. In 1977, the government established the De Kock Commission in response to a growing disappointment with the failure of monetary policy in controlling monetary aggregates. Following a period of reforms recommended by the commission, inflation entered a high, but moderately stable, range during the Eighties. Towards the late Nineties, inflation had declined to single digits.

With the aim to keep inflation low, monetary authorities adopted inflation targeting as a monetary policy framework in February 2000. Inflation targeting is a monetary policy approach in which the central bank makes public an explicit inflation target and implements a policy to achieve the specified target (see Ngalawa & Komba 2020). Bernanke et al. (1999) and Svensson (1997) argued that emerging inflation targeters would see significant macro-economic

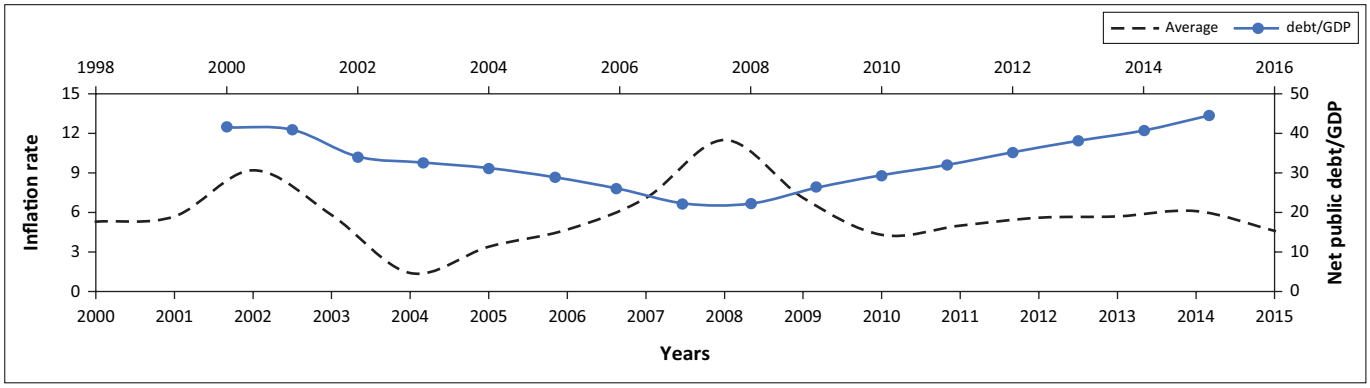
performance improvements. However, the success of inflation targeting requires economic policy coordination, credibility, accountability and institutional reforms (see Gonçalves & Salles 2008; Lin & Ye 2009). By January 2001, inflation in South Africa had dropped to 4.77%, within the target band. Since its inception, although relatively low compared to the period between 1968 and 1998, the rate of inflation has been fluctuating both in and out of the target band for most parts (see Ngalawa & Komba 2020). Failure to achieve the stated target renders the policy dynamically inconsistent (see Blinder 1999; Kydland & Prescott 1977; Rogoff 1985). This failure by the central bank has stimulated the debate of policy consistency of monetary policy in South Africa (see Gupta & Uwilingiye 2010; Kahn & De Jager 2011).

During the Seventies and Eighties, there were concerns that South Africa was approaching a 'debt trap'. Van der Merwe (1993) defined a 'debt trap' as an unsustainable fiscal financial position where an 'explosion' in the public debt–GDP ratio cannot be eradicated merely by adjusting the ratio of government taxation to GDP. A newly elected government in 1994 recognised the need to consolidate the fiscal balance inherited from the previous government. According to Hamilton and Viegi (2009), this was unusual for a nation which had just undergone a democratic regime change. Normally, when nations emerge from such regime changes, newly elected public officials engage in extensive borrowing to foster economic growth and development. From the year 2000, there were significant reductions in the debt–GDP ratio. The country's debt–GDP ratio fell from 42.27 in 2000 to 27.06 in 2007. By 2008, the debt–GDP ratio in the country had decreased to 26.5%. During this period, the consolidated budget balance had also experienced huge reforms, dropping the deficit from –1.4% in 2000 to –0.3% in 2005 and finally a surplus of 0.6% and 1% of GDP in 2006 and 2007, respectively. However, the global financial crisis (GFC) of 2008 saw this figure rising to –6.3% by 2009, and as of 2018, the figure is around –4.4%.

Eyeball inspection of Figure 1 shows clear patterns of co-movements of inflation and public debt–GDP ratio. Prior to the 2007–2008 financial crisis, inflation had fallen to low digit figures, while simultaneously the debt–GDP ratio had remained relatively low. After the financial crisis, the debt–GDP ratio entered an upward trajectory accompanied by a relatively high and persistent inflation rate hovering around the upper band of the inflation target. This study argues that when fiscal authorities ensured a relatively low debt–GDP ratio by containing debt–GDP ratio growth, monetary authorities could maintain inflation within the target band. Consequently, when the debt–GDP ratio started to accelerate, inflation pressures persisted.

Many studies have been carried out to try and find the true driver of inflation in South Africa. These studies have largely focused on the structuralist and monetarist ideas. This has largely been matched by the ever-increasing search for the elusive Phillips curve for the South African economy. Focusing on the monetarist and structuralist approach, Akinboade, Niedermeier and Siebrits (2002) explored the determinants of inflation in South Africa for the period 1970Q1–2000Q2 (pre-inflation targeting period) using a structural vector autoregression (SVAR) model and impulse response functions. Their focus was on exchange rates and foreign prices as a source of inflation for the South African economy. Accounting for the debt crisis of 1985, the global stock market crash of 1987 and the Asian crisis of 1988, they found inflation dynamics for the South African economy to be nested on the structural school of thought with limited but significant influence from the monetarist school of thought. Monetary variables like money supply and nominal interest rate were found to be significant.

Adusei (2013) revisited the question of whether inflation dynamics in South Africa follow a monetarist or structuralist approach as Akinboade et al. (2002) had done in 2002. Covering the period 1965–2006, this study found both schools of thought to be significant in determining inflation dynamics in South Africa. This was in contradiction to some of the findings by Akinboade et al. (2002). Swanepoel (2006) expanded the search to include the role of trade openness and international oil prices on local inflation dynamics in the country. Although a positive correlation between oil prices and inflation was observed, it was not significant. The oil price shock of 2004 had an even smaller influence on inflation dynamics than the oil price shocks of the Seventies and Nineties.



Source: South African Reserve Bank, 2017, *South African Reserve Bank Website*, South African Reserve Bank, Pretoria.

FIGURE 1: Inflation rate versus public debt–gross domestic product ratio, 2000–2015.

Studies by Burger and Marinkov (2006) and Malikane (2013) tried to explore the possible existence of Gordon's triangle for the South African economy in terms of inflation dynamics. The results of Burger and Marinkov (2006) were in line with those of Akinboade et al. (2002) in that they both asserted that inflation dynamics in South Africa are not demand driven. They argued that inflation dynamics in the country are driven by structural variables. Accordingly, they concluded that the Gordon triangular model is not applicable to the South African economy. However, using the output gap, a variable that captures the demand side, Malikane (2013) found a positive relationship between output gap and inflation. This is in line with Adusei (2013) but contrary to Burger and Marinkov (2006). Malikane (2013) concluded that for the Phillips curve to exist, more inflation lags and supply shock variables must be introduced in the model.

It is clear from the above-reviewed studies that only two schools of thoughts are ever considered for inflation dynamics in South Africa, namely the monetarist and the structuralist schools of thought. Even then, there are many conflicting results arising from model specification differences, robustness-testing errors and/or theoretical approaches not mimicking the reality of the South African economy. There is no question that further investigation on the sources of inflation dynamics in South Africa is warranted. To our knowledge, most studies have neglected the effects or role of fiscal factors on inflation dynamics in the South African economy. The basis of this study is that a persistent accumulation of public debt in an economy with no effort or no explicit control measure in place to limit the debt accumulation will inevitably raise inflation expectations and lead to sustained inflationary pressure in the future. Based on the FTPL, this outcome is possible. As a result, a cautionary tale is always needed for both monetary and fiscal authorities when it comes to their policy stance. This is especially necessary for South Africa, as we have witnessed after the global financial crisis (from 2009 and beyond) an ever-growing accumulation of public debt.

Literature review

The topic of persistent government budget imbalances, along with its dynamics both in the developing and developed economies, has drawn attention in theoretical and empirical field research. The emphasis is on the cause of these persistent budget imbalances and their corresponding impact on public debt. Over the last two decades, there has been a systematic rise in government debt in both developed and developing nations. This has been much more intense in the developing economies, as a result of which, a debt crisis has emanated. In the literature, these government imbalances have been considered a cause of money supply growth, persistent inflation and macro-economic instability in some cases (Catão & Terrones 2005; Hossain & Chowdhury 1998; Saleh & Harvie 2005; Tekin-Koru & Özemen 2003). Tanzi (1993) even argued that, especially in developing economies, the public sector, far from being a balancing factor, has contributed extensively to macro-economic imbalances. Along the same argument, Fischer and Easterly (1990) argued that rising inflation is almost always a fiscal phenomenon in these economies and that controlling inflation requires coordination between monetary and fiscal policies. These above-mentioned arguments were since put forward by Sargent and Wallace (1981) and Aiyagari and Gertler (1985), who emphasised that disregarding fiscal–monetary policy interactions may lead to policy errors and that theories that ignore fiscal policy are incomplete.

Despite the large body of literature on the relations among debt, money and inflation, no theoretical or empirical consensus exists on the exact economic consequences of large budget imbalances and, subsequently, government debt on inflation (Darrat 2000; Narayan, Narayan & Prasad 2006). According to Sargent and Wallace (1981), inflation is linked to the way budget deficits are financed, which means the extent to which government deficits are monetised. Sargent and Wallace (1981) posited that the degree to which monetary policy is independent and budget policy dependent or vice versa is key to knowing whether fiscal deficits would lead to higher rates of inflation or not. Elaborating on this theme, Saleh and Harvie (2005) and Vamvoukas (1998) put forward the existence of two transmission channels of the deficit to inflation. Firstly, when a central bank purchases government bonds, it kick-starts a process that increases high-powered money and aggregate money supply, consequently increasing the price level. Secondly, when deficits put an upward pressure on interest rates, an increase in the money supply is required to keep them stable, in which case deficits cause inflation by encouraging higher rates of monetary growth. As Vamvoukas (1998) posited, in a world without a Ricardian regime, increases in the real value of bond assets ultimately increase perceived private wealth that, added to income obtained from interest rates, makes bond holders feel richer, inducing them to increase their consumption spending. This leads to higher national income, which in turn leads to an increase in the demand for money and hence inflation (Keynesian perspective).

In contrast, Barro (1996) and other proponents of the Ricardian equivalence argued that government deficits do not matter given that current tax cuts will be financed by proportionate future tax hikes. According to them, this ensures that government deficit does not affect the economy. As opposed to the Keynesian viewpoint, current tax cuts and future tax hikes will offset each other, meaning that tax cuts will not make economic agents wealthier and do not encourage them to increase their consumption of goods and services. Hence, fiscal deficits do not matter because they do not have any effect on aggregate demand, interest rates and the price level. For Barro (1996) and his proponent, the net value of private sector wealth remains unchanged by taxes or debt financing, which is the reason why deficits do not cause inflation. On the contrary, deficits would be the result of inflation.

Another channel through which a government deficit might directly affect inflation is the output gap. The reason behind this is that the public sector also demands goods and services

produced by the private sector. Nevertheless, such effect can be positive or negative depending on the type of public expenditure. For instance, if the public deficit is the result of greater current expenditure on goods and services, the expected effect would be positive. However, if the expenditure is used to construct infrastructure, the effect could be negative (at least over the long run), given that it would tend to improve productivity and lower production costs for the private sector.

In a similar way to theory, empirical evidence also does not exhibit consensus with respect to the direction of the causal relation among inflation, fiscal deficit and money. In the case of South Africa, Anoruo (2003) showed evidence that deficits have a positive impact on the growth rate of money supply and inflation. Studies of this nature are commonly done in a panel analysis of economies. Catão and Terrones (2005) found a strong positive association between deficits and inflation among high-inflation and developing country groups. On the other hand, for low-inflation advanced economies, the authors do not find a relation between budget deficits and inflation. Barro (1989), Abizadeh, Benarroch and Yousefi (1996), Vieira (2000) and Wray (2005) argue that the 'inflation-deficit' nexus does not exist because larger deficits do not appear to cause inflation. Castro, De Resende and Ruge-Murcia (2003) then moved away from a budget-deficit approach to using government debt itself and estimate the degree of interdependence between fiscal and monetary policies in developed countries. They found that debt plays a minor role in determining the price level in developed economies. Along the same lines, Kwon et al. (2006). used a panel dataset, separating developed and developing economies, as well as net debtor or net credit economies based on their balance of payments data and the classification of the World Economic Outlook 2005 (IMF 2005). They found that the relation between debt and inflation is statistically significant and strong in indebted developing countries, weak in other developing countries and generally not valid in developed economies (Kwon et al. 2006). The outcomes of Castro, De Resende and Ruge-Murcia (2003), as well as those of Kwon et al. (2006), are in line with the FTPL described above.

Methodology

We formulate a dynamic stochastic general equilibrium (DSGE) model calibrated on South African data. There are several benefits of using a DSGE model. Firstly, an important feature of DSGE models is that it is 'possible', when employing these models, to bypass the Lucas critique, unlike the more traditional macro-economic forecasting models (see Ngalawa & Viegi 2013; Tovar 2008). This applies only to models where parameters do not vary with policy interventions. This is because DSGE models are derived from micro-economic foundations of constrained decision-making. That is, they describe the general equilibrium allocations and prices in the economy where all agents dynamically maximise their objectives subject to budget or resource constraints (see Ngalawa & Komba 2020). Secondly, DSGE models allow for precise and unambiguous examination of random disturbances, owing to their stochastic design. Thirdly, DSGE models are structural, implying that each equation has an economic interpretation, which allows clear identification of policy interventions and transmission mechanisms (Peiris & Saxegaard 2007). Fourthly, DSGE models are forward-looking in that agents optimise model-consistent forecasts about the future evolution of the economy (Peiris & Saxegaard 2007).

Model

Our framework is based on the frameworks of Woodford (1996), Blake and Kirsanova (2004) and Ida (2013). We extend the model to include a cost channel and simple financial frictions, as in the studies of Ravenna and Walsh (2006) and Chowdhury et al. (2006). This is consistent with the literature and the structural nature of the South African economy, where financial fragility can be associated with bad loans. Many DSGE models have been developed for forecasting the economy and analysing monetary policy in South Africa. To the best of our knowledge, no study has investigated the theoretical relationship between inflation and the stance of fiscal policy, specifically the role of public debt on inflation dynamics in South Africa. We run a series of experiments to capture the complexities of the economy and critically explore the stance of fiscal and monetary policy interactions.

The model is Keynesian in spirit and nests on standard features of a NKDSGE model. Lowercase letters denote log deviations from the steady state. A log-linearised variable around the steady state is expressed as at = log(At/Ā), where Ā denotes the value of the steady state. We consider a typical model with optimising forward-looking private sector agents, whose optimisation behaviour can be reduced to the Phillips curve and the intertemporal IS curve with a wealth effect. We close the model by including fiscal and monetary policy specifications.[1]

Following Blake and Kirsanova (2004), we formulate a standard new Keynesian dynamic IS curve modified to include the 'wealth effect' which is derived from the representative households' Euler equation for optimal consumption given by:

$$x_t = E_t x_{t+1} - \sigma^{-1}\left(i_t - E_t\pi_{t+1}\right) + v\ b_t, \qquad \text{[Eqn 1]}$$

where x_t denotes the output gap defined by $x_t = y_t - y_t^n$; y_t represents the log deviation of actual output and y_t^n denotes the log deviation of the full employment output; i_t is the nominal interest rate, which is an operating instrument of the central bank; π_t denotes the inflation rate and b_t denotes the real primary debt. Positive parameter σ is the inverse of the intertemporal elasticity of substitution for consumption and v denotes the consumption out-of-wealth coefficient.[2] Blake and Kirsanova (2004) clearly outlined how an optimal pure FTPL can occur.[3] Leeper (1991) identified this regime as

1. Derivations have been omitted in this article as they are standard in New Keynesian literature, but reference is made to relevant papers for in-depth analysis of relevant derivations.

2. See Blake and Kirsanova (2004) for a detailed derivation of $v = \gamma\left(\gamma + \frac{1-\beta}{\beta}\right)$, where γ denotes mortality rate.

3. $1 - \tau + \frac{v}{\sigma\beta} = 1$ condition from Blake and Kirsanova (2004).

one with 'active' fiscal policy and 'passive' monetary policy. Bhattarai, Lee and Park (2014) provided a series of proofs for all the regimes identified by Leeper (1991), modified to incorporate an inflation targeting regime. This arrangement is consistent with South Africa's monetary policy framework.

Inflation adjustment is represented by the New Keynesian Phillips curve. Firms are subject to monopolistic competition and Calvo (1983)-type staggered nominal price rigidities. Hence, under Calvo pricing, a fraction 1-ω of all firms optimally adjusts their prices, while the remaining fraction of firms ω do not. Furthermore, consistent with Steinsson (2003) and Gali and Gertler (1999), we employ the rule of thumb hypothesis. Among firms that can adjust prices, a fraction λ sets prices optimally, while the remaining fraction 1-λ sets the price based on a rule of thumb, which is given by:

$$P_t^r = P_{t-1}^* \left[\frac{P_{t-1}}{P_{t-2}} \right],$$

where P_t^r denotes the price for firms that use the rule of thumb pricing and P_t^* is optimal price index in period t, and P_t is price index in period t. Under these conditions, we can obtain the following hybrid NKPC[4]:

$$\pi_t = \vartheta_f E_t \pi_{t+1} + \vartheta_b \pi_{t-1} + \delta mc_t, \quad \text{[Eqn 2]}$$

where $\vartheta_f \equiv \omega\beta / \left[\omega + (1-\lambda)\left(1-\omega(1-\beta)\right) \right]$; $\vartheta_b \equiv (1-\lambda) / \left[\omega + (1-\lambda)\left(1-\omega(1-\beta)\right) \right]$ and $\delta \equiv \lambda(1-\omega)(1-\omega\beta) / \left[\omega + (1-\lambda)\left(1-\omega(1-\beta)\right) \right]$. β denotes the discount factor and mc_t denotes the real marginal cost. Inflation is a function of expected future inflation, lagged past inflation and real marginal cost.

Next, we introduce a cost channel in our framework. We follow Ravenna and Walsh (2006) and Chowdhury et al. (2006). Real marginal cost is given by:

$$mc_t = \left(1 + \Psi_i\right) i_t + \left(\sigma + \eta\right) x_t, \quad \text{[Eqn 3]}$$

where Ψ_i denotes the degree of incomplete lending rate pass-through and η denotes the inverse of the elasticity of labour supply. Both parameters are positive. Real marginal cost is now a function of the lending rate since a cost channel is present. Bernanke et al. (1999) emphasised that imperfect lending rate pass-through acts as a kind of a financial accelerator.

Finally, we close the model by introducing a fiscal and monetary policy to our model. Following Woodford (1996) and Blake and Kirsanova (2004), we formulate a debt accumulation equation into the model, where b_{t+1} evolves as follows:

$$b_{t+1} = i_t + \beta^{-1}\left(b_t - \pi_t\right) + \beta^{-1} d_t + \varepsilon_t^f, \quad \text{[Eqn 4]}$$

where d_t denotes real primary deficit. We assume that fiscal authorities conduct fiscal policy using the following feedback rule:

$$d_t = -\tau b_t, \quad \text{[Eqn 5]}$$

where τ denotes the weight fiscal authorities assigned for controlling public debt. Substitution reduces the debt accumulation equation to:

$$b_{t+1} = i_t + \beta^{-1}\left(\left(1-\tau\right) b_t - \pi_t\right) + \varepsilon_t^f, \quad \text{[Eqn 6]}$$

Where ε_t^f represents a fiscal policy shock assumed to be white noise.

We assume the monetary authorities follow a forward-looking policy rule of the Taylor type that treats i_t as an operating tool of monetary policy. The specification allows the central bank to consider a broad array of information to form beliefs about the future condition of the economy (Clarida, Gali & Gertler 2000). The Taylor-type rule calls for adjustment of the rate based on the output gap and a deviation of inflation from the target inflation:

$$i_t = \rho_i i_{t-1} + \left(1-\rho_r\right)\left[\theta_x\left(x_t\right) + \theta_\pi\left(\pi_t - \pi^*\right)\right] + \mu_t^{mp}, \quad \text{[Eqn 7]}$$

where ρ_i denotes an interest rate smoothing parameter; θ_x and θ_π are the relative weights of the importance placed on output and inflation, respectively; π^* is the target rate of inflation; and μ_t^{mp} is an error term representing monetary policy shock assumed to be white noise.

Calibration of model parameters

One of the shortcomings of our theoretical framework is that it conducts simulations based on limited levers of the South African economy. Standard calibrated parameters for the economy have been adopted from the existing literature. Studies by Liu and Gupta (2007), Ortiz and Sturzenegger (2007), Steinbach, Mathuloe and Smit (2009) and Alpanda, Kotze and Woglom (2011) and Liu (2013) provided the standard calibrated parameters of the economy. The focus of this article is not to re-estimate these parameters but rather use them as levers to conduct our simulations, given varying degrees or limits of other parameters we are going to deploy. We acknowledge that the parameters are subject to change over time, given structural changes that the economy might experience. However, there is no reason to believe that there has been a major structural shift of the South African economy between the time these studies were conducted and now. Accordingly, we hold the view that our study results are adequately robust.

All parameters except υ, γ and τ (see Table 1) are borrowed from the existing literature. To gauge the value for υ (the consumption out-of-wealth coefficient), we obtained the value of γ which denotes the mortality rate which can be reasonably estimated as 0.02 as of 2010 (StatsSA 2012). It is important to note that since our analysis will run a series of experiments, certain parameters will have varying degrees of weights for different simulations. This includes τ which denotes the weight on controlling public debt and Ψ_R which

4.See Gali and Gertler (1999) and Steinsson (2003) for a detailed derivation of the NKPC.

denotes the degree of incomplete lending rate. θ_x and θ_π are the relative weights of the importance placed on output and inflation and ρ_i denotes interest rate smoothing parameter.

Simulation results

We ran two sets of experiments simulating two different scenarios of policy application. Experiment 1 was our baseline model. The experiment examined the behaviour of inflation given a certain degree of economic policy shocks under varying degrees of public debt control (tau(τ) = 0.2; 0.5 and 0.99). We set both $\rho_r = 0$ (interest rate smoothing parameter) and $\Psi_i = 0$ (incompleteness of the lending rate) as a benchmark. All the remaining parameters were borrowed from the South African literature and are consistent with the existing New Keynesian literature (see Alpanda et al. 2011; Liu 2013; Liu & Gupta 2007; Ortiz & Sturzenegger 2007; Steinbach et al. 2009). Experiment 2 examines the behaviour of inflation where monetary authorities try to anchor inflation expectations by including policy inertia through interest rate smoothing. Note that this article does not focus on the non-negativity constraint on nominal interest rates. Therefore, strictly speaking, our prescription can be applied to the South African economy.

TABLE 1: Calibrated parameters.

Parameter	Description	Value
β	Consumer subjective discount factor	0.99
σ	The inverse of the intertemporal elasticity of substitution for consumption	2.1
η	The inverse of the elasticity of labour supply	1.5
ω	The degree of price rigidity	0.75
λ	The fraction of firms that set price optimally	0.4
θ_x	Output gap elasticity of REPO rate changes	0.25
θ_π	The factor of the importance of inflation deviation from the target	1.8

Source: Please see the full reference list of the article for more information Liu and Gupta (2007); Ortiz and Sturzenegger (2007); Steinbach et al. (2009); Alpanda et al. (2011) and Liu (2013)

REPO, repurchase agreement.

Experiment 1

Figure 2 shows that a contractionary monetary policy shock generates an increase in inflation. The response of inflation varies with the degree of weight placed by fiscal authorities in controlling public debt. Simulations show that as the value of τ converges towards 0 (weaker control of public debt), the degree of inflation volatility increases. As fiscal authorities put a smaller weight on controlling public debt, the price puzzle emerges. This occurs possibly because a small weight on controlling public debt weakens the demand channel such that monetary policy affects the intertemporal allocation of the demand through a change in the real interest rate. In this case, the cost channel (cost of capital is rising with rising higher real interest rates) dominates the demand channel such that a monetary tightening shock will ultimately generate inflation. This is consistent with what Ravenna and Walsh (2006) put forward regarding the rise in working capital induced by monetary contraction and the inflationary pressure that might have on the economy. The inflation rate declines back to its steady state after about 14 periods. These results imply that the central bank will not fully stabilise inflation just by raising the real interest rate when fiscal authorities put a small weight on controlling public debt.

In our analysis, it is the weakening of the demand channel effect caused by a relatively small weight on control of public debt that causes the price puzzle. So when monetary authorities raise the interest rates, they are simply raising the cost of capital and hence influence the prices in the economy. In Chowdhury et al. (2006) and Castelnuovo (2007), a monetary tightening shock generates the price puzzle only when the parameter Ψ_i takes on a higher value. In contrast to their results, our results show that the price puzzle is present even when we set $\Psi_i = 0$ as our benchmark.

Figure 3 illustrates the impulse response of inflation to a positive fiscal shock, that is, an increase in public debt. The

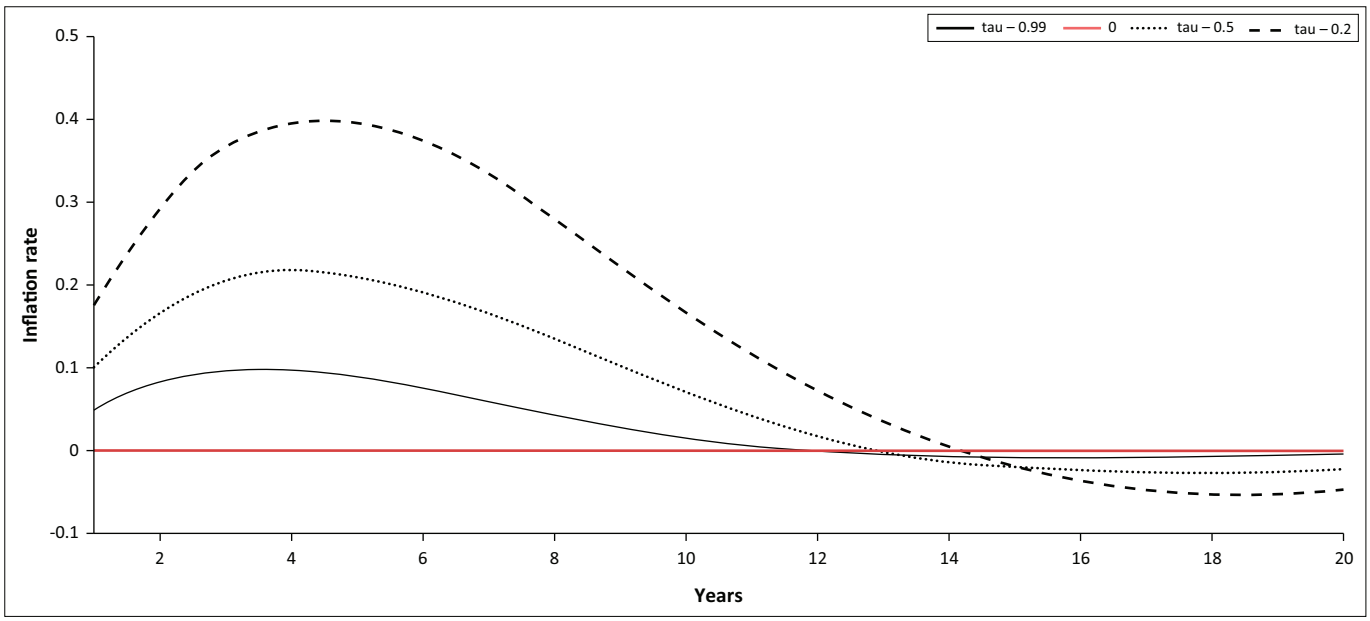


FIGURE 2: Impulse responses of inflation to a monetary tightening policy shock.

simulation results show that a positive fiscal shock generates an even higher inflation rate. The smaller the value of τ, the larger the response of inflation. These simulation results are intuitive. A positive fiscal shock increases the expected inflation rate because the private sector anticipates that a small weight on controlling public debt will aggressively induce the accumulation of more government debt, hence leading to higher inflation in the future to finance this debt.

In addition, when we simulate a more aggressive monetary policy rule aimed at fighting inflation deviating from the target, given varying degrees of control of the public debt, inflation volatility is even greater for both economic shocks. This means a less accommodating monetary policy rule increases the gap between inflation and its target. This is consistent with the theoretical predictions of Bhattarai et al. (2012) and Woodford (1996).

Experiment 2

The second part of our analysis discusses how the price puzzle associated with an accumulation of public debt as discussed above can be eliminated. The literature has come to acknowledge the role of introducing policy inertia through interest rate smoothing (see Castelnuovo 2007). The interest rate smoothing parameter acts as an anchor in stabilising the expected inflation rate. We incorporated the term for interest rate smoothing into the monetary policy rule. The existing Keynesian literature posits that the coefficient for interest rate smoothing ranges between 0.6 and 0.9 (see Clarida et al. 2000). We set the term for interest rate smoothing as 0.6. We set the weights of the relative importance of inflation and output as $\theta_{\pi} = 1.8$; $\theta_{x} = 0.25$. These terms are consistent with the South African literature when modelling monetary policy.

Figure 4 shows the impulse response of inflation to a monetary tightening shock when the central bank employs an interest rate rule modified to include an interest rate smoothing parameter. For simplicity, we considered the case in which the value of τ is equal to 0.2. We chose this smallest weight because it generates the highest inflationary response in our baseline model. The simulation results showed that when monetary authorities employ an interest rate specification with interest rate smoothing, inflation volatilty is drastically reduced. In our case, it fell from a high rate of 0.4% to less than 0.1%. These results posit that a monetary policy rule that includes interest rate smoothing can stabilise the real economy to some extent even if fiscal authorities put a small weight on controlling public debt. These simulation results appeared to support the literature about interest rate smoothing anchoring inflation expectations.

Figure 5 shows the impulse response of the inflation rate to the same positive fiscal shock, an increase in public debt under a monetary policy specification with interest rate smoothing. The results posit that the response of inflation is relatively smaller under a monetary policy rule with interest rate smoothing than in the case without interest rate smoothing. The results imply that an interest rate smoothing parameter can reinforce the demand channel because the presence of the lagged interest rate in a monetary policy specification can stabilise expectations about future inflation, and hence the price puzzle may possibly be eliminated, depending on the degree of interest rate smoothing and weight on control of the public debt.

Based on our analysis in both Experiments 1 and 2, it can be concluded that a small weight on controlling public debt in a fiscal policy rule induces an increase in the inflation rate given a monetary contractionary or a positive fiscal policy shock. A less accomodating monetary policy rule induces more inflation volatility. Interest rate smoothing helps to mitigate inflationary pressure by anchoring expectations.

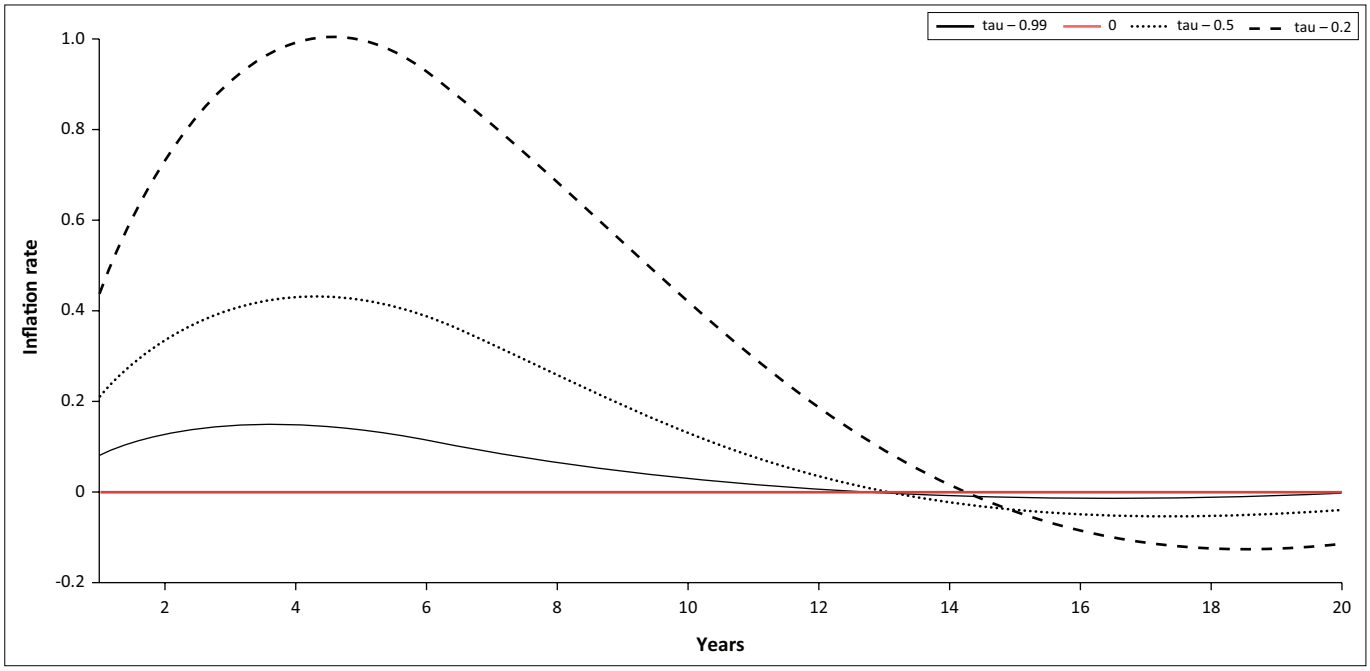


FIGURE 3: Impulse responses of inflation to a positive fiscal policy shock.

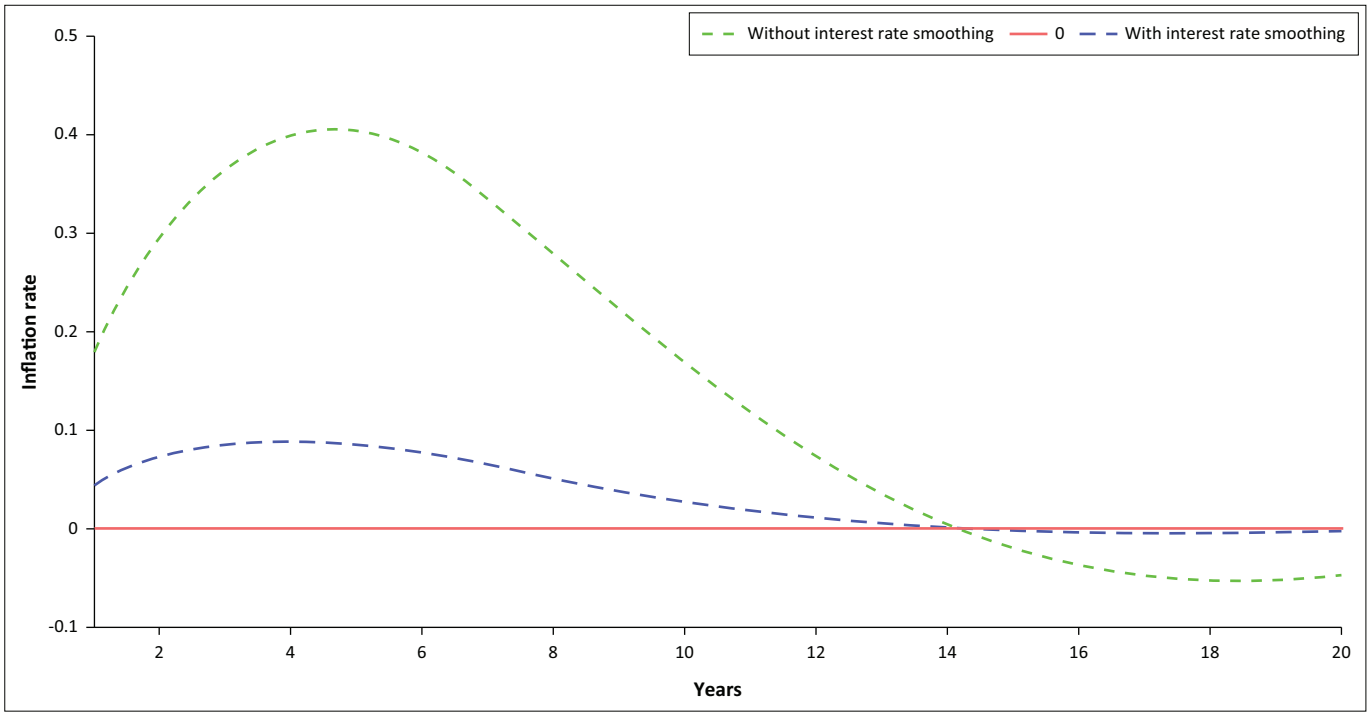


FIGURE 4: Impulse responses of inflation to a monetary tightening shock ($\tau = 0.2$).

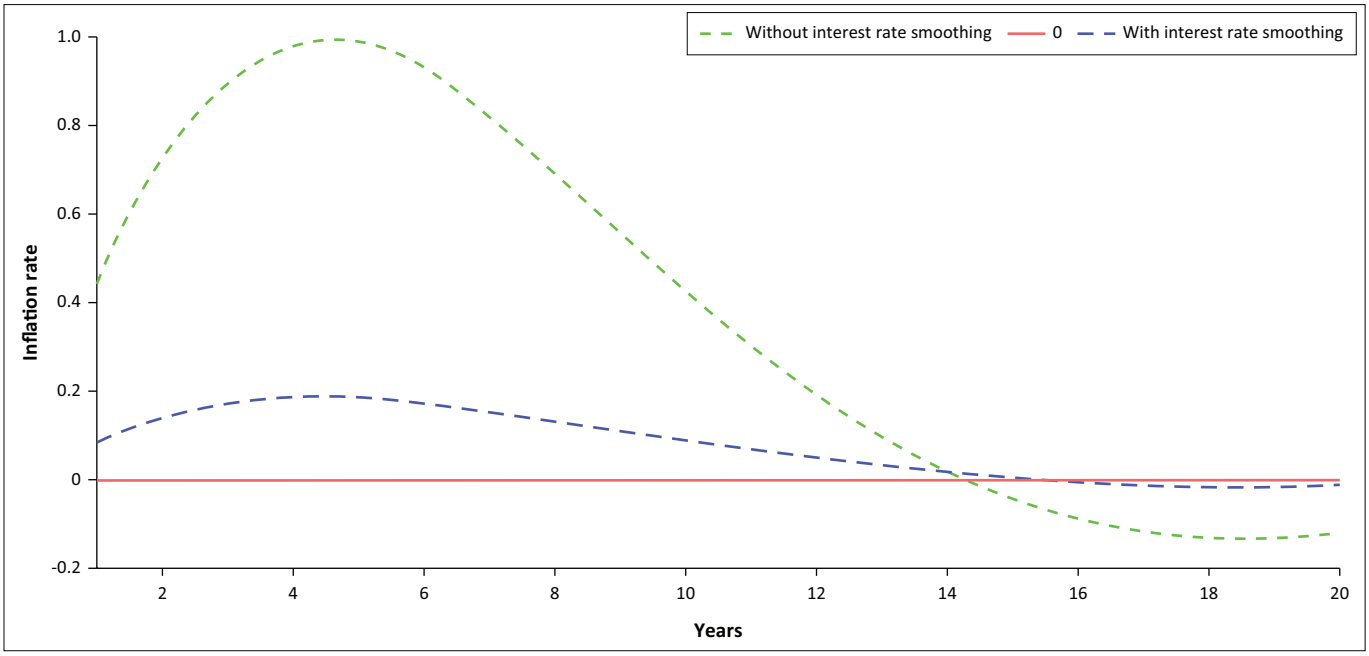


FIGURE 5: Impulse responses of inflation to a fiscal shock ($\tau = 0.2$).

However, it is not a silver bullet. Continuous acceleration of public debt will ultimately create inflationary pressure based on the dominance of the demand channel and cost channel, and the central bank will not have an effective instrument for fighting inflation.

Although our experiments have intuitively meaningful implications, it would be imperative if these experiments were conducted as per the fiscal policy rules with explicit debt limits or thresholds by fiscal authorities. Although based on some standardised calibrated parameters for the South African economy, a gap exists for exploring the debt limit that will see monetary authorities have significant power of control over inflation dynamics in the South African economy. We recommend research on the debt ceiling or debt threshold that will be appropriate for the South African economy, given the mandate of the monetary authority's inflation target policy of 3% – 6%.

Conclusion

This study was carried out to investigate the theoretical relationship between inflation dynamics and the stance of fiscal policy. Focusing on the role of public debt, this study employed a standard NKDSGE model with financial frictions to mimic the structural nature of the South African economy.

Our results showed that inflation significantly increases in response to economic shocks when fiscal authorities put a small weight on controlling public debt. This highlighted the existence of elements of a price puzzle in monetary policy analysis for the South African economy. An interest rate smoothing parameter was seen to reduce the response of inflation to the economic shocks by anchoring expectations. These results highlighted the importance of fiscal discipline and its potential adverse effects on monetary authorities' ability to achieve price stability as set out in its monetary framework.

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Competing interests

The authors have declared that no competing interest exists.

Authors' contributions

S.D.S. conceptualised the topic and the study area for a bigger project. H.N. put together the article from the bigger project.

Ethical considerations

Ethical clearance to conduct this study was obtained from the University of KwaZulu-Natal Humanities and Social Sciences Research Ethics Committee (ref. no. HSS/1468/016M).

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Data availability

This study employs a calibrated model. As such, data sharing is not applicable since no new data were analysed.

Disclaimer

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References

Abizadeh, S., Benarroch, M. & Yousefi, M., 1996, 'A multilevel government model of deficits and inflation', *Atlantic Economic Journal* 24(2), 118–130. https://doi.org/10.1007/BF02299002

Adusei, M., 2013, 'Is inflation in South Africa a structural or monetary phenomenon?', *British Journal of Economics, Management and Trade* 3(1), 60–72. https://doi.org/10.9734/BJEMT/2013/2553

Aiyagari, R. & Gertler, M., 1985, 'The backing of government debt and monetarism', *Journal of Monetary Economics* 16(1), 19–44. https://doi.org/10.1016/0304-3932(85)90004-2

Akinboade, O.A., Niedermeier, E.W. & Siebrits, F.K., 2002, 'The dynamics of inflation in South Africa: Implications for policy', *South African Journal of Economics* 70(3), 213–223. https://doi.org/10.1111/j.1813-6982.2002.tb01300.x

Alpanda, S., Kotze, K. & Woglom, G., 2011, 'Forecasting performance of an estimated DSGE model for the South African economy', *South African Journal of Economics* 79(1), 50–67. https://doi.org/10.1111/j.1813-6982.2011.01260.x

Anoruo, E.C., 2003, 'An empirical investigation into the budget deficits-inflation Nexus in South Africa', *The South African Journal of Economics* 71(2), 282–296. https://doi.org/10.1111/j.1813-6982.2003.tb01309.x

Barro, R.J., 1989, 'The neoclassical approach to fiscal policy', in R.J. Barro (ed.), *Modern business circle theory*, pp. 178–235, Harvard University Press, Cambridge, MA.

Barro, R.J., 1996, 'Inflation and growth', *Federal Reserve Bank of St. Louis Review* 78(3), 153–169. https://doi.org/10.20955/r.78.153-169

Bernanke, B.S., Gertler, M. & Gilchrist, S., 1999, 'The financial accelerator in a quantitative business cycle framework', in J.B. Taylor & M. Woodford (eds.), *Handbook of macroeconomics*, pp. 1341–1393, vol. 1C, Elsevier Science, Amsterdam.

Bhattarai, S., Lee, J.W. & Park, W.Y., 2014, 'Inflation dynamics: The role of public debt and policy regimes', *Journal of Monetary Economics* 67(4), 93–108. https://doi.org/10.1016/j.jmoneco.2014.07.004

Blake, A.P. & Kirsanova, T., 2004, 'A note on timeless perspective policy design', *Economics Letters* 85(1), 9–16. https://doi.org/10.1016/j.econlet.2004.03.009

Blinder, A.S., 1999, *Central bank credibility: Why do we care? How do we build it?*, NBER Working Paper No. 7161, National Bureau of Economic Research, Cambridge, MA.

Burger, P. & Marinkov, M., 2006, 'The South African Phillips Curve: How applicable is The Gordon Model?', *South African Journal of Economics, Economic Society of South Africa* 74(2), 172–189. https://doi.org/10.1111/j.1813-6982.2006.00062.x

Calvo, G., 1983, 'Staggered prices in a utility-maximizing framework', *Journal of Monetary Economics* 12(1), 383–398. https://doi.org/10.1016/0304-3932(83)90060-0

Castelnuovo, E., 2007, *Cost channel and the price puzzle: The role of interest rate smoothing*, Mimeo, New York, NY.

Castro, R., De Resende, C. & Ruge-Murcia, F., 2003, *The backing of government debt and the price level*, CIREQ Working Paper No. 16-2003, The Centre for Interuniversity Research in Quantitative Economics, Montreal.

Catão, L.A.V. & Terrones, M.E., 2005, 'Fiscal deficits and inflation', *Journal of Monetary Economics* 52(3), 529–554. https://doi.org/10.1016/j.jmoneco.2004.06.003

Chowdhury, I., Hoffman, M. & Schabert, A., 2006, 'Inflation dynamics and the cost channel of monetary policy transmission', *European Economic Review* 50(1), 995–1016. https://doi.org/10.1016/j.euroecorev.2005.01.007

Christiano, L.J. & Fitzgerald, T.J., 2000. 'Understanding the fiscal theory of the price level', *Economic Review, Federal Reserve Bank of Cleveland*, issue Q II, 2–38.

Clarida, R., Gali, J. & Gertler, M., 2000, 'Monetary policy rules and macroeconomic stability: Evidence and some theory', *Quarterly Journal of Economics* 115(1), 147–180. https://doi.org/10.1162/003355300554692

Cochrane, J.H., 2001, 'Long-term debt and optimal policy in the fiscal theory of the price Level', *Econometrica* 69(1), 69–116.

Cochrane, J.H., 2005, 'Money as stock', *Journal of Monetary Economics* 52(3), 501–528. https://doi.org/10.1016/j.jmoneco.2004.07.004

Darrat, A.F., 2000, 'Are budget deficits inflationary? A reconsideration of the evidence', *Applied Economics Letters* 7(10), 633–636. https://doi.org/10.1080/135048500415914

Fischer, S. & Easterly, W., 1990, 'The economics of the government budget constraint, *World Bank Research Observer* 5(2), 127–142. https://doi.org/10.1093/wbro/5.2.127

Gali, J. & Gertler, M., 1999, 'Inflation dynamics', *Journal of Monetary Economics* 44(1), 195–222. https://doi.org/10.1016/S0304-3932(99)00023-9

Gonçalves, C. & Salles, J., 2008, 'Inflation targeting in emerging economies: What do the data say?', *Journal of Developmental Economics* 85(1–2), 312–318. https://doi.org/10.1016/j.jdeveco.2006.07.002

Gordon, D. & Leeper, E., 2002, *The price level, the quantity theory of money, and the fiscal theory of the price level*, NBER Working Paper No. 9084, National Bureau of Economic Research, Cambridge, MA.

Gupta, R. & Uwilingiye, J., 2010, 'Dynamic time inconsistency and the South African Reserve Bank', *South African Journal of Economics* 78(1), 77–88. https://doi.org/10.1111/j.1813-6982.2010.01234.x

Hamilton, L. & Viegi, N., 2009, 'Debt, democracy and representation in South Africa', *Representation* 45(1), 191–209. https://doi.org/10.1080/00344890902945798

Hossain, A.A. & Chowdhury, A., 1998, *Open-economy macroeconomics for developing countries*, Edward Elgar Publishing, Cheltenham.

Ida, D., 2013, 'Public debt and inflation dynamics in a sticky price model', *International Journal of Business* 18(4), 351–358.

International Monetary Fund (IMF), 2005, *World economic outlook: September 2005: Building institutions*, International Monetary Fund (IMF), Washington, DC.

Kahn, B. & De Jager, S., 2011, 'An assessment of inflation targeting and its application in South Africa', *Economic History of Developing Regions* 26(S1), 73–93. https://doi.org/10.1080/20780389.2011.586409

Kwon, G., McFarlane, L. & Robinson, W., 2006, *Public debt, money supply, and inflation: A cross-country study and its application to Jamaica*, International Monetary Fund, Washington, DC. WP/06/121.

Kydland, E. & Prescott, E.C., 1977, 'Rules rather than discretion: The inconsistency of optimal plans', *Journal of Political Economy* 85(3), 473–491. https://doi.org/10.1086/260580

Leeper, E.M., 1991, 'Equilibria under "active" and "passive" monetary and fiscal policies', *Journal of Monetary Economics* 27(1), 129–147. https://doi.org/10.1016/0304-3932(91)90007-B

Lin, S. & Ye, H., 2009, 'Does inflation targeting make a difference in developing countries?', *Journal Development Economics* 89(1), 118–123. https://doi.org/10.1016/j.jdeveco.2008.04.006

Liu, G., 2013, 'Will the SARB always succeed in fighting inflation with contractionary policy?', *South African Journal of Economics* 81(3), 330–340. https://doi.org/10.1111/j.1813-6982.2012.01327.x

Liu, D.G. & Gupta, R., 2007, 'A small-scale DSGE model for forecasting the South African Economy', *South African Journal of Economics* 75(2), 179–193. https://doi.org/10.1111/j.1813-6982.2007.00118.x

Malikane, C., 2013, *A New Keynesian triangle Phillips Curve,* Munich Personal RePEc Archive, MPRA Paper No. 43548, University Library of Munich, Munich.

Narayan, P.K., Narayan, S. & Prasad, A.D., 2006, 'Modelling the relationship between budget deficits, money supply and inflation in Fiji', *Pacific Economic Bulletin* 21(2), 103–116.

Ngalawa, H. & Komba, C., 2020, *Inflation, output and monetary policy in South Africa*, Working Papers 398, African Economic Research Consortium (AERC), Research Department, Nairobi.

Ngalawa, H. & Viegi, N., 2013, 'Interaction of formal and informal financial markets in quasi-emerging market economies', *Economic Modelling* 31(1), 614–624. https://doi.org/10.1016/j.econmod.2013.01.005

Ortiz, A. & Sturzenegger, F., 2007, 'Estimating SARB's policy reaction rule', *South African Journal of Economics* 75(1), 659–680. https://doi.org/10.1111/j.1813-6982.2007.00146.x

Peiris, S. & Saxegaard, M., 2007, *An estimated DSGE model for monetary policy analysis in low-income countries*, Working Paper Series No. WP/07/282, International Monetary Fund, Washington DC.

Ravenna, F. & Walsh, C.E., 2006, 'Optimal monetary policy with the cost channel', *Journal of Monetary Economics* 53(1), 199–216. https://doi.org/10.1016/j.jmoneco.2005.01.004

Rogoff, K., 1985, 'The optimal degree of commitment to an intermediate monetary target', *Quarterly Journal of Economics* 100(4), 1169–1189. https://doi.org/10.2307/1885679

Saleh, A.S. & Harvie, C., 2005, 'The budget deficits and economic performance', *The Singapore Economic Review* 50(2), 211–243. https://doi.org/10.1142/S0217590805001986

Sargent, T.J. & Wallace, N., 1981, 'Some unpleasant monetarist arithmetic', *Federal Reserve Bank of Minneapolis Quarterly Review* 5(3), 1–17. https://doi.org/10.21034/qr.531

Sims, C.A., 1994, 'A simple model for the study of the determination of the price level and the interaction of monetary and fiscal policy', *Economic Theory* 4(3), 381–399. https://doi.org/10.1007/BF01215378

South African Reserve Bank, 2017, *South African Reserve Bank Website*, South African Reserve Bank, Pretoria.

Statistics South Africa, 2012, *Census 2011: Census in brief*, Statistics South Africa, Pretoria.

Steinbach, M.R., Mathuloe, P.T. & Smit, B.W., 2009, 'An open economy New Keynesian DSGE model of The south African economy', *South African Journal of Economics, Economic Society of South Africa 77*(2), 207–227.

Steinsson, J., 2003, 'Optimal monetary policy in an economy with inflation persistence', *Journal of Monetary Economics* 50(1), 1425–1456. https://doi.org/10.1016/j.jmoneco.2003.08.008

Svensson, L., 1997, 'Inflation forecast targeting: Implementing and monitoring inflation targets', *European Economic Review* 41(6), 1111–1146. https://doi.org/10.1016/S0014-2921(96)00055-4

Swanepoel, J.A., 2006, 'Do international economic developments affect the South African economy?', *South African Journal of Economics and Management Sciences* 9(1), 128–148. https://doi.org/10.4102/sajems.v9i1.1162

Tanzi, V., 1993, 'Fiscal issues in adjustment programs', in R. Faini & J. De Melo (eds.), *Fiscal issues in adjustment in developing countries*, pp. 21–42, Palgrave Macmillan, London.

Tekin-Koru, A. & Özmen, E., 2003, 'Budget deficits, money and inflation: The Turkish experience', *Applied Economics* 35(5), 591–596. https://doi.org/10.1080/0003684022000025440

Tovar, C., 2008, *DSGE models and central banks*, BIS Working Paper Series WP No. 258, Bank for International Settlements, Basel.

Vamvoukas, G.A., 1998, 'The relationship between budget deficits and money demand: Evidence from a small economy', *Applied Economics* 30(1), 375–382. https://doi.org/10.1080/000368498325895

Van der Merwe, E., 2004, *Inflation targeting in South Africa*, Occasional Paper No. 19, SARB, Pretoria.

Van der Merwe, E.J., 1993, *Is South Africa in a debt trap?*, Occasional Paper No. 6, South African Reserve Bank, Pretoria.

Vieira, C., 2000, *Are fiscal deficits inflationary? Evidence from EU*, Economic Research Paper, No. 00/7, Loughborough University, Reino Unido.

Woodford, M., 1994, 'Monetary policy and price level determinacy in a cash-in-advance economy', *Economic Theory* 4(3), 345–380. https://doi.org/10.1007/BF01215377

Woodford, M., 1996, *Control of the public debt: A requirement for price stability?*, NBER Working Papers 5684, National Bureau of Economic Research, Inc, Cambridge, MA.

Woodford, M., 2001, 'Fiscal requirements for price stability', *Journal of Money, Credit and Banking* 33(3), 669–728. https://doi.org/10.2307/2673890

Wray, L.R., 2015, 'Deficits, inflation, and monetary policy', *Journal of Post Keynesian Economics* 19(4), 543–571. https://doi.org/10.1080/01603477.1997.11490128