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The short-term costs of reducing trend inflation in South Africa

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Abstract

South Africa's inflation target remains well above the emerging market average. This imposes unnecessary costs on households, firms and economic growth. Benefits to lowering the inflation target to the emerging market average include better predictability of investment and savings returns and clearer relative price signals. The policy discussion in South Africa, however, tends to focus on the short-term transition costs of lowering inflation, while ignoring the medium- to long-run benefits of a permanently lower inflation rate. We employ two approaches to calculate the sacrifice ratio for South Africa to get a clearer view of the costs of reducing the inflation rate. The trend analysis approach developed by Ball (1994) shows that the most recent reduction in trend inflation (2016–2019) was not associated with output losses from policy setting. The structural vector autoregression approach developed by Cecchetti and Rich (2001) similarly produces a very low sacrifice ratio of just over 0.5 for the whole post-apartheid period. Using statistical methods, we further show that lower headline inflation will also reduce administrative price inflation. This can contribute to clearer relative price signals in the economy.

JEL classification: E52, E58

Keywords: sacrifice ratio, inflation, inflation targeting

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1. Introduction

South Africa's inflation target remains high relative to many emerging markets, which mostly have point targets of around 3%. This is an unambiguous cost to the economy over time. The benefits of lowering the inflation target to the emerging market average include better predictability of investment and savings returns and clearer relative price signals that support economic growth (De Gregorio 1992; Frenkel and Mehrez 2000).[1]

The public debate, however, tends to focus on the short-term transition costs, while ignoring the medium- to long-run benefits. These short-run costs are known as the 'sacrifice ratio', a measure of the output loss due to a percentage point decline in inflation.

When inflation is moderate and high, sacrifice ratios are usually thought of as being low and far below the permanent gains that are achieved by low real interest rates, more competitive price levels and more certainty about future inflation rates – all of which improve investment and productivity growth.

The primary reason, both conceptually and empirically, for the trade-off between disinflation and output is that inflation can be persistent (Mankiw 2001). Where economic agents are insensitive to forecasts of lower inflation, monetary authorities must increase the policy rate to slow aggregate demand growth to create temporary slack in the economy to reduce inflation (Cecchetti and Rich 2001). There are various drivers of price inertia. These include wage and price rigidities, which lengthen the adjustment process as nominal wage growth or price inflation decelerates only slowly. A more adaptive, or backward-looking, formation of inflation expectations also slows down the disinflationary process as it takes time for people and firms to adjust their expectations. More forward-looking expectations reduce inertia and the trade-off between inflation and output (Belke and Böing 2014). Finally, a lack of central bank commitment to keeping inflation low increases inertia and the size of the sacrifice ratio.

The credibility of central banks' inflation forecast is therefore a powerful tool to decrease inflation and reduce the economic costs of disinflation. This applies even in the presence of wage and price rigidities. In the model developed by Ball (1995), a fully

[1] See also Fischer and Modigliani (1978) for a discussion of the real effects and costs of inflation.

credible central bank can impact inflation instantaneously as economic agents renew contracts that embed inflation projections. Firms reduce their price increases in anticipation of further disinflation. Inflation falls even though most contract terms remain fixed. Even under incomplete rationality and price and wage rigidities, central bank credibility can eliminate any short-term output costs if the disinflation period is preannounced or phased gradually (Chadha, Masson, and Meredith 1992), a technical point that has been backed up by the lived experiences of many economies (and helps to account for the robust popularity of adopting inflation targets).

In this paper, we review the determinants of the sacrifice ratio identified in the literature and the different approaches to calculating it. We highlight some recent inflation trends and calculate sacrifice ratios using two different methodologies. Administrative prices are often seen as a major obstacle to reducing trend inflation, so we also discuss the two-way relationship between headline inflation and administrative price inflation.

Our analysis shows that the sacrifice ratio is small and at times close to zero. This finding is mirrored in recent literature, which shows increased central bank credibility, more forward-looking inflation expectations and low exchange rate pass-through.[2] Each of these can also be strengthened if the policy is defined further. The most recent episode of lowering trend inflation in South Africa from 6% to 4.5% was achieved with a negative sacrifice ratio, indicating that there were no output losses. Our analysis also shows that administered prices are less of a problem in reducing trend inflation as lower headline inflation also decreases administered price inflation, while preserving relative price changes and making them clearer. For some administered prices, changes to the regulatory methodology can improve relative price signals and reduce administered price inflation.

2. Determinants of the sacrifice ratio

Several factors determine the size of the sacrifice ratio, in addition to the nature of inflation expectations. These include the speed of disinflation; the presence of an inflation targeting regime and the extent of central bank independence; the size of government debt; the relative trade openness of an economy and the size of exchange

[2] See for example Coco and Viegi (2020) and Reid and Siklos (2020).

rate pass-through; and the structure of labour markets and the wage-setting process. In this section, we discuss these determinants.

2.1 Speed of disinflation

Inflation outcomes can be a function of what people believe future inflation will be, and hence, of how policy and other factors shape the formation of expectations. More rapid disinflation can reduce the sacrifice ratio by signalling a strong central bank commitment, which leads to faster convergence in inflation expectations (Sargent 1983). In the presence of large nominal rigidities that are formed by backward-looking expectations or institutional barriers to price adjustments, however, rapid disinflation can produce large output losses (Taylor 1983). Nonetheless, the empirical evidence suggests that higher initial inflation and more rapid disinflation tend to reduce the sacrifice ratio (Brumm and Krashevski 2003; Fischer 1996; Jordan 1997; Katayama, Ponomareva, and Sharma 2019; Magkonis and Zekente 2020). This finding holds across different measures of the sacrifice ratio (Mazumder 2014b).[3]

2.2 Central bank independence

More independent central banks tend to have higher credibility that they will achieve their inflation goals, which in turn makes anchoring inflation expectations easier and leads to a lower sacrifice ratio. Earlier studies often found little connection between central bank independence and the size of the sacrifice ratio. Posen (1998), for instance, studied the impact of central bank independence in a sample of 17 Organisation for Economic Co-operation and Development (OECD) countries from 1950 to 1989 and found that more independence is not associated with higher credibility or a lower sacrifice ratio. One explanation for this outcome is that higher independence cannot generate a credibility bonus without a rules-bound and constrained fiscal policy. Independence and its effect on the sacrifice ratio can,

[3] Mazumder (2014b) finds, however, that the relationship does not hold when using core rather than headline inflation. The difference between headline and core is driven by supply shocks that help to reduce headline inflation but not core inflation. An alternative explanation is that most central banks target headline inflation and wage contracts are based on expectations of headline inflation, making it easier to reduce headline inflation more rapidly.

however, be strengthened by combining legal independence with policy instrument independence (Debelle and Fischer 1994).[4,5]

Alternatively, more recent literature finds that greater central bank independence, like having a formal inflation target, reduces output losses.[6] Central bank credibility increases the probability of having a successful disinflationary episode (Boschen and Weise 2001). Cukierman (2002) argues that, even if the relationship between central bank independence and disinflationary costs is positive, greater independence of central banks increases the probability that inflation targets are met, which improves welfare. Central bank independence also appears to be particularly important for reducing disinflationary costs in non-OECD countries (Mazumder 2014a).

2.3 Openness and exchange rate pass-through

The impact of trade openness on the sacrifice ratio can be positive or negative depending on certain economic and institutional factors, as the wide-ranging literature shows. Daniels and VanHoose (2006) argue that higher openness exposes imperfectly competitive firms to more competition, reducing their pricing power and increasing the observed responsiveness of output to changes in the inflation rate. In the model developed by Razin and Loungani (2005), openness reduces the responsiveness of consumption to changes in the output gap, which increases the sacrifice ratio. Badinger (2009) and Daniels, Nourzad, and VanHoose (2005) show empirically in cross-sectional studies that more open economies tend to have higher sacrifice ratios.[7]

In the theoretical model developed by Romer (1993), more open economies have larger negative terms of trade effects from a real exchange rate depreciation caused by expansionary monetary policy. This steepens the Phillips curve, when expectations are adaptive, and reduces the sacrifice ratio. Bowdler (2009) provides empirical

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4 Goal independence refers to whether central banks set their policy goal independently. Instrument independence refers to whether central banks can decide on their own which instrument to use to achieve the policy goal.

5 The relationship between central bank independence and the sacrifice ratio also depends on how independence is measured and on other proxy indicators used in the analysis. Legally defined independence is not always an indicator of true independence, and so can generate misleading results. For example, even if central bank independence is written in law, there is no true independence in the presence of fiscal dominance. Other country characteristics such as the share of government-controlled prices also affect the impact of central bank independence on the sacrifice ratio.

6 For a review of the literature, see Cukierman (1992) and Magkonis and Zekente (2020).

7 See also Magkonis and Zekente (2020).

support to show that a higher level of openness is associated with a lower sacrifice ratio. Mazumder (2014a) finds that more open non-OECD economies have lower sacrifice ratios.

These differences in results are explained by specific country characteristics that change the relationship between openness and the sacrifice ratio. In countries with stronger central bank independence, openness tends to have a positive effect on the sacrifice ratio (Daniels, Nourzad, and VanHoose 2005). Controlling for political regimes, as in Carporale and Carporale (2008), also generates a positive relationship. Higher mark-ups tend to reduce the impact of openness (Neiss 2001). Other important elements include labour market structures and the progressivity of income taxation.[8]

Introducing exchange rate dynamics in the analysis of sacrifice ratios reduces the impact of openness. Higher exchange rate pass-through is associated with a higher sacrifice ratio. This result holds across different specifications, with higher union density and multiple-year wage contracting further amplifying the exchange rate impact on the sacrifice ratio (Daniels and VanHoose 2013). In summary, the microeconomic and institutional factors that are associated with persistence in prices worsen the sacrifice ratio.

2.4 Labour market structures

The structure of labour markets and the wage-setting mechanism have important implications for inflation inertia and thus the sacrifice ratio, a core finding of economic analysis going back to the late 1970s experience with high inflation. In the model developed by Calmfors and Driffill (1988), the relationship between the degree of centralised wage-setting and the equilibrium rate of unemployment is hump-shaped. The framework assumes that all workers are unionised and compares the unemployment outcomes under different wage-setting regimes at firm level, at industry level and at the level of the economy as a whole. These different levels are associated with different levels of inflation inertia. When wage negotiations take place on an economy-wide level, unions are more likely to recognise that wage moderation for one set of workers is occurring alongside economy-wide moderation. This leaves relative

[8] See Bowdler and Nunziata (2010) and Daniels and VanHoose (2009).

wages unchanged and reduces the costs of nominal adjustments (Bowdler and Nunziata 2010).

The frequency of wage adjustments and types of wage contracting also affect the cost of disinflation. For example, three-year staggered contracts make wages more rigid and increase the costs of disinflation (Bruno and Sachs 1985). Ball (1994) provides empirical support for the argument that more flexible wage-setting is associated with lower disinflation costs. In a more recent study, Bowdler and Nunziata (2010) find, for a set of OECD countries, that coordination between wage setters reduces the sacrifice ratio as it supports moderation in nominal wages to reduce inflation. At the same time, higher employment protection increases the sacrifice ratio.

2.5 Government debt

Government debt is an important determinant of disinflation costs in emerging market and developing countries. More indebted countries have a greater incentive to maintain high inflation to reduce the real stock of debt. This makes it difficult to convince the private sector that government is committed to lower inflation. However, the analyses of Goncalves and Carvalho (2009) and Roux and Hofstetter (2014) suggest that the ratio of public debt to gross domestic product (GDP) is not an important determinant of the sacrifice ratio. Surprisingly, Mazumder (2014a) finds that, even in non-OECD countries, higher government debt is not associated with a higher sacrifice ratio. The study does not control for debt threshold effects but assumes that any increase in debt is likely to reduce government's commitment to lowering inflation. However, the negative effects of sovereign debt generally occur only at high levels of government debt when the trajectory is perceived as unsustainable. The results can therefore reflect that much of the increase in government debt over the period was perceived to be sustainable. On balance, then, debt increases below some thresholds are less inflationary and, with increased central bank independence and credibility, reduce concern that inflation will rise.

3. Why is the sacrifice ratio likely to be small in South Africa?

A range of studies suggests that South Africa has a low sacrifice ratio. In this section, we look at those results and the country-specific characteristics that give rise to them.

Gereziher and Nuru (2021) calculate the cost of disinflation in South Africa and find that the average sacrifice ratio between 1998 and 2019 is 0.031, with a minimum value of zero and maximum value of 0.23. Kabundi, Schaling, and Some (2016) find a higher sacrifice ratio, but one that has decreased from 3.1 in 1990 to between 1 and 1.5 after the global financial crisis (GFC).

Botha, Kuhn, and Steenkamp (2020) show that inflation expectations play a much bigger role in explaining inflation than measures of slack do. Stronger central bank credibility and more anchored inflation expectations have contributed to flattening the Phillips curve, while still preserving the role of monetary policy as a tool to manage aggregate demand (Barnichon and Mesters 2021). This suggests a different interpretation of the Phillips curve results that is more consistent with a lower sacrifice ratio, which is simply that greater credibility of monetary policy has improved the effectiveness of policy communications. As a result, inflation has moderated because expectations have been better managed and guided rather than because of any output loss.[9] This highlights the role of communication and the inflation expectations as an increasingly important channel of monetary policy transmission.

Has the central bank's credibility and communication improved? Coco and Viegi (2020) use several techniques to assess the implicit inflation target, the effectiveness of the South African Reserve Bank's (SARB's) communication, and the predictability and credibility of monetary policy. The results show improved communication and credibility since 2014, which is reflected in lower responsiveness of forward market rates to repo rate changes. Kabundi and Mlachila (2018) also find that credibility has increased, reducing the exchange rate pass-through. Generally, lower and more stable inflation in South Africa tends to reduce the impact of exchange rate changes on headline inflation (Jooste and Jhaveri 2014).[10] This also illustrates the mutually reinforcing nature of multiple factors that work together to reduce the sacrifice ratio.

The exchange rate pass-through effect is amplified by trade and financial openness. Despite trade policy becoming more protectionist through trade tariffs and non-tariff

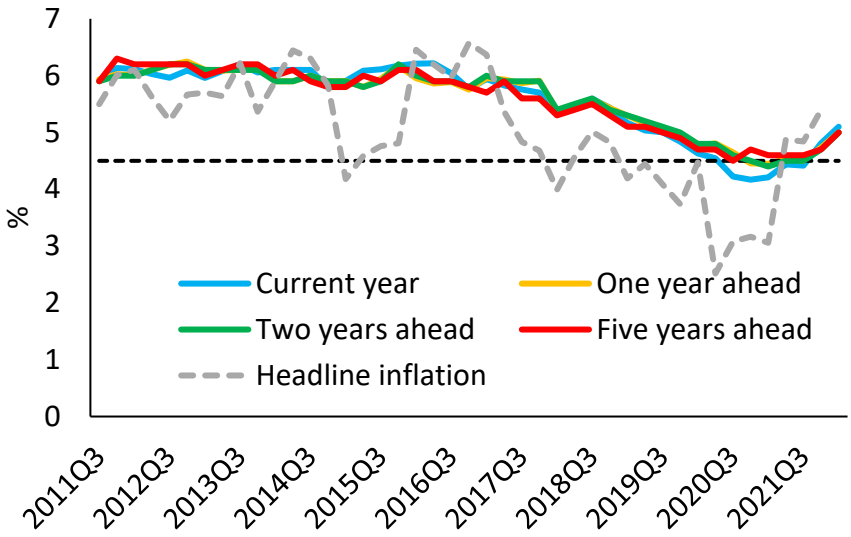
9 There are also other factors that explain the slope of the Phillips curve. These include, for example, mismeasurement of economic slack, the behaviour of imported inflation or the reduced sensitivity of certain inflation items to the business cycle. See, for example, Blinder et al. (2008).

10 The reduction in exchange rate pass-through is also supported by the empirical estimates of Kabundi and Mbelu (2018) and Aron et al. (2014).

barriers,[11] the South African economy remains relatively open. South Africa also has a well-developed financial sector with deep and liquid financial markets.

Inflation expectations have become more forward-looking. Miyajima and Yetman (2018) show that the SARB has become more effective in anchoring inflation expectations of analysts (Figure 1). Reid and Siklos (2021) estimate Phillips curves for firms and analysts. The results show that both groups have forward-looking expectations, though the coefficient for analysts is larger. Greater central bank credibility, along with more forward-looking inflation expectations, increases the impact of central bank communication on inflation and inflation inertia.[12]

Figure 1: Headline inflation and inflation expectations



Source: BER and Stats SA

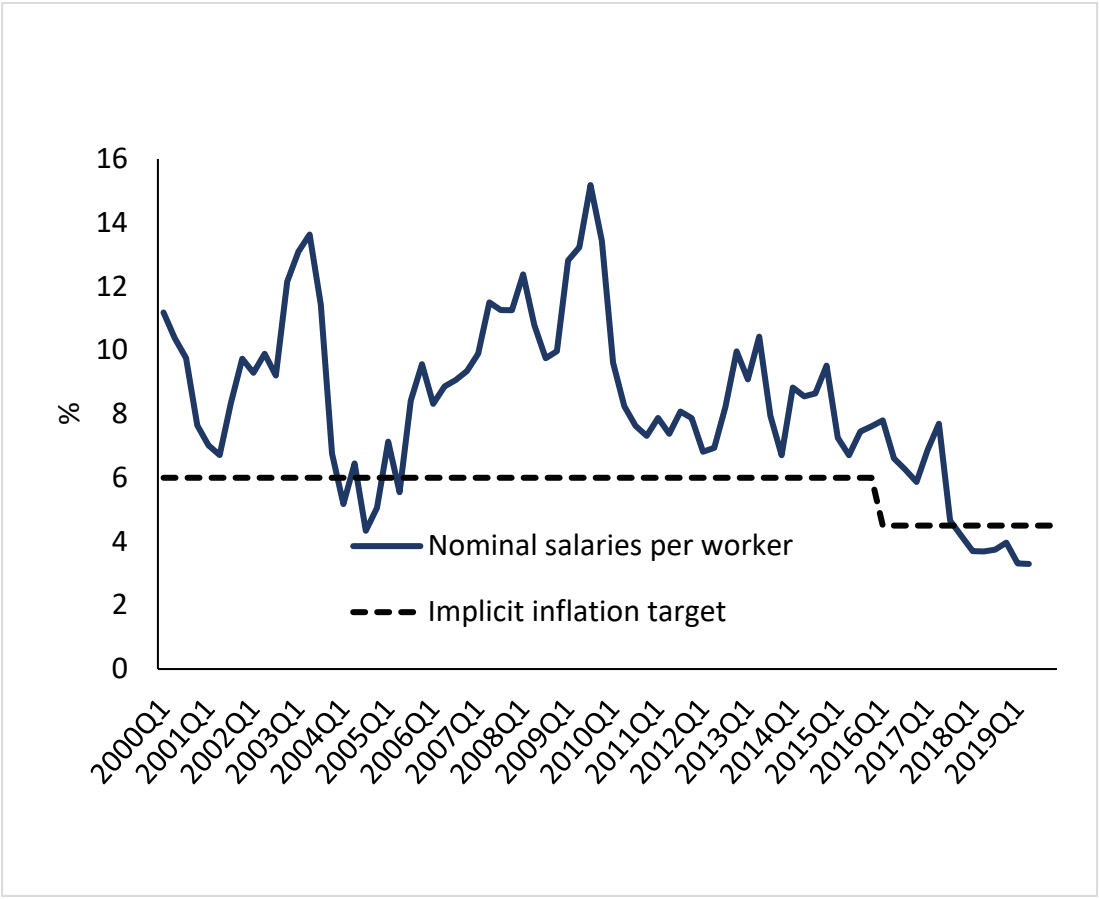
The size of the sacrifice ratio also depends on labour market structures and how wages are set. The South African labour market is often characterised as inflexible with very high firing costs and wages, which are unresponsive to employment conditions (Loewald, Makrelov, and Wörgötter 2021; Viegi and Dadam 2020). Under these conditions, the inflation-unemployment trade-off is normally high, increasing the cost of disinflation. However, since 2017, private sector wage determination appears to

11 See, for example, Stern and Ramkolowan (2021).

12 See Eggertsson and Woodford (2003) for a discussion on the relationship between communication, inflation expectations and actual inflation.

have become more responsive to the slowing economy, highlighting the importance of nominal wage indexation in inflation outcomes. This further suggests that disinflation costs have eased in recent years. Public sector agreements, which were well above inflation in the past, are also now below inflation and the current midpoint of the inflation target. Public sector wage increases were 1.5% in 2021 according to the Andrew Levy Wage Settlement Survey, while those in the steel and engineering sector were 7%. Figure 2 shows growth in nominal salaries per worker, which have become better anchored in the post-GFC period. As the SARB became more explicit about targeting the midpoint of the target range, growth in nominal salaries per worker also moderated. This provides a costless opportunity for a reduction in the inflation target.

Figure 2: Compensation of employees

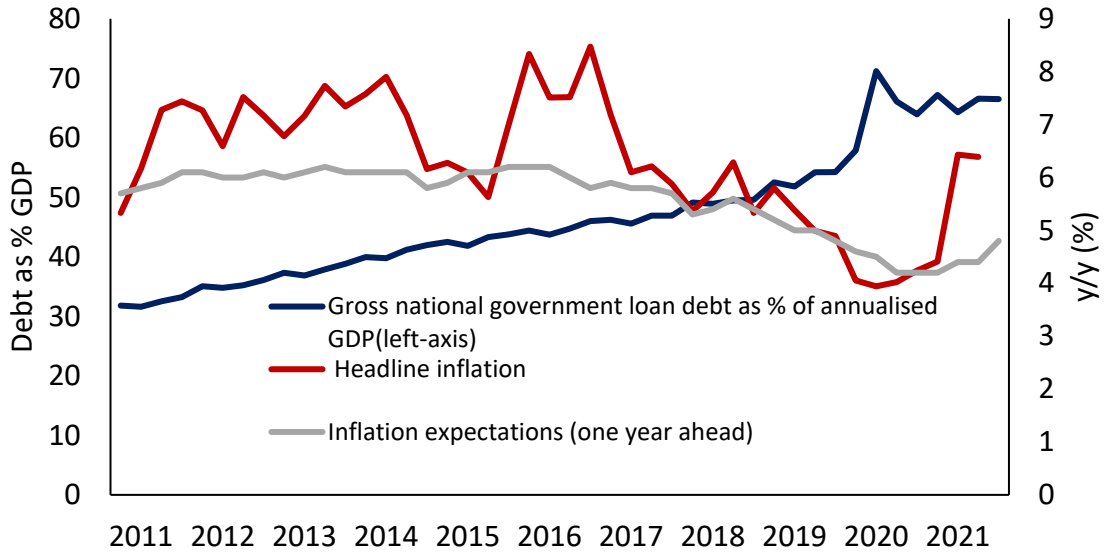


Source: SARB

The public sector debt stock is certainly at a level that may cause investors to worry about the fiscal commitment to low inflation. Again, this seems to be less of a concern as rising levels of public debt have coincided with declining inflation and inflation expectations for labour unions, firms and economic analysts (Figure 3). This again suggests that monetary policy credibility has increased. Reversal of the current fiscal

consolidation path will undermine central bank credibility and increase the sacrifice ratio, making a lower inflation target more difficult to achieve.

Figure 3: Headline inflation and government debt levels



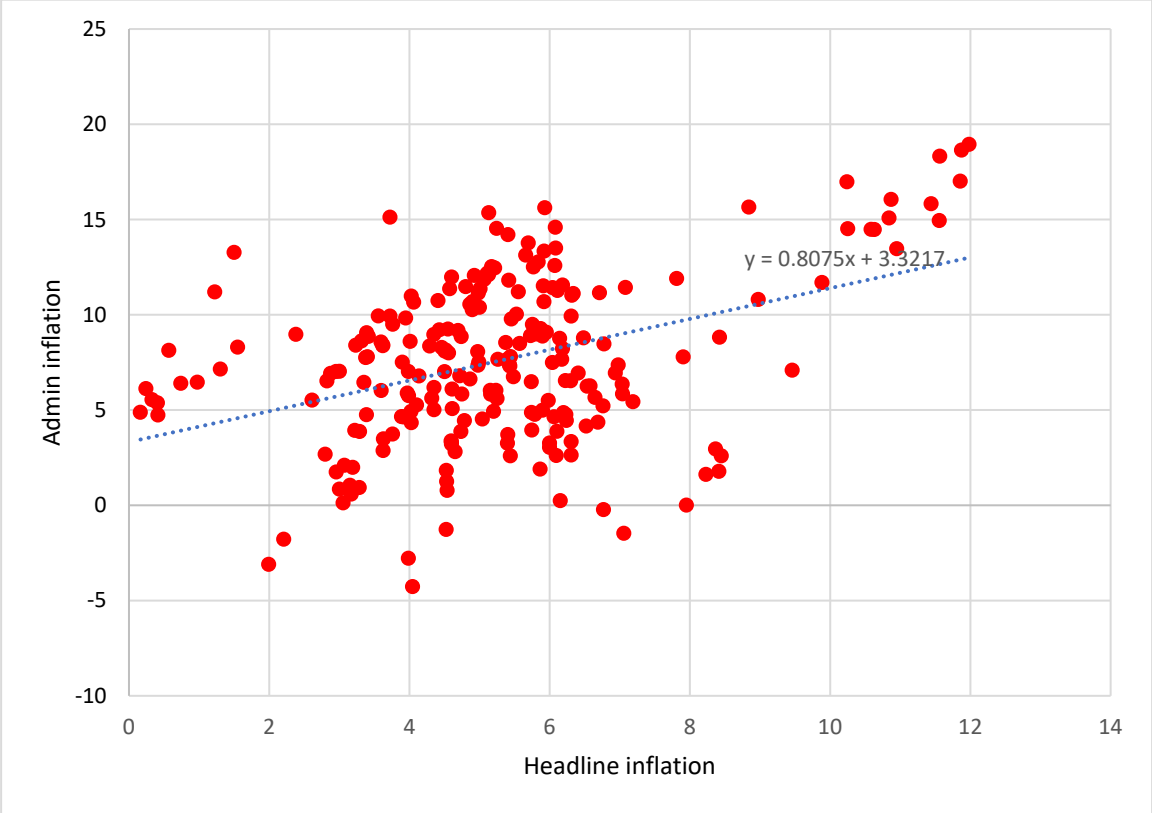
Source: SARB, BER and Stats SA

One of the most important drivers of inflation inertia in South Africa is administrative price inflation. This is not a determinant of the sacrifice ratio identified in the literature, but it is important in the South African context due to its high share in the overall consumption basket. Administrative price inflation responds less to economic and financial conditions than wage inflation, implying an increase in the sacrifice ratio (Figure 4). For example, De Wet (2021) argues that any inflation target below 4% is unrealistic. Assuming a 3% inflation target and administrative price inflation of 6% requires non-administrative prices to increase by only 2.4% to achieve the new target.

This approach, however, ignores that administrative prices are not only a determinant of headline inflation but also driven by headline inflation. Input costs, including wages, are all functions of producer and consumer inflation. Price changes in South Africa

relative to other countries affect the value of the rand and the costs associated with importing goods and services.[13] These feed into the various regulatory approaches to determine administrative prices.[14]

Figure 4: Administrative price inflation and headline inflation (monthly data over the period January 2003 to February 2022)



Source: SARB and Stats SA

Higher administrative price changes reflect real relative price adjustments. Reducing headline inflation in the economy can allow for the same relative price adjustments necessary to direct resources towards regulated sectors but with smaller nominal changes in administrative and other prices. These lower nominal changes will also make the real relative prices signals clearer, improving the allocation of resources and productivity (Frenkel and Mehrez 2000).

The second issue often ignored is that much can be done to improve administrative price setting. For example, Heinrich and Crompton (2020) and Crompton et al. (2020)

13 This is a particularly important channel for petrol prices, which are less affected by domestic cost factors and more affected by exchange rate movements and global oil price changes.

14 See, for example, Storer and Teljeur (2003) for a review of administrative price setting in South Africa.

illustrate how changes to the regulatory mechanism for setting petrol prices can reduce the overall price level and volatility, and support economic activity. They argue for a move away from the current model of price regulation that supports import substitution towards more effective price deregulation. Similar opportunities exist in other areas and require the public sector to more decisively guide administered prices. These include eliminating unnecessary wastage in public entities, which increases their cost base; limiting nominal wage growth; aligning inflation assumptions with the new inflation target; and revising administered pricing methodologies, which often create unnecessary price volatility and inefficient pricing.[15]

4. Methodology

Measuring the sacrifice ratio is not an easy task. It requires separating the impact of monetary policy changes on output and inflation from other factors such as supply-side shocks that may affect the economic environment (Cecchetti and Rich 2001). Policymakers also need to understand the precision of sacrifice ratio estimates and which policy and structural factors determine their size. As is common in economics, no approach is perfect in calculating the sacrifice ratio.

4.1 Trend analysis

Ball (1994) presents the simplest and most prominent approach. This methodology is widely used in multi-country studies to identify which country factors determine the size of the sacrifice ratio.

According to this methodology, disinflation episodes are identified as periods when trend inflation falls by more than 2 percentage points per year. Trend inflation is determined as a nine-quarter moving average of actual inflation. The accumulated output losses over the disinflation episodes are calculated as the sum of deviations of actual from trend output. Trend output is defined under the assumptions that, first, output is at its trend level at the start of a disinflation episode; second, output is back to its trend level four quarters after the end of a disinflation episode; and third, trend output grows log-linearly.

[15] Storer and Teljeur (2003) review administrative price methodologies in several sectors. While their study is quite old, it is still relevant as many of the methodologies remain largely unchanged. The conclusion from the study is that many of the regulatory approaches should be changed to ensure more efficient pricing of administrative goods and services.

A key drawback of this approach is that it does not distinguish between disinflation due to monetary policy actions and disinflation due to other factors, which can affect both output and inflation (Cukierman 2002). Extensions to Ball's approach do not address the major limitations. For example, Zhang (2005) and Hofstetter (2008) focus on alternative ways to measure trend growth rather than on the identification of monetary shocks.

4.2 SVAR approach

Cecchetti and Rich (2001) developed the second approach to calculating sacrifice ratios, which is based on the estimation of a simple structural vector autoregression (SVAR) model. The approach aims to address some of the limitations of the other approaches by identifying unanticipated monetary policy shocks. Cecchetti and Rich are able to identify changes in output due to a monetary policy shock and changes due to other factors. The approach also distinguishes between systemic changes to monetary policy and those associated with major policy shifts aimed, for example, at structurally reducing inflation.

The vector autoregression (VAR) model specification includes real GDP growth, Δy_t, and inflation change, $\Delta\pi_t$; the change in the inflation rate is included in the model to allow shocks to have a permanent effect on the level of inflation. The structural form of the Cecchetti and Rich (2001) model can be written as:

$$B(L)\begin{bmatrix}\Delta y_t \\ \Delta\pi_t\end{bmatrix} = \begin{bmatrix}\epsilon_t^y \\ \epsilon_t^\pi\end{bmatrix} \quad (1)$$

where $B(L)$ is a matrix of polynomial lags and structural shocks to aggregate supply ϵ_t^y and to aggregate demand ϵ_t^π. These are zero mean and serially uncorrelated with the covariance matrix $E[\epsilon_t\ \epsilon_t']$. To estimate the effect of the structural shocks over time, the vector moving average (VMA) representation of the model is considered:

$$\begin{bmatrix}\Delta y_t \\ \Delta\pi_t\end{bmatrix} = A(L)\begin{bmatrix}\epsilon_t^y \\ \epsilon_t^\pi\end{bmatrix} \quad (2)$$

Following Cecchetti and Rich (2001), aggregate demand shocks are used to identify changes in monetary policy, such that the estimate of the sacrifice ratio can be obtained from the structural impulse response functions of the VMA form. In particular, the sacrifice ratio is calculated as the cumulative effect of a monetary policy shock on GDP growth per unit of change in the level of inflation at time horizon τ. Given (2), the sacrifice ratio is calculated as:

$$SR(\tau) = \frac{\sum_{j=0}^{\tau} \frac{\delta y_{t+j}}{\delta \epsilon_t^{\pi}}}{\frac{\delta \pi_{t+\tau}}{\delta \epsilon_t^{\pi}}} = \frac{\sum_{i=0}^{\tau} \sum_{j=0}^{i} a_{12}^{i}}{\sum_{i=0}^{\tau} a_{22}^{i}} \quad (3)$$

where a_j^i are the elements of $A(L)$.

Aggregate demand shocks are identified using the long-run restriction of Blanchard and Quah (1989). Specifically, demand shocks are assumed to have no permanent effect on the level of output. This is equivalent to assuming monetary neutrality. Additionally, it is assumed that structural shocks in (2) have unit variance and are uncorrelated.

To expand the three-variable VAR, we follow Cecchetti and Rich (2001) and estimate a three-variable VAR model with the structure suggested in Shapiro and Watson (1988) (1988). An ex-post real interest rate variable $(i_t - \pi_t)$ is introduced in addition to real GDP growth and inflation growth, so the structural form is given by:

$$B(L)\begin{bmatrix} \Delta y_t \\ \Delta \pi_t \\ (i_t - \pi_t) \end{bmatrix} = \begin{bmatrix} \epsilon_t^{y} \\ \epsilon_t^{LM} \\ \epsilon_t^{IS} \end{bmatrix}$$

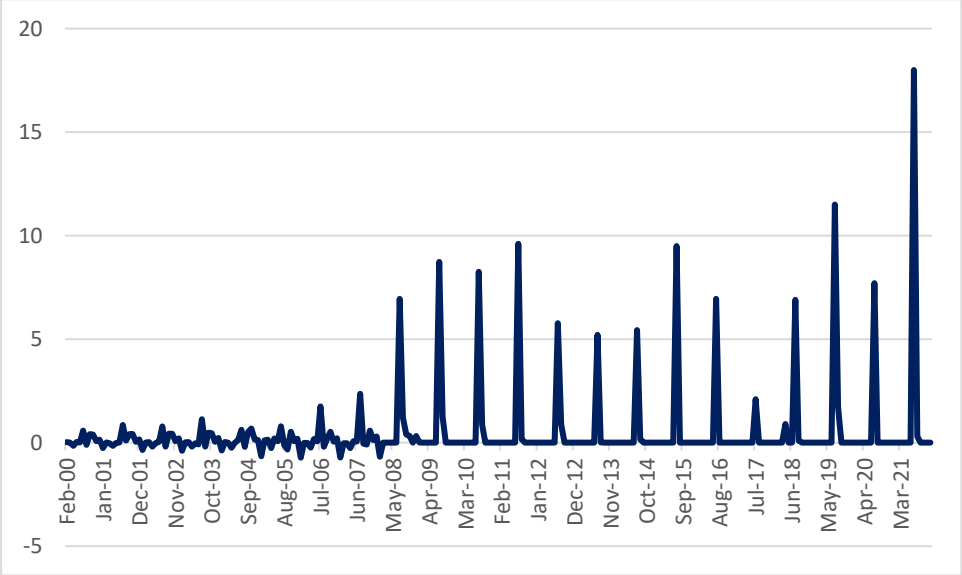
where the structural shock to aggregate supply, ϵ_t^{y}, liquidity and money (LM) shock, ϵ_t^{LM}, and investment and savings (IS) shock, ϵ_t^{IS}, are zero mean and are serially uncorrelated with the covariance matrix $E[\epsilon_t\, \epsilon_t']$. Again, the long-run restriction of Blanchard and Quah (1989) is used to identify the zero long-term effect of demand shocks on output. Short-run restrictions are added to impose no contemporaneous effect from the monetary policy shock, ϵ_t^{LM}, on output, in order to disentangle the effects of LM- and IS-type aggregate demand shocks.

We use the SVAR and Ball's approaches to calculate the sacrifice ratio for South Africa.[16] Next, we run a set of ordinary least squares (OLS) regressions to determine the effect of headline inflation on disaggregated administered prices. The relationship considered is specified by the following regression equation:

$$\pi_t^{AdPj} = \alpha\, \pi_{t-1}^{AdPj} + \beta\, \pi_t^{CPI} + \gamma\, \pi_{t-1}^{CPI} + c \qquad (4)$$

where π_t^{AdPj} is administered price j inflation, that is, inflation in prices for one of the following components: communication, education, electricity, tax rates, water, trains, university boarding fees and television licence. The frequency of administered price changes is low; most prices considered change annually (see Figure 5 for the case of electricity prices). Hence, the regressions use data with annual frequency.[17]

Figure 5: Monthly unit changes in electricity price index



Source: SARB and Stats SA

16 A third approach relies on Phillips curve estimates. A small slope coefficient suggests that large changes in aggregate demand are required to generate substantial changes in inflation, producing a large sacrifice ratio. This interpretation relies on expectations being more adaptive, which creates inflation inertia. With high central bank credibility and forward-looking expectations, a small coefficient indicates that the ratio is small (Belke and Böing 2014). Monetary policy communication is a powerful tool in reducing trend inflation with less need for a slowdown in aggregate demand.

17 Most administrative items are surveyed once a year, but some such as paraffin are surveyed every month. For items that are surveyed monthly, we run monthly regressions.

To deal with the small number of observations at annual frequency in the OLS regressions and as a robustness check, we run a panel regression with fixed effects on the same annual frequency data series:

$$\pi_{jt}^{AdPj} = \beta\, \pi_{jt-1}^{AdPj} + \gamma\, \pi_t^{CPI} + \alpha_j + u_{jt} \qquad (5)$$

And finally, we use the Granger causality test to assess the relationship between administrative price inflation and headline inflation.

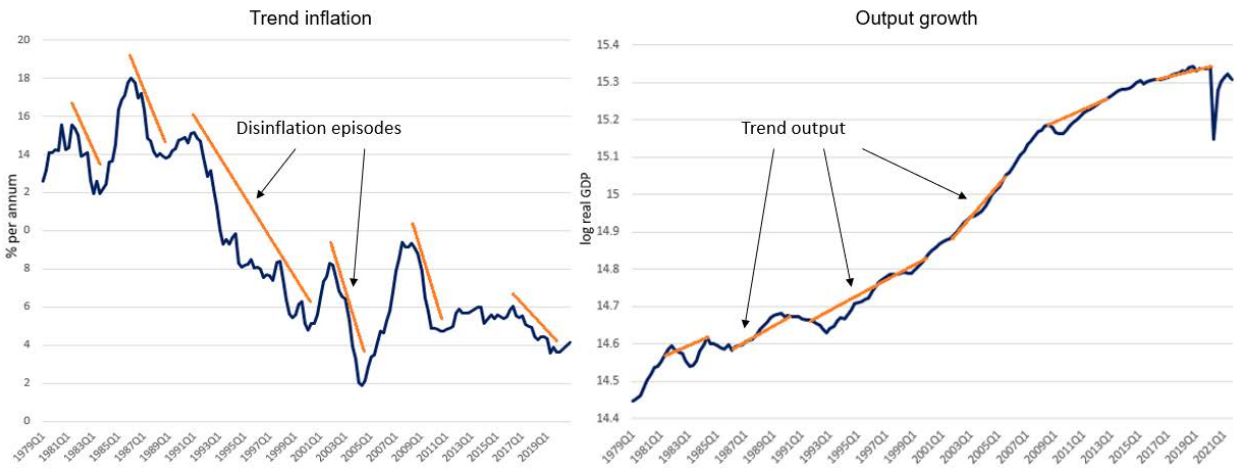
5. Sacrifice ratio estimates

In this section we present our estimates of the sacrifice ratio.

5.1 Trend analysis

Figure 6 presents trend inflation and GDP growth, while Table 1 lists the specific periods that satisfy the criteria and the associated sacrifice ratios following Ball's approach.

Figure 6: Trend inflation and trend output in disinflation episodes



Note: The vertical axes are in % per annum and in log real GDP units on the left and right plots respectively. Orange lines in the right plot indicate the trend output growth over the disinflation episodes identified according to Ball (1994).

Source: Authors' own calculation

Table 1: Sacrifice ratio in disinflation episodes according to Ball (1994) – quarterly data

Episode	Length (quarters)	Initial inflation (%)	Drop in inflation (percentage points)	Sacrifice ratio
1981Q2–1983Q1	7	15.6	3.63	4.38
1986Q1–1988Q4	11	18	4.19	-1.72
1991Q1–2000Q1	36	15.2	10.4	12.04
2001Q4–2004Q2	10	8.3	6.43	1.41
2008Q2–2010Q3	9	9.4	4.64	4.78
2016Q2–2019Q2	12	6	2.45	-1.97

Source: Authors' own calculation

The results illustrate the problem associated with calculating sacrifice ratios using this approach. For example, the period from 2008 to 2010 was not associated with monetary policy actions to reduce trend inflation. The GFC led to a large fall in both inflation and output. The two recent periods that reflect monetary policy actions to reduce trend inflation are the initial period when inflation targeting was introduced (2001 to 2004) and the most recent period from 2016. In the first case, the sacrifice ratio is 1.41, which is large but still below estimates for other countries that had recently introduced inflation targeting. In the second case, the ratio is negative, indicating that efforts to reduce trend inflation generated positive output gains. This period is characterised by improved central bank credibility and more forward-looking expectations, contributing to a lower (even negative) sacrifice ratio.

To test the sensitivity of our results to our quarterly data frequency, we calculate the sacrifice ratio using annual data. The results are presented in Table 2. The general conclusions are the same but the estimates are smaller. Again, the period from 2008 to 2010 has a larger sacrifice ratio than other disinflationary periods post-1994. The most recent sacrifice ratio is large and negative, indicating large positive output gains. Using different measures of trend growth generates similar results.

Table 2: Sacrifice ratio in disinflation episodes according to Ball (1994) – annual data

Episode	Length (years)	Initial inflation (%)	Drop in inflation (percentage points)	Sacrifice ratio
1975–1977	3	12.6	2.1	0.35
1981–1983	3	15.6	3.8	1.42
1986–1988	3	17.4	3.5	0.08
1991–1993	3	15.1	6.2	0.86
1994–2000	7	8.9	3.3	-0.47
2002–2004	3	7.9	5.9	0.38
2008–2010	3	9.8	5.2	0.90
2016–2019	4	5.8	2.3	-6.00

Source: Authors' own calculation

Our estimates are small but in line with recent sacrifice ratios calculated for other countries. Table 3 provides the sacrifice ratios for a set of countries calculated by Mazumder (2014a). His results also show that sacrifice ratios were generally larger across countries in the 1980s and 1990s, when many central banks introduced frameworks to reduce trend inflation and central bank credibility was still low.

Table 3: Sacrifice ratios for a selected set of countries (using the trend approach)

Country	Start of episode	Length (in years)	Sacrifice ratio
Australia	1981	5	2.43
	1995	3	0.17
Brazil	2002	6	1.72
Germany	1981	7	2.14
	1993	7	0.91
India	1991	4	1.75
	1997	6	0.41
Ireland	1990	5	3.32
	2001	4	-0.65
Lesotho	1992	4	2.55
	2003	3	0.43
Namibia	1988	4	1.21
	2004	4	-0.27
New Zealand	1986	8	2.44
	1995	4	1.06
Sri Lanka	2002	2	-0.14

Source: Mazumder (2014a)

Next, we present the SVAR estimates.

5.2 Structural VAR approach

The SVAR model is estimated using quarterly seasonally adjusted data from 1991Q4 to 2019Q4.[18] The stationarity properties of the series are in line with the VAR specification presented earlier – the real GDP and inflation series are found to contain a unit root, when using the augmented Dickey and Fuller (1979) test. This allows, first, for a permanent disinflation effect and, second, for the use of the long-run restriction for the aggregate demand shock identification. The lag length of the reduced-form VAR was set to 5 according to the lag selection criteria.[19]

Table 4 shows the point estimates of the sacrifice ratio at four- to 20-quarter horizons, while Figure 7 presents the estimated responses of output and inflation to one standard deviation aggregate demand shock Values in Table 4 are interpreted as the accumulated loss of GDP growth per percentage point decline in inflation at horizon τ. Broadly, they indicate that the size of output losses doesn't change much at longer horizons and that sacrifice ratio estimates beyond four quarters are statistically insignificant. The sacrifice ratio is 0.51, four quarters after the change in monetary policy. This estimate is lower than the estimate of Kabundi, Schaling, and Some (2016). The result indicates that monetary policy in the post-apartheid period has reduced trend inflation at a low cost to output.

The size of the sacrifice ratio for the four-quarter horizon is larger than the estimates produced by Gereziher and Nuru (2021). The result, however, is not directly comparable as they transform the data differently.[20] They find significance only at the one-quarter horizon, which is reflected in the wide confidence bands of the accumulated real GDP growth response shown in the paper.[21]

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18 We limit our analysis to the post-apartheid period as we argue that the period before 1994 is not structurally comparable to the period after.

19 The Akaike information criterion, the sequential modified likelihood ratio test statistic and the final prediction error tests are used to determine the lag structure.

20 The data transformation used in Gereziher and Nuru (2021) doesn't allow their sacrifice ratio estimates to be interpreted as output loss driven by permanent disinflation in percentage points.

21 We do not use the three- and four-variable models from Cecchetti and Rich (2001) in our estimation exercise (those are respectively Shapiro and Watson (1988) and Gali (1992) models), as the stationarity properties of the real interest rate and the growth of real money balances series in the South African data do not allow them to be used in the proposed setup. We illustrate this problem later in the section. This presents one of the limitations of the structural VAR methodology in assessing the sacrifice ratio (see the 'Restrictions at Longer Horizons' section in Ramey (2016)).

Table 4: Sacrifice ratio estimates from the two-variable structural VAR model

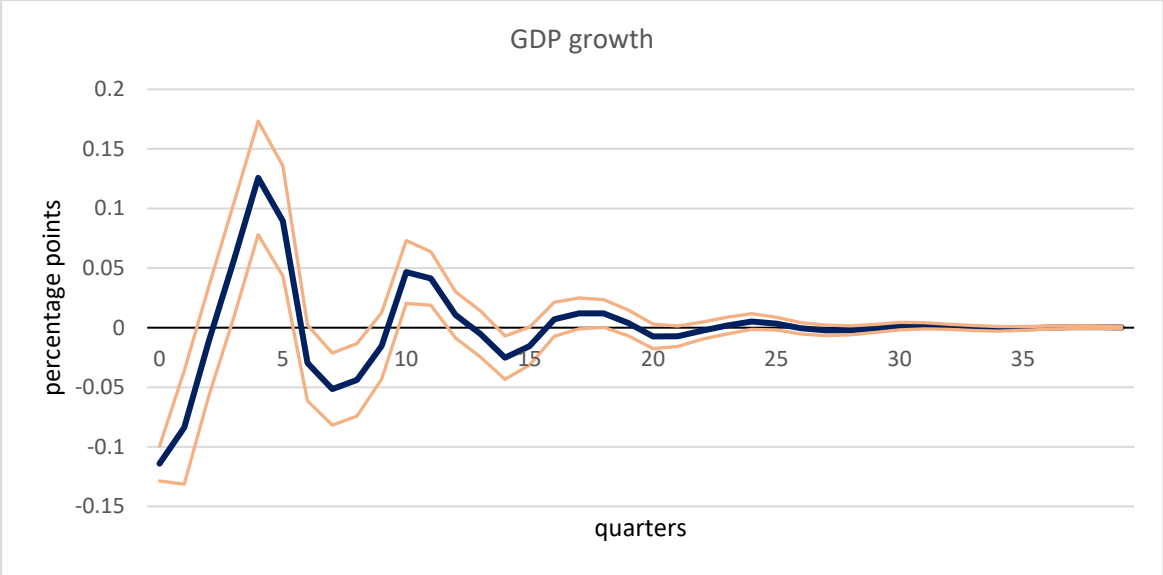
	$\tau = 4$	$\tau = 8$	$\tau = 12$	$\tau = 16$	$\tau = 20$
Cumulative output loss as a percentage of real GDP	0.508**	0.517	0.859	0.677	0.770

Note: The model is estimated at the 1991Q4–2019Q4 sample. Values marked with ** are significant at the 5% level.

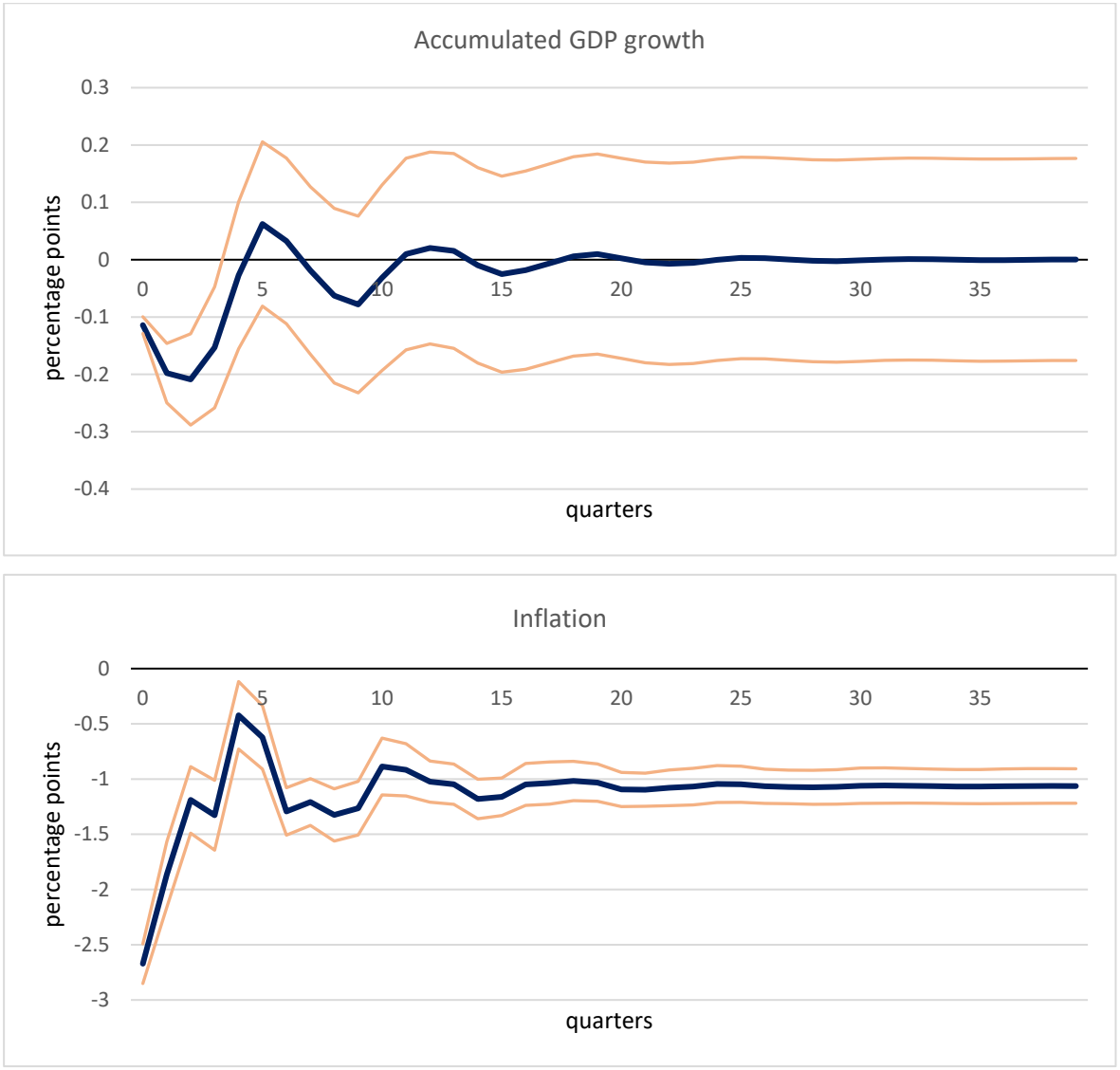
Source: Authors' own calculation

In the two-variable structural VAR, the monetary policy change driving permanent disinflation makes GDP growth fall on impact (Figure 7). This estimated negative effect on output is not persistent. As output growth increases and turns positive four quarters after the shock, the accumulated growth response becomes insignificant and therefore the sacrifice ratio estimates are also insignificant (see values for $\tau > 4$ in Table 3).[22]

Figure 7: Impulse responses to a permanent disinflation shock in the two-variable Cecchetti (1994) model



[22] With the aim of analysing how the aggregate demand costs have changed over time in response to the permanent shift in inflation, and whether there is a reduction in costs associated with inflation expectations being better anchored during the recent period, we obtained sacrifice ratio estimates using the bivariate SVAR setup pre- and post-2009. For a sufficient number of observations to estimate SVARs over these two periods, we employed monthly data on coincident indicators. These estimates appeared insignificant and are not reported here.



Note: The effect of one standard deviation structural innovation with two standard error confidence bands is reported.

Source: Authors' own calculation

The ratio calculated using the SVAR approach is lower compared to estimates from previous studies for South Africa and in line with those generated for other emerging market inflation-targeting countries. Table 5 lists the estimates produced by Torres (2005). The results from the study indicate that inflation-targeting countries have lower sacrifice ratios than non-inflation targetters.

Table 5: Sacrifice ratios for a selected set of countries (using the SVAR approach)

	τ				
	4	8	12	16	20
Brazil	-0.044	-0.022	-0.019	-0.021	-0.022
Chile	-0.269	-0.181	-0.047	-0.229	-0.103
Israel	-0.015	-0.083	-0.205	-0.246	-0.294
Korea	0.378	0.409	0.353	0.361	0.361
Mexico	0.364	0.515	0.351	0.433	0.381
South Africa	1.498	0.485	2.024	0.757	1.479

Source: Torres (2005)

To expand the two-variable structural VAR, we also ran a three-variable VAR model (Shapiro and Watson, 1988). In addition to real GDP growth and inflation growth, the ex-post real interest rate variable is used. According to the results of the augmented Dickey-Fuller (1979) test, the real interest rate series is found to be non-stationary. This poses a major limitation for the use of three-variable VAR, given that the model is unstable. Below are the sacrifice ratio estimates that emerge from the three-variable VAR (see Table 6) and impulse responses to a monetary policy shock identified to deliver permanent disinflation (Figure 8). Impulse response functions show that a permanent disinflation shock yields a positive response of aggregate demand, implying large output gains. These results, however, are all insignificant.

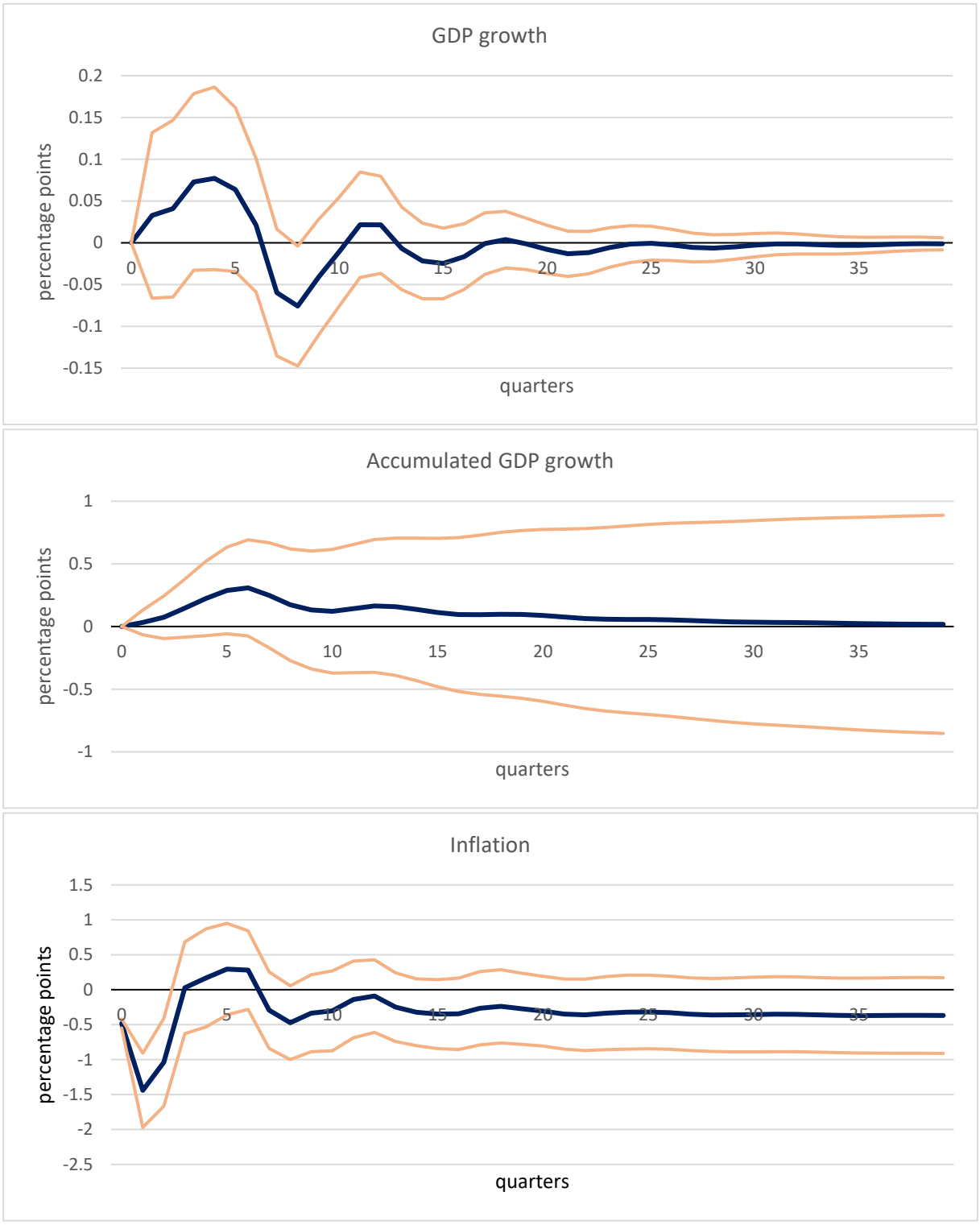
Table 6: Sacrifice ratio estimates from the three-variable structural VAR model

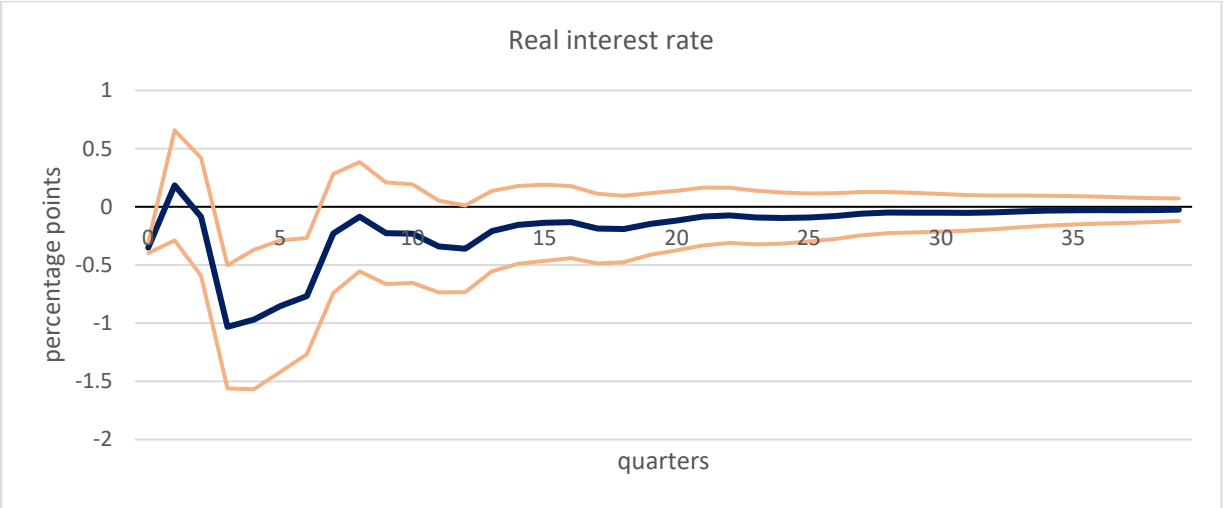
	$\tau = 4$	$\tau = 8$	$\tau = 12$	$\tau = 16$	$\tau = 20$
Cumulative output loss as a percentage of real GDP	2.834	-3.167	-22.571	-7.408	-9.551

Note: The model is estimated on the 1991Q4–2019Q4 sample. None of the sacrifice ratio estimates are found to be significant due to wide confidence bands (see Figure 8).

Source: Authors' own calculation

Figure 8: Impulse responses to a permanent disinflation shock in the three-variable Shapiro and Watson (1988) model





Note: The effect of one standard deviation structural innovation with two standard errors confidence bands is reported.

Source: Authors' own calculation

It is important to emphasise that the sacrifice ratio estimates presented above do not account for the expectations of the private sector. If the change in the inflation target is communicated in advance, this shift in monetary policy is anticipated by the market, and that could significantly reduce the effect of the shock (see, for example, Cochrane (1998)). Employing high-frequency identification of monetary policy shocks allows for the separation of anticipated and unanticipated shifts in monetary policy. However, the anticipation effects that are controlled for in this case pertain to market expectations of future policy rate changes and not to changes in the inflation target. For this reason, using high-frequency identification of monetary policy shocks does not allow for the estimation of the effects of a downward shift in the inflation target as announced by the central bank. Introducing the inflation expectations channel in our SVAR framework is challenging – one would need to enlarge the VAR information set by including a variable that proxies for agents' expectations about future changes to the inflation target.[23] However, given that the shift of the inflation target is a unique event with no past observations available, obtaining such a proxy is not possible.

[23] A related problem of 'fiscal foresight' is addressed in the empirical literature by estimating the effects of fiscal policy shocks using forward-looking variables such as a series of forecasts/forecast revisions of future government spending or an estimate of revisions to the present value of defence spending ('defence news') to account for future fiscal changes (see, for example, Perotti (2011), Ramey (2011) and Fisher and Peters (2010)).

6. Headline inflation and its impact on administrative prices

In this section we analyse the impact of headline inflation on administrative prices using the statistical methods outlined earlier. We start with the Granger causality test.[24] Table 7 shows the test results. The Granger causality test suggests that administered prices do have a causal effect on headline inflation. Importantly, headline inflation also Granger-causes administered prices, as the null hypothesis of no causality effect of headline inflation on administered prices inflation is rejected at 1% significance level. This supports our hypothesis of a two-way relationship.

Table 7: The Granger causality test – administered prices and headline CPI

Null hypothesis	Prob.	Obs	F-statistic
Headline CPI does not Granger-cause administered prices index	0.004	227	2.548
Administered prices index does not Granger-cause headline CPI	0.002	227	2.665

Note: Aggregate administered prices index and headline CPI over 2000M02–2019M12 are used. The test lag is set to 12 months.

Source: Authors' own calculation

Next, we present the results from the simple OLS regressions. The results in Table 7 indicate that headline inflation has a significant effect on administered prices inflation. The contemporaneous or lagged headline CPI inflation is found to have a significant positive effect on price inflation for electricity, education, communication, tax rates, uniboard,[25] TV licence, motor licence and paraffin.[26] A reduction in headline inflation would put downward pressure on administered prices. Again, this is expected as headline inflation directly affects many of the factors used in the setting of different administrative prices.

[24] A linear relationship between administered prices and headline CPI is established using the Ramsey RESET test. No structural breaks are found with the Bai-Perron test. See Appendix for details.

[25] Uniboard is university boarding fees.

[26] In case of TV licence, motor licence and paraffin, the overall effect of a change in headline inflation, seen as a sum of coefficients for its contemporaneous and lagged components, is positive.

Table 8: The effect of headline inflation on administered price inflation in linear regressions

	Elec-tricity	Education	Communi-cation	Water	Tax rates	Uni-board	Trains	TV licence	Motor licence	Paraffin
π_{t-1}^{AdPj}	0.66***	0.17	0.46*	0.45*	0.43*	0.05	-0.36	-0.08	0.88***	0.93***
π_t^{CPI}	1.56**	-0.05	0.74**	-0.31	0.03	-0.16	-0.54	-1.05***	0.50**	2.71***
π_{t-1}^{CPI}	0.64	0.43**	-0.11	0.32	0.34*	0.40*	0.06	1.25***	-0.46**	-2.68***
c	-9.21**	4.38**	-2.89	5.09*	2.12	7.2***	13.08	0.94	0.44	0.30
R^{sq}	0.72	0.43	0.47	0.32	0.41	0.78	0.14	0.63	0.80	0.89

Note: All regressions except for motor licence and paraffin price inflation are at annual frequency. Regressions for motor licence and paraffin are run at monthly frequency.[27] The sample is 2002–2019 (except for tax rates – the sample is 2002–2017). *,** and *** indicate that coefficients are significant at the 1%, 5% and 10% levels respectively. The regression for the 'uniboard' variable includes year 2016 dummy to improve the error term properties.

Source: Authors' own calculation

The panel data results are presented in Table 9 and confirm the impact of headline inflation on administered prices inflation.

Table 9: The headline CPI inflation effect on administered prices inflation in a panel regression with fixed effects

	π_t^{AdP}
π_{t-1}^{AdP}	0.50**
π_t^{CPI}	0.38**
c	0.89
$Nobs$	118
R^{sq}	0.62

Note: Inflation of electricity, communication, education, tax rates, uniboard and TV licence prices are at annual frequency on the 2002–2021 sample.

Source: Authors' own calculation

The results suggest that administered prices inflation responds quickly to headline inflation for most subcategories. There are regulated prices such as fuel prices which are more responsive to global price developments and often contribute to high inflation. In this case, regulatory changes can reduce the overall price level and volatility and support economic activity. This is likely the case for many regulated prices. Reducing the inertia of administered prices inflation will also improve relative price signals in the

[27] The paraffin and motor licence and registration price indices feature variation at monthly frequency, allowing regressions to be run at higher than annual frequency, which is used for other series.

economy and the responsiveness of regulated industries to macroeconomic developments.

7. Conclusion

South Africa's inflation target remains well above the emerging market average. This imposes unnecessary costs on households and firms. Reducing the target, however, may impose some short-term output costs. Our analysis suggests that these costs have decreased as the Reserve Bank's credibility has improved and inflation expectations have become more forward-looking. These factors, along with a lower exchange rate pass-through, reduce the size of the sacrifice ratio. Using the trend analysis approach, we find that the most recent disinflationary episode over 2016 to 2019 was not associated with output losses. At the same time, the structural VAR approach shows a sacrifice ratio of just over 0.5 in the post-apartheid period.

Objections against a lower inflation target list high administered prices as the main obstacle. The reasoning is that administered prices inflation is not responsive to output and employment changes and remains well above the current inflation target. The adjustment to a lower inflation target will fall disproportionately on other prices, which will increase output costs. We argue that this argument ignores the two-way relationship between headline inflation and administered prices. Our results show that reducing headline inflation will also reduce administered prices inflation. This will make relative price signals clearer. More microeconomic analysis is required to establish the efficiency of different administered price-setting mechanisms and provide recommendations on how to improve them.

Our results have some limitations as is common in economic analysis. The structural VAR approach of Cecchetti and Rich (2001) has been criticised for its identification strategy. The inclusion of additional variables, such as the policy rate, can change the sacrifice ratio estimates significantly. A key drawback of the trend analysis approach is that it does not distinguish between disinflation due to monetary policy actions and disinflation due to other factors, which can affect both output and inflation (Cukierman 2002). We have combined approaches as well as reviewed the literature on determinants of the sacrifice ratio in South Africa to mitigate against these limitations.

References

Aron, J, Farrell, G, Muellbauer, J and Sinclair, P. 2014. ‘Exchange rate pass-through to import prices, and monetary policy in South Africa’. *Journal of Development Studies* 50: 144–164.

Badinger, H. 2009. ‘Globalization, the output–inflation tradeoff and inflation’. *European Economic Review* 53: 888–907.

Bai, J and Perron, P. 2003. ‘Computation and analysis of multiple structural change models’. *Journal of Applied Econometrics* 18: 1–22.

Ball, L. 1994. ‘What determines the sacrifice ratio?’ In *Monetary Policy*, edited by G Mankiw. Chicago: University of Chicago Press.

Ball, L. 1995. ‘Disinflation with imperfect credibility’. *Journal of Monetary Economics* 35: 5–23.

Barnichon, R and Mesters, G. 2021. ‘The Phillips multiplier’. *Journal of Monetary Economics* 117: 689–705.

Belke, A and Böing T. 2014. ‘Sacrifice ratios for Euro area countries: new evidence on the costs of price stability’. *Australian Economic Review* 47: 455–471.

Blinder, A S, Ehrmann, M, Fratzscher, M, De Haan, J and Jansen, D-J. 2008. ‘Central bank communication and monetary policy: a survey of theory and evidence’. *Journal of Economic Literature* 46: 910–945.

Bohlmann, H and Crompton, R. 2020. ‘The impact on the South African economy of alternative regulatory arrangements in the petroleum sector’. WIDER Working Paper 2020/153. Helsinki: UNU-WIDER.

Boschen, J F and Weise, C L. 2001. ‘The ex ante credibility of disinflation policy and the cost of reducing inflation’. *Journal of Macroeconomics* 23: 323–347.

Botha, B, Kuhn, L and Steenkamp, D. 2020. ‘Is the Phillips curve framework still useful for understanding inflation dynamics in South Africa?’. *South African Reserve Bank Working Paper Series*, WP/20/07.

Bowdler, C. 2009. ‘Openness, exchange rate regimes and the Phillips curve’. *Journal of International Money and Finance* 28: 148–160.

Bowdler, C and Nunziata, L. 2010. ‘Labor market structures and the sacrifice ratio’. *Journal of Macroeconomics* 32: 816–826.

Brumm, H J and Krashevski, R S. 2003. ‘The sacrifice ratio and central bank independence revisited’. *Open Economies Review* 14: 157–168.

Bruno, M and Sachs, J D. 1985. *Economics of worldwide stagflation*. Boston: Harvard University Press.

Calmfors, L and Driffill, J. 1988. ‘Bargaining structure, corporatism and macroeconomic performance’. *Economic Policy* 3: 13–61.

Carporale, B and Carporale, T. 2008. ‘Political regimes and the cost of disinflation’. *Journal of Money, Credit and Banking* 40: 1541–1554.

Cecchetti, S G and Rich, R W. 2001. ‘Structural estimates of the U.S. sacrifice ratio’. *Journal of Business & Economic Statistics* 19: 416–427.

Chadha, B, Masson, P R and Meredith, G. 1992. ‘Models of inflation and the costs of disinflation’. *Staff Papers* 39: 395–431.

Cochrane, J H. 1998. ‘What do the VARs mean? Measuring the output effects of monetary policy’. *Journal of Monetary Economics* 41(2): 277–300.

Coco, A and Viegi, N. 2020. ‘The monetary policy of the South African Reserve Bank: stance, communication and credibility’. *South African Reserve Bank Working Paper Series*, WP/20/06.

Crompton, R, Sing, M, Filter, V and Msimango, N. 2020. ‘Petrol price regulation in South Africa: is it meeting its intended objectives?’ WIDER Working Paper 2020/140.

Cukierman, A. 1992. *Central bank strategy, credibility, and independence: theory and evidence*. Cambridge: MIT Press Books.

Cukierman, A. 2002. ‘Does a higher sacrifice ratio mean that central bank independence is excessive?’ *Annals of Economics and Finance* 3: 1–25.

Daniels, J P, Nourzad, F and VanHoose, D D. 2005. ‘Openness, central bank independence, and the sacrifice ratio’. *Journal of Money, Credit, and Banking* 37: 371–379.

Daniels, J P and VanHoose, D D. 2006. 'Openness, the sacrifice ratio, and inflation: is there a puzzle?’ *Journal of International Money and Finance* 25: 1336–1347.

Daniels, J P and VanHoose, D D. 2009. ‘Openness, income-tax progressivity, and inflation’. *Journal of Macroeconomics* 31: 485–491.

Daniels, J P and VanHoose, D D. 2013. ‘Exchange-rate pass through, openness, and the sacrifice ratio’. *Journal of International Money and Finance* 36: 131–150.

De Gregorio, J. 1992. ‘The effects of inflation on economic growth: lessons from Latin America’ *European Economic Review* 36: 417–425.

De Wet, W. 2021. ‘SARB’s inflation target: 4%, not 3% or 4,5%’. *Nedbank CIB Insight*.

Debelle, G and Fischer, S. 1994. ‘How independent should a central bank be?’ In *Conference Series [Proceedings]*, 195–225. Boston: Federal Reserve Bank of Boston.

Dickey, D A and Fuller, W A. 1979. ‘Distribution of the estimators for autoregressive time series with a unit root’. *Journal of the American Statistical Association* 74: 427–431.

Eggertsson, G and Woodford, M. 2003. ‘The zero bound on interest rates and optimal monetary policy’. *Brookings Papers on Economic Activity* 1: 139–211.

Fischer, A M. 1996. ‘Central bank independence and sacrifice ratios’. *Open Economies Review* 7: 5–18.

Fisher, J D M and Peters, R. 2010. ‘Using stock returns to identify government spending shocks’. *The Economic Journal* 120(544): 414–436.

Fischer, S and Modigliani, F. 1978. ‘Towards an understanding of the real effects and costs of inflation’. *Weltwirtschaftliches Archiv* 114: 810–833.

Frenkel, M and Mehrez, G. 2000. ‘Inflation and the misallocation of resources’. *Economic Inquiry* 38: 616–628.

Galí, J. 1992. ‘How well does the IS-LM model fit postwar U. S. data?’ *The Quarterly Journal of Economics* 107(2): 709–738.

Gereziher, H Y and Nuru, N Y. 2021. ‘Structural estimates of the South African sacrifice ratio’. WIDER Working Paper 2021/12.

Goncalves, C and Carvalho, A. 2009. ‘Inflation targeting matters: evidence from OECD economies’ sacrifice ratios’. *Journal of Money, Credit and Banking* 41: 233–243.

Hofstetter, M. 2008. ‘Disinflations in Latin America and the Caribbean: a free lunch?’ *Journal of Macroeconomics* 30: 327–345.

Jooste, C and Jhaveri, Y. 2014. ‘The determinants of time-varying exchange rate pass-through in South Africa’. *South African Journal of Economics* 82: 603–615.

Jordan, T J. 1997. ‘Disinflation costs, accelerating inflation gains, and central bank independence’. *Weltwirtschaftliches Archiv* 133: 1–21.

Kabundi, A and Mbelu, A. 2018. ‘Has the exchange rate pass-through changed in South Africa?’ *South African Journal of Economics* 86: 339–360.

Kabundi, A N and Mlachila, M. 2018. ‘Monetary policy credibility and exchange rate pass-through in South Africa’. *South African Reserve Bank Working Paper Series*, WP/18/04.

Kabundi, A, Schaling, E and Some, M. 2016. ‘Estimating a time-varying Phillips curve for South Africa’. *South African Reserve Bank Working Paper Series*, WP/16/05.

Katayama, H, Ponomareva, N and Sharma, M. 2019. ‘What determines the sacrifice ratio? A Bayesian model averaging approach’. *Oxford Bulletin of Economics and Statistics* 81: 960–988.

Loewald, C, Makrelov, K and Wörgötter, A. 2021. ‘Addressing low labour utilisation in South Africa’. *South African Reserve Bank Working Paper Series*, WP/21/09.

Magkonis, G and Zekente, K-M. 2020. ‘Inflation-output trade-off: old measures, new determinants?’ *Journal of Macroeconomics* 65: 103217.

Mankiw, N G. 2001. ‘The inexorable and mysterious tradeoff between inflation and unemployment’ *The Economic Journal* 111: 45–61.

Mazumder, S. 2014a. ‘Determinants of the sacrifice ratio: evidence from OECD and non-OECD countries’. *Economic Modelling*, 40: 117–135.

Mazumder, S. 2014b. ‘The sacrifice ratio and core inflation’. *Journal of Macroeconomics* 40: 400–421.

Miyajima, K and Yetman, J. 2018. ‘Assessing inflation expectations anchoring for heterogeneous agents: analysts, businesses and trade unions’ *BIS Working Paper Series*, No. 759.

Neiss, K S. 2001. ‘The markup and inflation: evidence in OECD countries’. *Canadian Journal of Economics/Revue canadienne d'économique* 34: 570–587.

Perotti, R. 2011. ‘Expectations and fiscal policy: an empirical investigation’. *IGIER Working Paper Series*, No. 429

Posen, A. 1998. ‘Central bank independence and disinflationary credibility: a missing link?’ *Oxford Economic Papers* 50: 335–359.

Ramey, V A. 2011. ‘Identifying government spending shocks: it’s all in the timing’. *The Quarterly Journal of Economics*, Oxford University Press 126(1): 1–50.

Ramey, V A. 2016. ‘Macroeconomic shocks and their propagation’, in *Handbook of Macroeconomics*, edited by J B Taylor and H Uhlig. 1st ed. Volume 2. Elsevier. 71–162.

Razin, A and Loungani, P. 2005. *Globalization and inflation-output tradeoffs*. *NBER Working Paper Series*, No. 11641. National Bureau of Economic Research.

Reid, M B and Siklos, P L. 2021. ‘How firms and experts view the Phillips curve evidence from individual and aggregate data from South Africa’. *South African Reserve Bank Working Paper Series*, WP/21/03.

Romer, D. 1993. ‘Openness and inflation: theory and evidence’. *The Quarterly Journal of Economics* 108: 869–903.

Roux, N D and Hofstetter, M. 2014. ‘Sacrifice ratios and inflation targeting: the role of credibility’. *International Finance* 17: 381–401.

Sargent, T. 1983. ‘Stopping moderate inflations: the methods of Poincare and Thatcher’. In *Inflation, Debt and Indexation*, edited by R Dornbusch and M Simonsen. Cambridge: MIT Press.

Stern, M and Ramkolowan, Y. 2021. ‘Understanding South Africa’s trade policy and performance’. *South African Reserve Bank Working Paper Series*, WP/20/17.

Storer, D and Teljeur, E. 2003. ‘Administered prices’. Executive report for National Treasury. Pretoria.

http://www.treasury.gov.za/publications/other/epir/summary%20of%20sector%20reports.pdf (accessed 29 July 2022).

Taylor, J B. 1983. ‘Union wage settlements during a disinflation’. *The American Economic Review* 73: 981–993.

Torres, R I M. 2005. ‘Inflation targeting in emerging economies: a comparative sacrifice ratio analysis’. In *Dynamic models and their applications in emerging markets*, edited by S Motamen-Samadien. Centre for the Study of Emerging Markets Series. London: Palgrave Macmillan.

Viegi, N and Dadam, V. 2020. ‘Estimating a new Keynesian wage Phillips curve’. *South African Reserve Bank Working Paper Series*, WP/20/13.

Zhang, L H. 2005. ‘Sacrifice ratios with long-lived effects’. *International Finance* 8: 231–262.

Appendix

Prior to testing for Granger causality, linearity and no structural breaks are established for the relationship between administered prices index and headline CPI. The following specification is tested:

$$ADM_t = \rho\, ADM_{t-1} + \beta\, CPI_t + c$$

where ADM_t is the administered price index, CPI_t is headline CPI, and c is a constant. The results of the Ramsey RESET test in Table 11 indicate that the linear model of a relationship between administered prices and headline CPI is correctly specified. The results of the Bai-Perron test in Table 12 show that no structural break is found in specified relationships.

Table 10: Relationship between administered prices and headline CPI

	ADM_t
ρ	0.88***
β	0.15***
c	-2.35***
Nobs	239
R^{sq}	0.99

Note: Equation is estimated with OLS at the 2000M2–2019M12 sample. Aggregate administered prices index and headline CPI monthly series are used. Values marked with *** are significant at the 1% level.

Table 11: Ramsey RESET test results

	ADM_t			
Variable	Coefficient	Std. error	T-stat	Prob.
CPI_t	0.155	0.032	4.832	0.000
c	-2.252	0.679	-3.316	0.001
ADM_{t-1}	0.873	0.032	26.86	0.000
$FITTED^2$	2.68E-05	0.000	0.246	0.806
R^{sq}	0.99			

Table 12: Multiple breakpoint Bai-Perron test results

Sequential F-statistic determined breaks: 0			
Break test	F-statistic	Scaled F-statistic	Critical value
0 vs. 1	4.659	13.97	13.98

Note: Breaking variables over the 2000M2–2019M12 sample are CPI_t, ADM_{t-1} and c. Break test options: trimming 0.15, max. breaks 5, significance level 0.05, allow heterogeneous error distributions across breaks. Critical values are from Bai and Perron (2003).