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WIDER Working Paper 2018/43

Identifying monetary policy rules in South Africa with inflation expectations and unemployment

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April 2018

United Nations University World Institute for Development Economics Research
wider.unu.edu

Abstract: This paper investigates whether a Taylor rule accurately describes the South African Reserve Bank's reaction function in setting interest rates using quarterly data, covering the period since inflation targeting was formally adopted in 2000. The classic Taylor rule is modified to determine whether the South African Reserve Bank takes into account inflation expectations and labour market conditions. Our findings indicate that a modified Taylor rule does describe the South African Reserve Bank's policy rate adjustments. Our estimates of the modified rule yield two significant findings: the South African Reserve Bank's policy rate decisions respond to expected inflation (rather than current inflation), and its relationship to real economy fluctuations is evident in measures of labour market conditions rather than output gap variables. We conclude that under inflation targeting, South Africa's monetary policy has had a forward-looking inflation target that is pursued flexibly in the light of labour market conditions.

Keywords: employment, labour, monetary policy, output gap, South Africa, Taylor rule, unemployment gap
JEL classification: E43, E52, E58, J69

Acknowledgements: The authors express their gratitude to Aroop Chatterjee and Konstantin Makrelov for their invaluable assistance and suggestions.

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This study has been prepared within the UNU-WIDER project 'Southern Africa—Towards inclusive economic development (SA-TIED)'.

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ISSN 1798-7237 ISBN 978-92-9256-485-8 https://doi.org/10.35188/UNU-WIDER/2018/485-8

Typescript prepared by Gary Smith.

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

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1 Introduction

South Africa formally adopted an inflation targeting monetary policy regime in February 2000, with the announcement of a 3–6 per cent target for 2002 onwards. Following the development of inflation targeting as a monetary framework, and its implementation by New Zealand's and Chile's central banks in 1990, numerous countries chose similar policy frameworks to replace discretionary policies that had aimed at stabilizing a measure such as gross domestic product (GDP), unemployment, or an exchange rate (Svensson 2010).

Inflation targeting includes more than the choice of policy target. It is widely accepted that a full inflation targeting regime includes five elements: (1) the public announcement of medium-term numerical targets for inflation; (2) an institutional commitment to price stability as the primary goal of monetary policy, to which other goals are subordinated; (3) an information-inclusive strategy in which many variables, and not just monetary aggregates or the exchange rate, are used for deciding the setting of policy instruments; (4) increased transparency of the monetary policy strategy through communication with the public and the markets about the plans, objectives, and decisions of the monetary authorities; and (5) increased accountability of the central bank for attaining its inflation objectives (Mishkin 2000). While adoption of inflation targeting always involves a regime with an announced inflation target, individual countries' frameworks combine some or all of the elements to different degrees. South Africa's framework includes all five elements and since inception has evolved to strengthen several, especially transparency.

This study examines the operation of monetary policy using quarterly data from 1994 through 2015 and the sub-period covering 2002–15, when monetary policy was formally defined by inflation targeting. The principal research question we address is the extent to which the monetary policy instrument, the South African Reserve Bank's (SARB) repo rate, has systematically responded to deviations of an inflation measure from its target range and its responsiveness to other variables such as the output gap and unemployment gap. We model the SARB's monetary policy reaction function as a Taylor rule, with measures related to inflation and the output gap as arguments.

Estimates for many countries have found that a Taylor rule does describe the monetary policy reaction function well, but that result would not be expected for a country that has a simple and rigid regime that targets only currently observed inflation and adjusts policy to correct only for current inflation deviations. In such a model, the coefficient on the output gap or other variables would be expected to be not significantly different from zero. Our estimates shed light on whether the SARB has focused on current inflation alone.

The issue is important for South Africa's choice of macroeconomic strategy. At various times since the introduction of inflation targeting, political and technical debates have included prominent criticisms of inflation targeting or the interest rate policies resulting from it. For example, pressure for SARB to abandon interest rate policies pursued under inflation targeting has been voiced by the trade union confederation, COSATU, which argued in 2007 and subsequently 'that the narrow focus on inflation targeting is not an appropriate monetary policy approach' (COSATU 2007, 2011). Similarly, some independent experts have argued for flexibility in the SARB's operation of inflation targeting to make interest rate setting responsive to GDP growth and unemployment, as well as inflation (*Business News* 2016).

Although critics argue against a narrow South African inflation targeting regime defined in terms of current inflation, the SARB, like other central banks, defines its approach as flexible inflation

targeting (Marcus 2015). Explicitly, its flexibility is marked by targeting a band of inflation rates rather than a specific level, but it also has discretion over the speed with which it aims to achieve corrections to the target band (policy rate smoothing) and has the ability to take into account the sources of inflation shocks when determining the policy interest rate (van der Merwe 2004). Since SARB's explicit mode is to target expected inflation, the Monetary Policy Committee (MPC) could be expected to form its own expectations on the basis of maximum available information and take into account numerous indicators of broad economic conditions, including measures of the output gap and labour market conditions.

With unemployment in South Africa remaining high at around 25 per cent, or 33 per cent on a broad measure including discouraged work seekers, the extent to which its monetary policy has actually followed a Taylor rule responding partly to measures of the output gap or unemployment while maintaining its focus on the inflation target is of particular importance. The theoretical foundations of Taylor rule policies relate to medium-term, countercyclical measures, while—as indicated by long-term unemployment persistently being around 66 per cent of the total—structural unemployment is a high proportion of South Africa's total.

In this paper, we aim to investigate whether a Taylor rule accurately describes the SARB's policy rate decisions during the official inflation targeting period, which formally commenced in February 2000, by estimating the SARB's monetary policy reaction function as a modified Taylor rule, framed in terms of measures of expected inflation and labour market slack.

Our results suggest that the SARB's monetary policy reaction function is not distinguishable from a stochastic modified Taylor rule; its rate setting is a function of both expected inflation and labour market slack. The finding is similar to that of Ellyne and Veller (2011), who find that a Taylor rule equation fits the data more strongly for the period after the formal adoption of inflation targeting than before. Our study strengthens that finding by addressing two sources of potential mismeasurement. Instead of using current inflation as a proxy for expected inflation, we use direct measures of inflation expectations; and instead of using a Hodrick–Prescott (HP) measure of the GDP output gap (Hodrick and Prescott 1997), we use measures of labour market slack.

2 Literature review

The rule developed by Taylor (1993) as a guide for monetary policy prescribes setting the policy rate as a function of two variables: current inflation's deviation from a target rate, and a measure of the GDP output gap:

$$i = r^* + \pi^* + b\left(\pi - \pi^*\right) + gy \tag{1}$$

where i is the policy rate, r^* is the long-run or equilibrium interest rate, π^* is the central bank's inflation target, π is the rate of inflation over the last four quarters, and y is the output gap. The output gap is calculated as

$$y = 100(Y - Y^*) / Y^* \tag{2}$$

where Y is real GDP and Y^* is trend real GDP.

For the United States, Taylor estimated that the Federal Reserve's monetary policy decisions had been consistent with such a rule with coefficient values $b > 1$ and $b > g$:

$$i = r^* + \pi^* + 1.5\left(\pi - \pi^*\right) + 0.5\, y \tag{3}$$

Under a monetary policy in accordance with Equation (1), inflation higher than the target should exert a positive influence on the chosen policy interest rate, while a negative output gap, measured as real GDP below its trend level, should exert a downward influence. Such an instrument rule enables the authorities to achieve the inflation target if $b > 1$ (the Taylor Principle), as in Equation (3).

Empirical studies for several economies have examined the extent to which the monetary policy reaction functions exhibited by central banks have approximated that prescribed by the Taylor rule. This study adds to knowledge on that question. Whether policy makers' choices do conform with those a Taylor rule would prescribe is an empirical question; does their revealed reaction function contain the same variables (however measured) as the Taylor rule, and are its estimated coefficients similar to the magnitudes in Taylor's 1993 model? A distinct issue is whether such reactions could have resulted from choices taken by policy makers conscious of both Taylor's principles and their mandate. The possibility depends on the central bank's mandate. A Taylor rule could guide policy in a 'dual mandate' system such as that of the Federal Reserve, which, since 1977, has been mandated to conduct monetary policy 'so as to promote effectively the goals of maximum employment, stable prices and moderate long-term interest rates' (US Congress 1977)—a mandate interpreted as requiring equal twin targets of maximum employment and stable prices. It could also guide policy under a mandate such as South Africa's under which SARB operates flexible inflation targeting with expected inflation as the target. In line with a Taylor rule, SARB's policy rate could respond to both inflation and output divergences from target; the output gap can influence policy in its own right because the policy makers can adopt flexibility in moving towards the inflation target (or within its target band) and also because policy makers may take it into account in forming their inflation expectations.

A standard stochastic model of a central bank's reaction function can be derived from the Taylor rule (Kendall and Ng 2013):

$$i_t^R = i^* + b_\pi \left(\pi_t - \pi_t^T\right) + b_y y_t \tag{4}$$

$$i_t = \left(1 - \lambda\right) i_t^R + \lambda i_{t-1} + v_t y_t \tag{5}$$

$$v_t = \varrho v_{t-1} + \varepsilon_t \tag{6}$$

where i_t^R is the interest rate that the classic Taylor rule (Equation (1)) would prescribe, i_t is the policy rate, i^* is the 'neutral' interest rate, π_t is the current inflation rate, π_t^T is the inflation target, and y_t is the output gap. The degree of smoothing (characteristic of policy flexibility) is captured by λ, where higher values correspond to more smoothing.

Treating inflation targeting as forward-looking, Equation (4) may be written as:

$$i_t^R = i^* + b_\pi \left(\pi_t - \pi_t^e\right) + b_y y_t \tag{7}$$

Since the model's key variables, including y_t and π_t^e, may be represented by various measures, studies vary in part according to the modeller's choice of measured or estimated variables. Using survey-based estimates of inflation expectations, our study investigates the effect of using measures

of labour market slack instead of the output gap as an explanatory variable, following an approach initiated by Orphanides (2002), Orphanides and Williams (2002), and others.

2.1 Labour market slack

Since the output gap is not observable, many researchers use a HP filter to estimate capacity output, but the likelihood of measurement error cannot be discounted; Kendall and Ng (2013) find that a simple HP filter may produce output gaps that can be highly uncertain. Although the natural rate of unemployment is also not directly observable, an alternative specification of a Taylor rule uses deviations of unemployment from the natural rate—the unemployment gap—instead of the output gap.

Orphanides (2002) used a forward-looking Taylor rule based on perceptions regarding the outlook for inflation and unemployment to evaluate monetary policy in the United States during the 1970s and found that policy responded strongly to forecasts of inflation and the unemployment gap. This is an important consideration for the aims of our paper, and we take into account the following forward-looking version of a Taylor rule that was estimated assuming the policy objective is to maintain unemployment at its full-employment non-inflationary level (the NAIRU or natural rate, u^*) and inflation around a target, π^*:

$$f = r^* + \pi^* + \beta\left(\pi - \pi^*\right) + \gamma(u^* - u) \tag{8}$$

where f denotes the fed funds rate or the policy instrument, r^* the 'natural' rate of interest, π the outlook for inflation, and u the outlook for unemployment.

Despite the difficulty of quantifying the natural rate of unemployment, Orphanides and Williams (2002) consider a variant of a Taylor rule that responds to the unemployment gap instead of the output gap, assuming that the two are related by Okun's Law (Okun 1962):

$$f_t = \hat{r}_t^* + \pi_t + \theta_t\left(\pi_t - \pi^*\right) + \theta_u(u_t - \hat{u}_t^*) \tag{9}$$

where f_t is the federal funds rate, π_t is the rate of inflation, u_t is the rate of unemployment, π^* is the policy maker's inflation target, and $\hat{r}_t^*$ and $\hat{u}_t^*$ are the policy maker's estimates of the natural rate of interest and unemployment, respectively.

Orphanides and Williams (2002) also explore two generalizations of a Taylor rule in an attempt to mitigate the problem of natural rate mismeasurement, namely replacing the response to the unemployment gap with a response to the change in the unemployment rate and the incorporation of policy inertia. In general, the unemployment rate is not a perfect substitute for responding to the unemployment gap directly. However, responding to the change in the unemployment rate could be effective because it calls for an easing of policy when unemployment is rising and tightening when unemployment is falling. Meanwhile, incorporating inertia could significantly improve the stabilization performance of a Taylor rule in forward-looking models, while reducing the influence of the estimate of the natural rate of interest on the current setting of monetary policy and, therefore, the extent to which misperceptions regarding the natural rate of interest affect policy decisions. An example of a policy rule that is immune to natural rate mismeasurement presented by Orphanides and Williams (2002) is:

$$f_t = f_{t-1} + \theta_\pi\left(\pi_t - \pi^*\right) + \theta_{\Delta u}(u_t - u_{t-1}) \tag{10}$$

In practice, Equation (10) is simpler to implement than a Taylor rule because it does not require knowledge of the natural rates of interest or unemployment. However, this type of rule ignores potentially useful information about the natural rates of interest and unemployment. Furthermore, its performance relative to a Taylor rule and the generalized rule will depend on the degree of mismeasurement and the structure of the model economy.

In comparing various measures of the natural rate of unemployment, including HP and band-pass filters, the authors find widespread divergence in natural rate measures. Such uncertainty over the natural rate may lead to its underestimation and, consequently, policy decisions that are costly for the real economy in terms of unutilized resources.

We face similar challenges in quantifying the natural rate of unemployment in South Africa, with limited research on the topic. In order to address the problem of under- or overestimating the natural rate of unemployment, we assume a natural rate of unemployment of 25 per cent, which is also the average unemployment rate in South Africa. This is in line with Viegi (2015), who used a New Keynesian DSGE (dynamic stochastic general equilibrium) model with unemployment in order to examine how the labour market structure affects the transmission of monetary policy. The author argues that due to sticky wages—weak response of wages to changes in employment—in South Africa, the SARB faces a short-run employment–inflation trade-off. This, in turn, has implications for the efficiency of monetary policy and inflation targeting regime and provides motivation for estimating an unemployment-augmented Taylor rule.

Two things stand out from the literature presented above. First, since the natural rate of unemployment is difficult to estimate accurately, there are implications for how we measure the unemployment gap. Second, the literature on monetary policy rules has typically assumed that unemployment gaps and output gaps can be viewed as roughly equivalent (Orphanides 2002), while ignoring any broader measures of labour market slack.

Those observations are registered by Erceg and Levin (2013), who point out that macroeconomists have largely focused on the unemployment rate as a business cycle indicator instead of the labour force participation rate (LFPR), with consequences for the design of monetary policy. Using a New Keynesian model, the authors find that labour market slack is not well summarized by the unemployment gap, especially in recessionary periods. They conclude that monetary rules may have to be adapted to account for broader measures of labour market slack, such as the LFPR. This may have very different implications for how the economy recovers from a deep recession than 'standard' rules that focus on the unemployment gap. This same sentiment is expressed by Blanchflower and Levin (2015). However, one drawback identified in this area of research is that it does not incorporate the trade-off between inflation stabilization and the LFPR gap. We attempt to address this shortfall using an LFPR-augmented Taylor rule in addition to an unemployment-augmented Taylor rule.

2.2 South African Taylor rule estimates

Empirical research on the SARB's monetary policy reaction function finds that a Taylor rule provides a good fit for the inflation targeting period. While Ellyne and Veller (2011) find that the SARB's policy has been closer to a Taylor rule in the period of inflation targeting than previously, its policy actions show a high degree of flexibility in targeting inflation; estimated reaction function coefficients on both the inflation gap variable and the output gap variable are significant, but the inflation gap coefficient is notably lower than that on the output gap (and the values violate the Taylor principle). Similarly, Klein (2012) finds that SARB policy is well-described by a Taylor rule, noting that the implicit inflation target is at the upper level of the band with the inflation target gradually creeping up. Du Plessis and Smit (2003) estimate an extended policy rule for the period

1986–93, making use of a monetary M3 target and the output gap, and 1994–2002, which includes inflation and the output gap, in line with inflation targeting.

To the best of our knowledge, estimating a Taylor rule for South Africa using the unemployment gap and the LFPR has not been carried out. We do this by estimating a modified Taylor rule type of model to study the effects on policy of unemployment changes and labour force participation movements.

3 Methodology

Using ordinary least squares (OLS) to estimate alternative specifications of a Taylor rule we first follow Kendall and Ng (2013) and estimate a 'classic' Taylor rule with an output gap, and compare the results with alternatives in which the output gap is replaced by an unemployment gap, and finally by an LFPR gap. The specification for the classic Taylor rule regression is as follows:

$$i_t^R = i^* + b_\pi \left(\pi_t - \pi_t^T \right) + b_y (y_t - y_t^{pot}) \tag{11}$$

where: i_t^R is the interest rate that the classic Taylor rule would prescribe, π_t is the inflation rate or inflation expectations, π_t^T is the target inflation target (we use the midpoint of the 3–6 per cent target range, namely 4.5 per cent), y_t is real annualized output, and y_t^{pot} is potential output.

When using an unemployment gap, the regression equation is specified as follows:

$$i_t^R = i^* + b_\pi \left(\pi_t - \pi_t^T \right) + b_y (u_t - u_t^*) \tag{12}$$

where: u_t is the unemployment rate and u_t^* is the natural rate of unemployment.

Lastly, our LFPR gap regression is as follows:

$$i_t^R = i^* + b_\pi \left(\pi_t - \pi_t^T \right) + b_y (\text{LFPR}_t - \text{LFPR}_t^*) \tag{13}$$

where: LFPR_t is the labour force participation rate and LFPR_t^* is the long-term average of the labour force participation rate.

4 Data

Our full dataset comprises quarterly data from 1994Q1 to 2015Q3. Although data are available from 1994 onwards, using data post-2000 captures the inflation targeting period; the sample 2000Q1 to 2015Q3 is used for our central estimates.

The main instrument for monetary policy in South Africa is the repurchase (or repo) rate. Changes in the repo rate affect the demand and supply of goods and services which, in turn, is a source for inflationary pressure. As such, our dataset consists of different measures of inflation, including headline inflation and inflation expectations, the SARB's repo rate, real annualized GDP, the official unemployment rate provided by Stats SA, and lastly, various measures of an output gap

and an unemployment gap.[1] Typically, the output gap and the unemployment rate should move in the same direction; however, this depends on the participation rate. Hence, we also consider a Taylor rule augmented with the LFPR.[2] The two main data sources are Stats SA and the SARB. Using these variables, we were able to calculate the deviation of inflation and inflation expectations from the target as well as various gaps that are used in our Taylor rule estimations. Inflation expectations are only available from 2002Q3, which is after formal inflation targeting was implemented in February 2000.

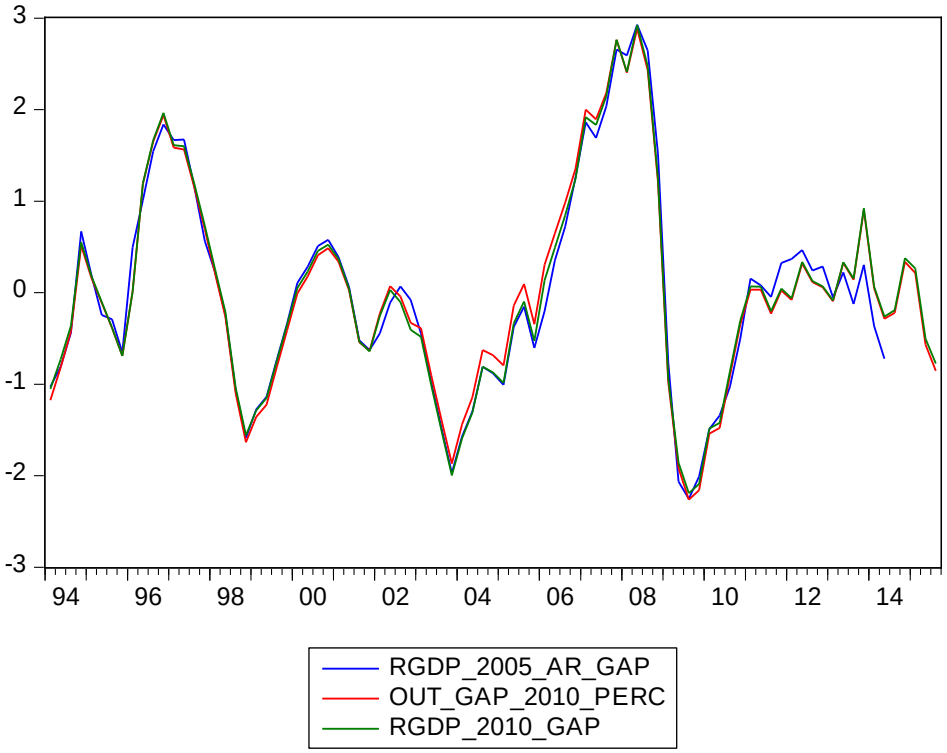
More details on the variables that were used are provided in Table A1 in the Appendix. Stationarity tests were also carried out, indicating, as shown in the Appendix, that the time series in levels are stationary.

Since the simple HP filter may produce output gap measures that are unreliable, as a robustness test we calculate two output gaps in 2010 prices using two different formulae. RGDP_2010_GAP is the output gap in 2010 prices calculated using the output gap formula provided by Taylor (1993), while OUT_GAP_2010_PERC is the difference, in logs, between annualized real GDP in 2010 prices and trend GDP obtained using the HP filter. As can be seen in Figure 1, these two measures are practically identical. RGDP_2005_AR_GAP is calculated in the same way as RGDP_2010_GAP (i.e. using Taylor 1993); however, this is calculated using 2005 prices and is used in the estimations below as a potential proxy of the unrevised data that the SARB would have had at their disposal in making their policy rate decisions. As can be seen, the three output gap measures largely map each other. Some differences can be seen towards the end of the period, given the rebasing of GDP data as well as data availability.

[1] When interpreting results, it is important to keep in mind that South African labour market data are subject to several weaknesses. Data collected in the early post-apartheid period are problematic due to different sampling techniques. Comparability over time is problematic due to the changes in the various surveys, especially the transition between the October Household Survey (OHS), the Labour Force Survey (LFS), and the Quarterly Labour Force Survey (QLFS). The way in which employment and unemployment were defined changed between the different surveys.

[2] The unemployment gap may not show as much variance as the participation rate, which typically moves with the economic cycle. The labour force participation rate gap is calculated as the deviation of the labour force participation rate from its long-run average (57 per cent).

Figure 1: Comparison of output gap estimations



Source: authors, based on Taylor (1993).

5 Empirical results

In this section, we provide the results of our estimates for (1) the classic Taylor rule, paying specific attention to inflation expectations; and (2) a Taylor rule containing labour market variables as explanatory variables.

Table 1 provides our classic Taylor rule estimates using rebased GDP data in 2010 prices. Our a-priori expectations for the classic Taylor rule are in line with Taylor (1993). Specifically, we expect to see positive coefficients on both the output gap and inflation deviation measures, with more weight (i.e. a larger coefficient) given to the deviation of inflation than to the output gap, in line with the SARB's mandate of price stability. In Taylor (1993), the coefficients on the output gap and inflation deviation variable were found to be 0.5 and 1.5, respectively.

Table 1: Classic Taylor rule estimations (1995Q3 to 2015Q3)

	A Headline inflation	B Including neutral rate
OUT_GAP_2010_PERC	–0.263	0.380
	(0.41)	(0.11)***
CPI_DEVIATION	0.928	0.141
	(0.18)***	(0.06)**
NEUTRALR		0.965
		(0.01)***
CONS	8.789	
	(0.48)***	
R^2	0.27	0.94
N	83	83

Notes: *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

Figures in brackets represent standard errors.

Source: authors, based on data from Stats SA and the SARB.

In the first specification (column A) in Table 1, we make use of the deviation of current headline inflation from the midpoint of the SARB's target range together with an output gap measure. The CPI_DEVIATION variable, which is the deviation of headline inflation from the midpoint of the SARB's target range, has a coefficient close to unity, while the estimated coefficient on the output gap is not significant, suggesting that monetary policy has followed an inflation targeting rule without flexibility. This finding, which is contrary to the Reserve Bank's and others' descriptions of policy-making, is not borne out when we estimate models of policy rules that take account of labour market conditions.

In our second specification (column B) of Table 1 we include a 'neutral rate' instead of a constant to account for policy inertia.[3] All the variables appear to be significant; however, the estimated coefficients are a lot smaller than the canonical coefficients of Taylor (1993), namely 0.5 for the output gap and 1.5 for the deviation of inflation from the target. Furthermore, in this specification the coefficient on the output gap is larger than on the CPI deviation variable. This result would imply that the SARB puts more weight on the output gap than inflation, which appears inconsistent with data showing that the rate of change of CPI has achieved a high degree of stability under the inflation targeting regime.

5.1 Inflation expectations and a Taylor rule

Table 2 provides a summary of the Taylor rule estimates using inflation expectations data available from 2002Q3. These OLS regressions yield statistically significant results, while the coefficients are larger and more in line with our a-priori expectations than when using headline inflation as used in Table 1, suggesting that the SARB targets expectations of inflation rather than current headline inflation. This is especially the case when using year-ahead inflation expectations (column E), in line with Taylor's (1993) rule, suggesting that the SARB is forward-looking in setting its policy rate, and puts more weight on the deviation of inflation expectations from its target than

[3] The 'neutral rate' was calculated as an average of the past four quarters' repo rate to account for policy inertia as in Orphanides and Williams (2002).

the output gap. This is in line with its mandate of price stability and could be employment enhancing if high inflation is detrimental to economic growth and employment creation.

Table 2: Summary of Taylor rule estimates using inflation expectations (2002Q3 to 2015Q3)

	C Inflation expectations, *t*	**D** Inflation expectations, *t*; alternative output gap measure	**E** Inflation expectations, *t* + 1
OUT_GAP_2010_PERC		0.685	
		(0.19)***	
RGDP_2010_GAP	0.609		0.751
	(0.20)***		(0.21)***
INF_EXP_T_DEV	1.069	1.081	
	(0.16)***	(0.15)***	
INF_EXP_T1_DEV			1.561
			(0.26)***
_CONS	5.661	5.618	4.902
	(0.38)***	(0.37)***	(0.53)***
R^2	0.53	0.55	0.47
N	53	53	53

Notes: *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

Figures in brackets represent standard errors.

Source: authors, based on data from Stats SA and the SARB.

Our results suggest that inflation expectations are extremely important for the SARB when setting the interest rate. Indeed, it receives significant consideration in the communication of interest rate decisions, and hence we are not surprised that a Taylor rule using inflation expectations provides a good fit for the SARB's interest rate decisions. The inflation expectations used in Table 2 are aggregated inflation expectations of analysts, businesses, and trade unions. In order to infer whose expectations the SARB closely monitors when considering the interest rate, demand pressures, and the wider economy, in Table 3 we separately include year-ahead inflation expectations of these three groups.

Table 3: Summary of Taylor rule estimates using year-ahead inflation expectation of analysts, businesses, and trade unions (2002Q3 to 2015Q3)

	F	G	H
	Analysts' inflation expectations for the next year (t + 1)	Businesses' inflation expectations for the next year (t + 1)	Trade unions' inflation expectations for the next year (t + 1)
RGDP_2010_GAP	0.344	0.879	0.860
	(0.25)	(0.22)***	(0.21)***
INFL_E_ANA_T1_DEV	1.716		
	(0.46)***		
INFL_E_BUS_T1_DEV		1.300	
		(0.23)***	
INFL_E_TU_T1_DEV			1.134
			(0.19)***
_CONS	5.747	4.851	5.364
	(0.60)***	(0.56)***	(0.46)***
R^2	0.29	0.45	0.47
N	53	53	53

Note: *p < 0.1; **p < 0.05; ***p < 0.01.

Figures in brackets represent standard errors.

Source: authors, based on data from Stats SA and the SARB.

Using analysts' inflation expectations (column F) does not yield significant results. Furthermore, the coefficients are not in line with a-priori expectations. The results in the businesses' expectations specification (column G) are significant and in line with Taylor (1993), who found a coefficient of 0.5 for the output gap and 1.5 for the deviation of inflation from the target. Trade union inflation expectations (specification H) are also statistically significant and in line with a-priori expectations. In comparing the results, we find that the SARB may consider business and trade union expectations in making the policy rate decisions, given the significance of these two groups in our estimations. This could be because these two groups are seen as 'price setters' in the economy, whether it be directly via prices or indirectly via wages, while analysts are observers of the economy. Overall, the results confirm that inflation expectations are an important consideration for the SARB in making interest rate decisions, and that the SARB is forward-looking.

5.2 Unemployment and a Taylor rule

We introduce an innovation to South African literature by specifying a monetary policy reaction function with, alternately, the unemployment gap and deviation from the trend of the LFPR as explanatory variables. For the reasons offered by Erceg and Levin (2013), the latter might be a better measure of labour market slack influencing monetary policy decisions than the former. Results are presented in Table 4.

Table 4: Taylor rule estimates using alternative measures of labour market slack (1995Q1 to 2015Q3)

	I Taylor rule using the unemployment gap	**J** Taylor rule using the LFPR
CPI_DEVIATION	0.754	0.415
	(0.17)***	(0.14)***
UNEMP_DEV[a]	–0.363	
	(0.16)**	
LFPR_DEV		0.471
		(0.23)**
_CONS	8.626	7.835
	(0.47)***	(0.32)***
R^2	0.53	0.35
N	83	63

Notes: *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

Figures in brackets represent standard errors.

[a] The unemployment deviation could be capturing movements in the labour participation rate.

Source: authors, based on data from Stats SA and the SARB.

Specification I considers the deviation of the official unemployment rate from an assumed natural rate of 25 per cent (Viegi 2015) and the deviation of headline inflation from the midpoint of the SARB's target range. The results are significant and in line with a-priori expectations. As in Orphanides and Williams (2002), the negative relationship between the unemployment gap and the policy rate suggests that as unemployment rises above its natural rate, interest rates should fall to stimulate the economy to produce more, and hence increase demand for workers. When unemployment is falling, policy would tighten (i.e. interest rates would increase). However, the estimates suggest that a greater weight is placed on inflation in making monetary policy decisions, in line with the SARB's mandate of price stability.

Evidence from US data suggests that the LFPR is a significant component of labour market slack in addition to the unemployment rate, which only considers those seeking work. Whereas the participation rate has conventionally been modelled as a function of structural and demographic factors, Aaronson et al. (2012), Van Zandweghe (2012), Sherk (2012), and Hotchkiss and Rios-Avila (2013) find that a high proportion of decline in the US participation rate in the recession following the 2008 financial crash was cyclical. Similarly, while South Africa's unemployment rate rose from 21.5 per cent in 2008Q4 to 25.4 per cent in 2010Q3, the participation rate fell from 58.8 per cent in 2008Q4 to 55.4 per cent in 2010Q3 as discouraged people dropped out of the labour force entirely.

Erceg and Levin (2013) examine the implications for monetary rules and find that these rules may need to be adapted to take account of LFPR as a measure of labour market slack that is not fully captured in the unemployment rate. We introduce an innovation in specification J by using the deviation of the LFPR from its long-run average (57 per cent) as an alternative to the unemployment gap. This is because the LFPR is a broader measure of the conditions of the labour market that are not necessarily captured in the unemployment rate. We expect that if the participation rate falls below its long-run average, the SARB would reduce interest rates to stimulate domestic demand and output, and raise the participation rate back to its long-run average. Hence, the relationship is positive as the two variables are expected to move in the same direction. The results confirm our a-priori expectations, with almost an equal weight given to inflation and the deviation of the LFPR from its long-run average. This is an important finding and could be

used to confirm the results seen from the traditional Taylor rule as the LFPR may reflect economic conditions that are not captured in the unemployment rate.

Our results suggest that labour market slack, of which the unemployment gap and participation rate gap are components, does have a significant effect on the SARB's monetary policy, directly or indirectly. In following Taylor rule-like behaviour, the MPC might use these factors to confirm output gap measurements as the labour market measures avoid the difficulties associated with calculating potential growth and the output gap.

6 Conclusion

In this paper we set out to determine whether a Taylor rule accurately describes the SARB's policy rate decisions during the official inflation targeting period, and whether they account for labour market developments in making their policy rate decisions.

Our results indicate that the SARB's interest rate decisions are a close fit to a Taylor rule, especially when making use of inflation expectations instead of current headline inflation, suggesting the SARB is forward-looking in setting policy rates. Our results also indicate that in the classic Taylor rule setting, the SARB puts more weight on inflation expectations than the output gap, which aligns with the SARB's mandate of price stability. We also found that business and trade union expectations are of more significance in our Taylor rule specifications. This could be because these two groups are seen as price setters in the economy, either directly through prices, or indirectly through wages. This is an important consideration for policy, especially in anchoring expectations of those groups that weigh more heavily in the SARBs interest rate decisions. It also indicates that analysts struggle to persuade business and labour of the validity of their forecasts.

Another aim of the paper was to determine whether the SARB takes the unemployment gap into consideration when making interest rate decisions. We obtained significant results when accounting for the deviation of the unemployment rate from the natural rate of unemployment, which we assumed to be 25 per cent. The negative relationship between the unemployment gap and the repo rate suggests that as unemployment rises above its natural rate, interest rates should fall to stimulate the economy to produce more, and hence increase demand for workers.

Lastly, we included the LFPR as an explanatory variable in a Taylor rule and found that the participation rate may be a good proxy for labour market conditions as it reacts directly to economic conditions. Our results showed a positive relationship between the repo rate and the LFPR gap, showing that if the participation rate falls below its long-run average, the SARB would reduce interest rates to stimulate domestic demand and output, and raise the participation rate back to its long-run average. Thus, the SARB appears to consider the LFPR as an alternative to the traditional output gap measures used in addition to inflation deviations from the target. This may also prove to be a lot more robust to possible natural rate mismeasurements of output (otherwise known as potential output) or employment.

Possible future work on the South African Taylor rule could include estimating a Taylor rule that studies the potential effects of exchange rate movements on monetary policy. Such work would build on work done by Mohanty and Klau (2004) in their estimates of an augmented Taylor rule for 13 emerging economies, including India, Brazil, Chile, Mexico, and South Africa. In line with Mohanty and Klau's (2004) findings, our preliminary estimations using various exchange rate measures for South Africa were not significant and were not consistent with a-priori expectations. Mohanty and Klau (2004) did, however, find significant results when considering the exchange

rate for most of the other emerging economies explored. Although South Africa's monetary regime excludes targeting the exchange rate, it is possible that interest rate policy is influenced by exchange rate movements. The exchange rate pass-through is cited as a risk for the inflation target in many of the SARB's MPC statements, and in his statement on 17 March 2016, SARB governor Lesetja Kganyago stated that 'The exchange rate of the rand continues to be highly volatile and vulnerable to changes in both domestic and external developments. While the pass-through from the exchange to inflation is still relatively low, there are signs that this may be increasing.' (SARB 2016: 8).

Our paper confirms that the SARB's monetary policy reaction function behaves similarly to a stochastic Taylor rule when considering inflation expectations rather than headline inflation. Our paper further adds to the existing literature by distinguishing between business, analyst, and trade union inflation expectations in our Taylor rule estimations. We also found an alternative to the output gap in a Taylor rule in the form of a LFPR gap, which could address the difficulties and uncertainties associated with estimating an output gap.

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Appendix

The variables utilized in the model estimation are summarized in Table A1.

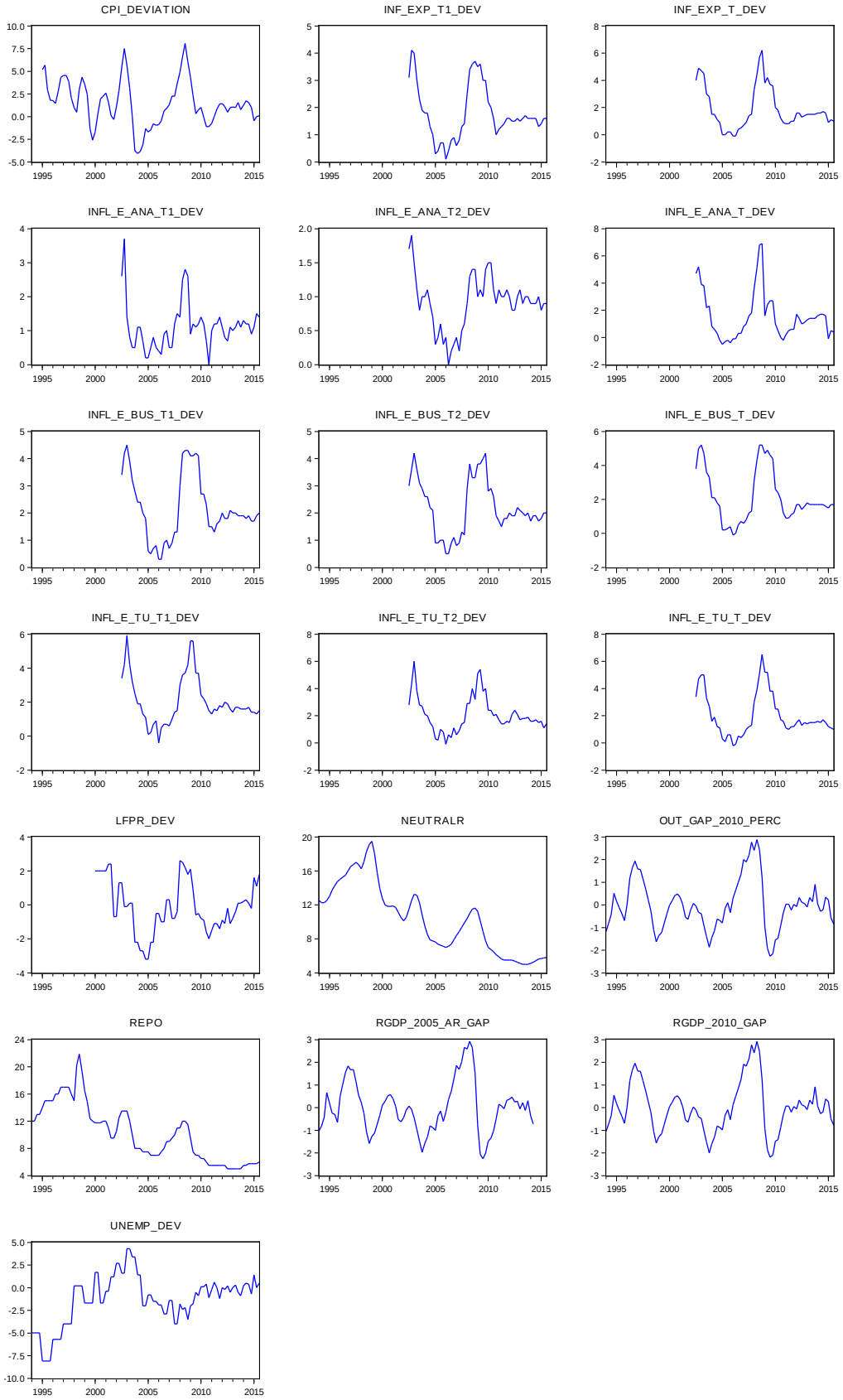
Table A1: List of variables

CPI_DEVIATION	The deviation of headline CPI inflation from the targeted inflation rate, set at the midpoint target range of 3–6% (i.e. 4.5%)
INF_EXP_T_DEV	Inflation expectations for the current year, *t* (full sample mean of Bureau for Economic Research (BER) expectations survey)
INF_EXP_T1_DEV	Inflation expectations for the next year, *t* + 1 (full sample mean of BER expectations survey)
INFL_E_ANA_T_DEV	BER inflation expectations of financial analysts for the current year, *t*
INFL_E_ANA_T1_DEV	BER inflation expectations of financial analysts for one year ahead, *t* + 1
INFL_E_ANA_T2_DEV	BER inflation expectations of financial analysts for two years ahead, *t* + 2
INFL_E_BUS_T_DEV	BER inflation expectations of business representatives for the current year, *t*
INFL_E_BUS_T1_DEV	BER inflation expectations of business representatives for one year ahead, *t* + 1
INFL_E_BUS_T2_DEV	BER inflation expectations of business representatives for two years ahead, *t* + 2
INFL_E_TU_T_DEV	BER inflation expectations of trade union representatives for the current year, *t*
INFL_E_TU_T1_DEV	BER inflation expectations of trade union representatives for one year ahead, *t* + 1
INFL_E_TU_T2_DEV	BER inflation expectations of trade union representatives for two years ahead, *t*+ 2
LFPR_DEV	The deviation of the LFPR from its long-run average of 57 per cent. The LFPR is sourced from the Labour Force Survey between 2000 and 2007, and the Quarterly Labour Force Survey (Stats SA) thereafter.
NEUTRALR	The neutral rate was used in some specification as a proxy for policy inertia and was calculated as the four-quarter average repo rate
OUT_GAP_2010_PERC	This is a measure of the output gap calculated as the difference between logged annualized real GDP in 2010 prices and trend GDP obtained using an HP filter, expressed as a percentage.
OUT_GAP2	Logged real GDP (from the expenditure side) divided by logged potential GDP multiplied by 100 to express as a percentage.
REPO	The SARB's repo rate is used to proxy the policy rate in a Taylor rule.
RGDP_2010_GAP	This is a measure of the output gap calculated using *rebased* (i.e. revised) data to 2010 and trend GDP estimated using an HP filter. It follows the formula from Taylor (1993): (100 × (rgdp_2010 – rgdp_2010_hp))/rgdp_2010_hp
RGDP_2005_AR_GAP	This is a measure of the output gap calculated using data 2005 prices (i.e. unrevised, and possibly the information the SARB had at the bulk of their MPC meetings) and trend GDP estimated using an HP filter. It follows the formula from Taylor (1993): (100 × (rgdp_2005_ar – rgdp_2005_ar_hp))/rgdp_2005_ar_hp
UNEMP_DEV	The deviation of the official unemployment rate from the assumed natural rate of 25 per cent. Alternatives for the 'unemployment gap' were estimated as the percentage deviation of actual unemployment from trend unemployment estimated by an HP filter over the whole sample, with λ = 1600.

Source: authors.

Figure A1 illustrates time plots of the relevant data series listed in Table A1.

Figure A1: Time plots of variables, 1970–2013



Source: authors, based on data from Stats SA and the SARB.

According to the graphical representations, the majority of the variables appear to be stationary. To statistically determine the univariate characteristics of the variables, augmented Dickey–Fuller (ADF) tests were utilized. Table A2 shows the results of the ADF tests on all the data series in their levels, while Table A3 summarizes the results of the ADF test on the data series in their first differenced form. The series are classified as integrated of order zero, and are thus rendered as stationary in their level.

Table A2: Augmented Dickey–Fuller test results, levels, 1994Q1 to 2015Q3

Series	Model	Lags	$\tau_\tau, \tau_\mu, \tau$ [a]
CPI_DEVIATION	Trend and intercept	5	–3.14
	Constant	5	–3.09**
	None	5	–2.50**
INF_EXP_T_DEV	Trend and intercept	0	–1.75
	Constant	0	–1.82
	None	0	–1.64*
INF_EXP_T1_DEV	Trend and intercept	1	–3.17
	Constant	1	–3.30**
	None	1	–2.22**
INFL_E_ANA_T_DEV	Trend and intercept	0	–2.49
	Constant	0	–2.56*
	None	0	–2.31**
INFL_E_ANA_T1_DEV	Trend and intercept	0	–3.71**
	Constant	0	–3.72***
	None	0	–2.06**
INFL_E_ANA_T2_DEV	Trend and intercept	0	–2.65
	Constant	0	–2.57*
	None	0	–1.47
INFL_E_BUS_T_DEV	Trend and intercept	1	–2.61
	Constant	1	–2.77*
	None	1	–2.14**
INFL_E_BUS_T1_DEV	Trend and intercept	1	–2.52
	Constant	1	–2.64*
	None	0	–1.14
INFL_E_BUS_T2_DEV	Trend and intercept	0	–1.74
	Constant	0	–1.79
	None	0	–1.00
INFL_E_TU_T_DEV	Trend and intercept	2	–3.57**
	Constant	2	–3.69***
	None	2	–2.64***
INFL_E_TU_T1_DEV	Trend and intercept	0	–1.85
	Constant	0	–1.89
	None	0	–1.38
INFL_E_TU_T2_DEV	Trend and intercept	0	–2.16
	Constant	0	–2.16
	None	0	–1.34
LFPR_DEV	Trend and intercept	0	–2.29
	Constant	0	–2.43
	None	0	–2.44**
NEUTRALR	Trend and intercept	5	–4.28***
	Constant	6	–1.22
	None	6	–1.15
OUT_GAP_2010_PERC	Trend and intercept	1	–3.67**
	Constant	1	–3.70***
	None	1	–3.72***
REPO	Trend and intercept	1	–3.90**
	Constant	2	–1.32
	None	2	–1.06

RGDP_2010_GAP	Trend and intercept	1	–3.66**
	Constant	1	–3.68***
	None	1	–3.71***
RGDP_2005_AR_GAP	Trend and intercept	1	–3.79**
	Constant	1	–3.81***
	None	1	–3.83***
UNEMP_DEV	Trend and intercept	0	–2.52
	Constant	0	–2.37
	None	0	–2.35**

Notes: *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

[a] At a 10 (5) [1] per cent significance level, the MacKinnon critical values are –3.19 (–3.52) [–4.19] when a trend and an intercept are included (τ_τ), –2.60 (–2.93) [–3.59] when only an intercept is included (τ_μ), and –1.61 (–1.95) [–2.62] when neither is included (τ).

Source: authors, based on data from Stats SA and the SARB.

Table A3: Augmented Dickey–Fuller test results, first differenced, 1994Q1 to 2015Q3

Series	Model	Lags	$\tau_\tau, \tau_\mu, \tau$ [a]
CPI_DEVIATION	Trend and intercept	4	–4.14***
	Constant	4	–4.17***
	None	4	–4.19***
INF_EXP_T_DEV	Trend and intercept	0	–6.11***
	Constant	0	–6.10***
	None	0	–6.09***
INF_EXP_T1_DEV	Trend and intercept	0	–5.44***
	Constant	0	–5.32***
	None	0	–5.30***
INFL_E_ANA_T_DEV	Trend and intercept	0	–6.85***
	Constant	0	–6.86***
	None	0	–6.88***
INFL_E_ANA_T1_DEV	Trend and intercept	0	–7.89***
	Constant	0	–7.71***
	None	0	–7.74***
INFL_E_ANA_T2_DEV	Trend and intercept	0	–6.93***
	Constant	0	–6.82***
	None	0	–6.83***
INFL_E_BUS_T_DEV	Trend and intercept	0	–5.12***
	Constant	0	–5.07***
	None	0	–5.06***
INFL_E_BUS_T1_DEV	Trend and intercept	0	–5.25***
	Constant	0	–5.22***
	None	0	–5.24***
INFL_E_BUS_T2_DEV	Trend and intercept	0	–6.34***
	Constant	0	–6.35***
	None	0	–6.39***
INFL_E_TU_T_DEV	Trend and intercept	1	–3.24*
	Constant	1	–3.21**
	None	1	–3.18***
INFL_E_TU_T1_DEV	Trend and intercept	0	–6.33***
	Constant	0	–6.36***
	None	0	–6.39***
INFL_E_TU_T2_DEV	Trend and intercept	0	–7.86***
	Constant	0	–7.93***
	None	0	–7.97***
LFPR_DEV	Trend and intercept	0	–7.77***
	Constant	0	–7.70***
	None	0	–7.76***
NEUTRALR	Trend and intercept	5	–3.10
	Constant	5	–3.15**
	None	5	–3.05***
OUT_GAP_2010_PERC	Trend and intercept	0	–5.68***
	Constant	0	–5.69***
	None	0	–5.73***
REPO	Trend and intercept	1	–6.31***
	Constant	1	–6.36***
	None	1	–6.35***
RGDP_2010_GAP	Trend and intercept	0	–5.69***
	Constant	0	–5.71***
	None	0	–5.74***
RGDP_2005_AR_GAP	Trend and intercept	0	–5.12***
	Constant	0	–5.14***
	None	0	–5.17***
UNEMP_DEV	Trend and intercept	0	–10.00***
	Constant	0	–10.05***
	None	0	–10.08***

Notes: *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

[a] At a 10 (5) [1] per cent significance level, the MacKinnon critical values are –3.19 (–3.52) [–4.19] when a trend and an intercept are included (τ_τ), –2.60 (–2.93) [–3.59] when only an intercept is included (τ_μ), and –1.61 (–1.95) [–2.62] when neither is included (τ).

Source: authors, based on data from Stats SA and the SARB.