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**Monetary Policy and Heterogeneous Inflation
Expectations in South Africa**

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Non-technical summary

The success of an inflation targeting (IT) regime depends largely on the ability of central banks to anchor expectations of agents to its official targets. Transparency and clear communication of monetary policy are essential factors to achieve this objective. The central bank should demonstrate determination in steering inflation within the target band. It is only then that long-run inflation expectations of the public are likely to remain largely unaffected even in the presence of adverse supply shocks such as a rise in oil or food prices. This implies that if the public believes the central bank's commitment, then their expectations will be closely tied to the target. However, if the regime is perceived to have less credibility, their expectations may be driven to a larger extent by realised past inflation. In this instance, agents are backward-looking instead of focused on the target. Long-term inflation expectations may then be volatile and transitory shocks to inflation can also have a more permanent effect on inflation expectations. It is therefore important to understand how agents form their expectations in an IT regime and determine their assessment of the credibility of monetary policy. Interestingly, different agents, such as business, unions and financial analysts may form their expectations quite differently.

In this paper we decompose aggregate - or economy-wide - inflation expectations. The relevant data is obtained from the quarterly survey conducted by the Bureau of Economic Research (BER) into individual expectations of these three types of agents. We use a simple macroeconomic model which estimates inflation expectations as a linear function of the inflation target and the lagged inflation. Our estimation is based on the history of South Africa's IT regime, i.e. the sample period runs from 2000Q3 to 2013Q1. This sample contains two inflationary shocks - namely in 2002Q3 and 2008Q3 - and a disinflationary shock in 2004Q1. The model has three key equations, namely, aggregate supply, monetary policy preferences, and inflation expectations. The expectations equation is estimated with a panel-data regression with fixed-effects approach where expectations of agents are linear functions of the inflation target and lagged inflation. The panel setup deals with heterogeneity in expectations.

Our findings are the following. (i) Expectations of agents are heterogeneous. Expectations of analysts are well-anchored within the official target band. In contrast, the remaining two price setters groups - whose behaviour directly affects actual inflation - i.e. business and labour - depict similar patterns in expectations formation with their mean expectations outside of the official target band. Their expectations are somewhat related to past realized inflation. (ii) The perceived - as opposed to the official - inflation targets of price setters are higher than the upper limit of the target band. This means that these two agents drive economy-wide expectations. On the contrary, the perceived target of analysts lies within the band. These results confirm the heterogeneity in agents. (iii) The implication of our analysis is that the SARB may find itself in a so-called *expectations trap*. This refers to a situation where a central bank wants to anchor inflation expectations - but because of imperfect perceived higher inflation expectations - paradoxically may find a less aggressive approach to this less costly.

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Monetary Policy and Heterogeneous Inflation Expectations in South Africa*

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Abstract

This paper examines the relationship between inflation and inflation expectations of analysts, business, and trade unions in South Africa during the inflation targeting (IT) regime. We consider inflation expectations based on the Bureau of Economic Research (BER) quarterly survey observed from 2000Q1 to 2013Q1. We estimate inflation expectations of individual agents as the weighted average of lagged inflation and the inflation target. The results indicate that expectations are heterogeneous across agents. Expectations of price setters (business and unions) are closely related to each other and are higher than the upper bound of the official target band, while expectations of analysts are within the target band. In addition, expectations of price setters are somewhat related to lagged inflation and the opposite is true for analysts. The results reveal that the SARB has successfully anchored expectations of analysts but that price setters have not sufficiently used the focal point implicit in the inflation targeting regime. The implication is that the SARB may be pushed to accommodate private agents' expectations.

JEL Classification Numbers: C51, E52, E58.

Keywords: Monetary Policy, Inflation Targeting, Heterogeneous Inflation Expectations, Expectations Trap.

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1 Introduction

Prior to the recent financial crisis, many countries – advanced and emerging market economies - have adopted inflation targeting (IT) as a monetary policy strategy to address the breakdown of the relationship between money growth rates and inflation (New Zealand, Canada and South Africa), or the disappointment following the use of exchange rates as an intermediate target (United Kingdom, Sweden and Finland). Most of these countries experienced a sharp decline in inflation right after the adoption of IT. The success of IT is attributed to, among others, the ability of central banks to anchor expectations of agents around its set targets (see Demertzis and Viegi, 2008). To achieve this objective, the central bank should clearly communicate its policy and should aim at further increasing its credibility. It is only in such an environment that the public would believe that the central bank is resolute in steering inflation towards the official target. Then inflation expectations will also converge to the official target and are likely to remain unchanged even in the presence of negative supply shocks such as rise in oil or food prices. In this instance, the public is convinced that the central bank will act to bring back inflation within the established target band. In that case inflation expectations will be tied closely to the target and the associated output cost of the disinflation will be lower. It is therefore crucial to analyse expectations formation of agents in an IT regime and determine the credibility of monetary policy.

Many studies have focused on the success of monetary policy in South Africa in curbing inflation in the IT era. For example, Gupta, Kabundi, and Modise (2010), Kabundi and Ngwenya (2011), Gumata, Kabundi, and Ndou (2013), and Aron and Muellbauer (2007) find that the South African Reserve Bank (SARB) has been successful in decreasing inflation in the IT regime compared to pre-IT periods. The SARB has achieved single-digit inflation for more than a decade, even though there were two instances (2002 and 2008) where inflation has risen to more than 10% due to the depreciation of the Rand and a rise in food prices. Notice that in these two instances inflation has stayed above the upper bound of the target band for less than three years. However, all the aforementioned studies are silent about the role played by expectations in the IT regime, and whether this success was a result of the ability of the SARB in anchoring expectations within the target band.

The following questions are crucial in determining the role played by expectations: (i) How does the SARB shape expectations of agents? (ii) Are these expectations homogeneous? (iii) Are perceived targets of agents consistent with its objective? (iv)

What explains the upward bias of inflation toward the upper bound of the target band? Kabundi and Schaling (2013, henceforth KS) attempt to answer these questions using a simple macroeconomic model which estimates inflation expectations as a linear function of inflation target and lagged inflation. They use aggregate (macroeconomic) inflation expectations obtained from the quarterly survey conducted by the Bureau of Economic Research (BER). Their results indicate that expectations formation of agents is backward-looking and that the implicit target of agents lies above the target band of 3 to 6%. This suggests that their expectations were not properly anchored. However, KS results can be somewhat misleading for two reasons. First, they assume that economic agents in South Africa are homogeneous. Aron and Muellbauer (2007) and Reid (2012), using the BER survey expectations and expectations obtained from Reuters, show that expectations of agents in South Africa are heterogeneous. The expectations of analysts adjust quickly to the official target band, while expectations of price setters (business and trade unions) adjust slowly. In general, price setters are somewhat backward-looking owing to the fact that wage setting in South Africa is backward-looking (Aron et al., 2004). Wage negotiation takes into account past inflation instead of future path in inflation. According to Aron and Muellbauer (2007), expectations of price setters eventually converge to those of analysts within the target band. They conclude that the SARB has been able to anchor expectations of all agents. Nevertheless, their study covers the sample period from 1994 to 2004, which misses important dynamics in inflation, such as the rise of 2008 due to exogenous shocks. Second, they work with current-year expectations.

In this paper we extend the KS analysis and decompose aggregate inflation expectations into individual expectations of three types of agents; businesses, trade unions and financial analysts. We use one-year and two-year ahead inflation expectations and a simple macroeconomic model with three key equations, namely, aggregate supply, monetary policy preferences, and inflation expectations. The expectations equation is estimated with a panel-data regression with fixed-effects approach where expectations of agents are linear functions of the inflation target and lagged inflation. The setting is appropriate to deal with heterogeneity observed in the intercepts and slopes, which in turn enables us to answer some key questions in determining the role of inflation expectations in the conduct of IT in South Africa. First, we conduct a Granger-Causality test. The results show that expectations of price setters are determined by lagged inflation. It implies that exogenous shocks to inflation also cause expectations of business and trade unions to rise. We find that expectations of analysts are unrelated to realized inflation, which indicates that the SARB has been successful in anchoring analysts' expectations. Further, the paper adopts a fixed-effects panel-data regression with respect to the three groups allowing for heterogeneity in perceived inflation targets as well as in lagged infla-

tion coefficients. The results show that inflation expectations are different across agents. While the price setters, i.e. business and labour, depict similar patterns in expectations formation with average expectations outside of the official target band, the analysts portray expectations that are well-anchored within the band. Unlike KS who derive a single perceived target for the aggregate, we obtain three implicit targets for the three groups. The implicit targets of price setters are consistent with KS findings, that is, they are higher than the upper limit of the target band. It means that these two agents drive aggregate expectations. The consequence is that the SARB may find itself in an *expectations trap*. When in the *expectations trap*, it may be pushed to accommodate private agents' expectations. In contrast, the perceived target of analysts lies within the band. These results confirm the heterogeneity in agents.

The remainder of the paper is organized as follows. Section 2 presents an overview of the relationship between inflation and inflation expectations for the aggregate and each individual agent. It is based on graphical representation of these variables. Section 3 presents the model. We describe the data, their transformation and the estimation of the model in Section 4. We discuss anchoring of expectations by the SARB and an analysis of the heterogeneity of expectations in Section 6. Section 7 concludes the paper.

2 Inflation and Inflation Expectations in South Africa: An Overview

Monetary authorities care about inflation expectations because realized inflation itself is partially driven by the public's expectations about future inflation. One channel is that nominal wages are partially set based on expected inflation. Inflation targeting was pioneered in New Zealand in 1990, and is now also in use by the central banks in the United Kingdom, Canada, Australia, South Korea , Egypt, South Africa, Iceland and Brazil, among other countries. The success of the regime depends largely on the behavior of the public's inflation expectations. If inflation expectations are equal to a point target or within the targeting band set by the central bank, the monetary policy regime is perfectly credible. But if the target or band - and thereby the IT framework - is imperfectly credible, long-term inflation expectations will be volatile and transitory shocks to inflation will also have an impact on inflation expectations. In a perfectly credible IT framework, long-term inflation expectations should be flat and tied to the central bank's inflation target level, or at least fluctuate inside the target band. In that case any adverse supply shock which increases the current inflation rate would have little effect on long-term inflation expectations because the public's - and thereby wage setters

- have confidence in the ability of the central bank to bring down inflation back to the target level - or into the band - over a certain time horizon, where the latter depends to what extent the central bank engages in flexible inflation targeting (this term was introduced by Svensson (1999)). It then appears that the presence of a strong correlation between long-term inflation expectations and the realized inflation rate is a sign of a lack of credibility of the IT regime.

As is common in countries who have adopted an IT framework, the SARB conducts a quarterly survey on inflation expectations to guide its policy. Figure 1 plots the BER inflation expectations at different horizons along with the realized CPI inflation (year-on-year change) from 2000Q3 to 2012Q3. Clearly, inflation has fluctuated a lot in 2000Q3-2009Q3 with two big negative shocks in 2002Q4 (due to massive depreciation of the South African rand) and 2008Q3 (due to increase in global food price coupled with a rise in oil price and another depreciation of the South African rand) and a positive shock in 2004Q1 (an appreciation of the rand) before stabilizing near the upper bound of the target (6%) during the financial crisis. Below we will look at inflation expectations of different agents, for now we look at the average across agents. Average inflation expectations series closely tracked actual inflation - seemingly with a lag - in 2000Q3-2009Q3 especially in periods when inflation exceeded the upper bound of the band. This suggests that during this period the shocks discussed above that increased inflation also drove up inflation expectations. Thus, from this graphical inspection, it seems that most of the time the Reserve Bank's monetary policy hardly anchors inflation expectations. However, after the financial crisis both inflation and inflation expectations have converged to the upper bound of 6%. We will provide formal tests for anchoring in the following sections. Notice that the SARB survey - conducted and published by the BER - has separate questionnaires for different societal groups: financial analysts (including economists), business people, and trade union representatives. Thus, the BER dataset has a panel structure. This will be used in our empirical work. Note that the inflation expectations series discussed above relates to the *aggregate* across these agents.

For policy implementation purposes, it would be interesting for the SARB to understand whether these groups are homogeneous in terms of their expectations formation for a number of reasons. First, if there is heterogeneity in expectations, it may be the case that some groups do not have a good understanding of the IT framework. Identifying these groups may help the SARB with its communication strategy. Second, trying to influence inflation expectations requires an understanding of the process by which these expectations are formed. Third, the appropriate monetary policy response to an expectations shock may differ across sectors or agents. For example, a shock to analysts' expectations may have less potential impact on actual inflation than a similar shock to

union’s or business expectations. Finally, inflation expectations across sectors or agents may influence each other because of the relationship between these two groups. In fact employees’ wages are usually negotiated in advance and are based on expected future prices. Next, firms will set prices according to a mark-up over marginal cost. For South Africa, research on the determinants of inflation has done by *inter alia* Fedderke and Schaling (2005) and Fedderke, Kularatne and Mariottti (2007). Both papers find that the mark-ups in South Africa over marginal cost are approximately twice that found in the U.S. This may give rise to a classic wage-price spiral.

In Figure 2, we plot the inflation expectations of the three types of agents at one-year and two-year ahead horizons along with the realized CPI inflation rate and the SARB official target range of 3% - 6%. Panel A depicts the expectations of the analysts, Panel B business expectations and Panel C trade union’s expectations. The inflation expectations pattern seems to be significantly different across agents. First, the analysts’ group expectations pattern is relatively flat with their two-year ahead inflation expectation within the target band. Second, the business and the trade union’s expectations patterns are very similar and seem to track realized inflation seemingly with a lag - as was the case with the aggregate inflation expectations pattern. Thus, it appears that the expectations of the analysts are well anchored, whereas those of business and unions are not. It means that the analysis based solely on aggregate expectations, such as KS, may lead to misleading conclusions.

3 The Model

Kabundi and Schaling (2013) discuss disinflation policy in South Africa using a simple macroeconomic model, which combines nominal wage and price stickiness and slow adjustment of expectations to a new monetary policy regime. The model analyses the interaction between private sector expectations and the monetary regime, and in particular the speed at which the inflation target implicit in the latter converges to price stability. It features nominal rigidity and an optimising central bank (CB) that trades inflation versus output stabilisation.

More specific, the model has three key equations: aggregate supply, monetary policy preferences and inflation expectations. Aggregate supply exceeds the natural rate of output when inflation is higher than was expected by agents when nominal contracts were set. This is captured by a simple short-run Phillips curve¹

$$z_t = \pi_t - \pi_t^e - \epsilon_t \tag{1}$$

¹In their analysis of U.S. monetary policy experimentation in the 1960s, Cogley, Colacito and Sargent (2005) use a model similar to ours but with unemployment instead of output.

Here π_t is the rate of inflation, z_t is the output gap, π_t^e indicates the expectation of inflation as the aggregate of the subjective expectations (beliefs) of private agents and ϵ_t is a supply (cost-push) shock.

$$\pi_t^e = 1/3 \sum \pi_t^{e,i} \quad (2)$$

where $i = a, b, u$ (and a denotes the analysts group, b the businesses group and u the unions group). Those beliefs do not necessarily coincide with rational expectations.² The model is not restrictive as long as inflation expectations are in part influenced by past monetary policy (see e.g., Bomfim and Rudebusch (2000)).³

The regime change is represented by a new inflation target π^* , which is announced to the public (business, unions and financial analysts) at the end of period $t - 1$. The new target is lower than the initial steady state inflation rate, denoted by π_0 .

The central bank's objective as of period t is to choose a sequence of current and future inflation rates $\{\pi_t\}_{t=0}^{\infty}$ so as to minimize its intertemporal loss

$$\sum_{t=0}^{\infty} \beta^t \frac{1}{2} [a(\pi_t - \pi^*)^2 + (z_t)^2] \quad (3)$$

where parameter $0 \leq a < \infty$ is the relative weight on inflation stabilisation, while $0 < \beta \leq 1$ is the discount factor.

The timing of events is such that the central bank chooses its disinflation policy *after* private sector inflation expectations are set. In the terminology of game theory the private sector is the Stackelberg leader. In Section 5.4 we analyze the opposite case.

The above statements can be analysed more precisely by explicitly considering the central bank's optimisation problem (where it takes inflation expectations as given, that is, under naïve discretion). The central bank's optimal inflation rate - or Best Response in terms of Sargent (1999) is:⁴

$$\pi_t = \frac{1}{1+a} (\pi_t^e + \epsilon_t) + \frac{a}{1+a} \pi^* \quad (4)$$

²For a New-Keynesian model where the central bank has a similar incentive structure and private agents are learning see Bullard and Schaling (2009).

³In the present paper - given expectations - the output costs of disinflation are constant and given by the slope of the Phillips curve. Here this parameter is normalised at unity. However, if we allow the output costs of disinflation to vary with the inflation rate, the central bank's incentives change substantially. Thus, one way of extending the model with state-contingent output costs of disinflation would be by means of a non-linear Phillips curve as discussed in Schaling (2004). For a preliminary analysis along those lines see Hoerberichts and Schaling (2006).

⁴According to the central bank's first order condition monetary policy responds to *aggregate* expectations. Thus the heterogeneity of agents is not taken into account in monetary policy. We leave this for further research.

Of course, from (4) it is clear that if expectations are slower to adapt, the disinflation should be more gradual as well. The inflation rate should decline as a constant proportion of the exogenous expected inflation rate.

In a standard New-Keynesian model the Phillips curve is $\pi_t = \beta E_t \pi_{t+1} + \lambda z_t + \epsilon_t$ and the first-order condition under discretion is $\pi_t = \frac{\beta}{1+\lambda^2 a} E_t \pi_{t+1} + \frac{1}{1+\lambda^2 a} \epsilon_t + \frac{\lambda^2 a}{1+\lambda^2 a} \pi^*$. This is very similar to the first order condition of the specification adopted in this paper if $\lambda = 1$ ⁵ since the discount factor $0 < \beta \leq 1$ is typically calibrated at 0.99. See for example Woodford (2003). This implementation of flexible inflation targeting is what Evans and Honkapohja (2003) call an expectations-based optimal rule, by construction, it implements what they label ‘optimal discretionary policy’ in every period and for all values of private expectations. Here as above the central bank also chooses its disinflation policy *after* private sector inflation expectations are set. The only difference is the timing of expectations (set at time t or $t - 1$) which has no bearing on our empirical results. What matters is who moves first, the central bank or the private sector.

In general, expectations are affected both by the inflation target and by actual inflation performance. After experiencing high inflation for a long period of time, there may be good reasons for the private sector not to believe the disinflation policy fully (See also Bomfim and Rudebusch (2000)). In light of this, in this section we assume that for each agent inflation expectations follow a simple rule, that is a linear function of the inflation target and the lagged inflation rate.

$$\pi_{t+h}^{e,i} = \rho^i \pi_{t-1} + (1 - \rho^i) \pi^* \quad (5)$$

where h is the forecast horizon. Put differently, the lower ρ , the better inflation expectations are anchored at long horizons.⁶

Note that if the regime switch to the new inflation target is completely credible, inflation expectations are immediately anchored by the inflation target, that is $\pi_{t+h}^{e,i} = \pi^*$ (we have $\rho^i = 0$). Conversely, if the regime switch is not credible at all, inflation expectations remain driven by the past inflation rate; $\pi_{t+h}^{e,i} = \pi_{t-1}$ ($\rho^i = 1$).⁷ In reality - and in the case of South Africa - we are likely to find in between cases. To that end

⁵As pointed out by Clarida, Gali and Gertler (2000, p. 170) there is no widespread consensus on the value of λ . Values found in the literature range from 0.05 to 1.22.

⁶For an empirical analysis for the U.S. examining observable measures of long-run inflation expectations, see Kiley (2008). Further our model generates persistent inflation (decreasing in a), although the central bank does not aim for an output target above the natural rate. An alternative framework that also generates an inflation bias is the paper by Cukierman and Gerlach (2003). Here the central bank aims for the natural rate - as in this paper - but is more concerned about negative than positive output gaps.

⁷Note that if we see the above as a game between the private sector and the central bank then the former’s expectations formation equation can be interpreted as its reaction function. The solution

we will now estimate equation (5) for South Africa (for each agent) over the period 2000-2013

$$\pi_{t+h}^{e,i} = c^i + \rho^i \pi_{t-1} + \varepsilon_t^i \quad (6)$$

and ε_t^i is the *iid* stochastic error term which follows a normal distribution. In so doing, we obtain $\hat{\rho}^i$ and \hat{c}^i , where $\hat{c}^i = (1 - \hat{\rho}^i)\hat{\pi}^*$. Therefore, for each agent we can easily compute their perceived (implicit) inflation target as: $\hat{\pi}^{i*} = \frac{\hat{c}^i}{1 - \hat{\rho}^i}$.

4 Econometric and Data Analysis

4.1 Econometric Analysis

Fully anchoring inflation expectations would mean that inflation expectations are equal to the target and hence completely uncorrelated with realized inflation. Then any shock to inflation has a limited effect on inflation expectations. One way to test whether expectations are well anchored is to perform a Granger causality test between inflation expectations and realized inflation. If realized inflation Granger causes inflation expectations that signals a lack of "anchoredness" as then lagged realized inflation will have an impact on expected inflation. We report the results of this test in our section on the empirical results.

To account for a potential heterogeneity in expectation formations, we exploit the panel structure of the BER dataset and estimate the following panel model

$$\pi_{t+h}^{e,i} = \alpha_{i_0} + \alpha_1 D_t^{i_1} + \alpha_2 D_t^{i_2} + \delta_0 \pi_{t-1} + \delta_1 D_t^{i_1} \pi_{t-1} + \delta_2 D_t^{i_2} \pi_{t-1} + u_t^i \quad (7)$$

where $i_0, i_1, i_2 \in \{a, b, u\}$, $i_0 \neq i_1 \neq i_2$, $\pi_t^{e,i}$ is a measure of time t inflation expectations of agent i , D_t^i is a dummy variable taking 1 if the agent type is i and 0 otherwise, π_{t-1} is lagged realized inflation, u_t^i is a time t independently distributed error term of agent i , and $\alpha_{i_0}, \alpha_1, \alpha_2, \delta_0, \delta_1, \delta_2$ are constant parameters. i_0 is a reference category and i_1, i_2 represent one of the two other categories.

Notice that equation (7) nests the equation by equation estimation. That is, for a given type i , the model is reduced to a regression of agent i 's inflation expectations on a constant and lagged realized inflation. Since we have three agents and the analysts group expectations seem to be anchored rather well relative to other groups, we use the analysts group as the reference category and hence only use the business and trade unions group dummies in the model. Thus $i_0 = a$ and α_{i_0} and δ_0 are respectively the intercept and the slope coefficients of the analysts' expectations equation. The intercept

for inflation can be obtained by substituting the latter in the central bank's first order condition: $\pi_t = \frac{\rho}{1+\alpha} \pi_{t-1} + \frac{(1-\rho)+\alpha}{1+\alpha} \pi^*$.

and the slope coefficients of the type i_1 agent are given by $\alpha_{i_0} + \alpha_1$ and $\delta_1 + \delta_0$ respectively (the corresponding coefficients of the type i_2 are $\alpha_{i_0} + \alpha_2$ and $\delta_2 + \delta_0$ respectively).

This panel framework is interesting in the sense that it allows heterogeneity in the intercept as well as in the slope coefficients. The advantage is that we are able to directly test whether there is heterogeneity in the intercepts as well as in the slope coefficients. As a consequence, we can derive each agent's perceived inflation target as in (6). For example a Wald test can be used to test heterogeneity in the intercepts by simply testing the significance of α_1 and α_2 while a Chow-type test can be used to test differences in the slope coefficients.

Since the validity of the above regression requires the series to be stationary, we employ the Philips-Perron (PP) unit root test as well as the KPSS test developed by Kwiatowski, Phillips, Schmidt, and Shin (1992) to test the stationarity of the inflation and inflation expectations series. In the PP test case, the alternative model is an autoregression with a constant but no trend. The spectral estimation method used is the autoregressive spectral (AR spectral) method and the lag truncation is automatically selected using recursive t-tests. With regard to the KPSS test, we used the same spectral estimation method (AR spectral) and lag length selection criteria as in the PP test case. The results of the test are reported in Table 1 and reveal that the inflation and inflation expectations series are stationary at the 1% level of significance. Except for the trade unions' inflation expectations, the null hypothesis of a unit root can be rejected at the 1% level for all series in the PP test case. As for the KPSS results, the null hypothesis of stationarity cannot be rejected at the 1% level (5% for the aggregate 1-year ahead inflation expectations) except for the business inflation expectations rate. However, when we apply a Dickey-Fuller test based on the generalized least squares (DF-GLS) method, we are able to reject the null hypothesis of a unit root for all of our series at the 5% level. Elliott, Rothenberg and Stock (1996) (ERS) show that the DF-GLS test performs well in small samples compared to existing unit root tests. Since our sample size is relatively small (49 observations), we use the DF-GLS test results and conclude that all of our series are stationary.

4.2 The Data

In this paper we consider aggregate inflation expectations as well as expectations of three agents: business, trade unions and analysts (including economists). The data for these expectations are obtained from the BER. The BER conducts a survey in South Africa where major market participants are asked questions about the prospect of inflation. More specifically, the panel is made of 1 061 business people, 40 financial sector participants and 25 participants representing the labour market. According to Kershoff

and Smit (2002) the BER survey uses the questionnaires of the Reserve Bank of New Zealand as a guideline. This series is released each quarter.

Realized inflation is the quarterly year-on-year percentage change in the headline Consumer Price Index (CPI)⁸ and is taken from the SARB.

The sample is from the third quarter of 2000 to the first quarter of 2013. There are two main reasons for this sample size. First, we want to examine the dynamics of inflation and inflation expectations during the IT regime in South Africa. Secondly, the BER survey started in 2000, hence there is no reliable series on survey inflation expectations in South Africa before 2000.

5 Empirical Results

5.1 Anchoring of Inflation Expectations

Table 2 presents the empirical results of the Granger causality test between realized inflation and aggregate two-year ahead inflation expectations as well as the two-year ahead inflation expectations per agent. The null hypothesis of " π_t does not Granger cause π_t^e " can easily be rejected at the 1% level for the aggregate, business people and the trade unions representatives groups. This means that lagged realized inflation impacts on the two-year ahead inflation expectations of these two groups as well as on aggregate inflation expectations. On the other hand, this hypothesis cannot be rejected for the analysts group. This confirms the graphical view that analysts' expectations are well anchored, while business people and workers groups' expectations are not. Since business people and trade unions represent two-thirds of the sample and tend to report higher inflation expectations, it follows that aggregate inflation expectations are driven by these two groups and are not anchored. This is an important result which has implications for monetary policy implementation as will be discussed below.

5.2 Heterogeneity of Inflation Expectations

In this section we investigate whether the three groups of agents form their expectations in a similar way. We start by testing whether the average of the business and trade unions groups, i.e. $\bar{\pi}^i = \frac{1}{T} \sum_{t=1}^T \pi_t^{e,i}$ where $i = b, u$, are different from the analysts group. That is, we estimate (7) by Ordinary Least Square (OLS) with the slope coefficients set to zero and test the significance of the intercept coefficients α_1 and α_2 . Then we estimate the unrestricted version of (7) and test heterogeneity of the slope coefficients.

⁸As a robustness check, we also try the Core CPI inflation but the results of the paper are unchanged.

Since the reference category is the analysts group, α_1 or $\alpha_2 \neq 0$ would indicate heterogeneity⁹ (relative to the analysts group) in the intercepts. Table 3 reports the results of the restricted model. The F-statistic is significant at the 1% level meaning that the null hypothesis of $\alpha_1 = \alpha_2 = 0$ is rejected. Since α_1 and α_2 are positive this also indicates that business and trade unions groups tend to report higher inflation expectations on average compared to the analysts group. The estimated average of the one-year ahead inflation expectations is 5.51% for the analysts group, and 6.61% ($\hat{\alpha}_{i_0} + \hat{\alpha}_1$) and 6.51% ($\hat{\alpha}_{i_0} + \hat{\alpha}_2$) for business, and trade unions respectively. On the other hand, a test of $\alpha_1 = \alpha_2$ cannot be rejected meaning that on average business people and trade unions report similar inflation expectations. This is not surprising given the economic relationship between these two groups. Business and trade unions are price setters and their actions affect each other. Notice that these results imply that the average inflation expectations of the analysts group is within the SARB target band of 3 - 6% whereas the business people and the trade unions expectations are outside the band. However, even the analysts group average inflation expectations (5.51%) are near the upper bound of the target and far from the mid-point of 4.5%. These findings are problematic from a price stability perspective which will be discussed in more detail.

Table 4 presents the results of the full estimation of (7) using the one-year ahead inflation expectations as the dependent variable. Results indicate that past inflation does explain one-year ahead inflation expectations but differently across agents. On average, 62% of the variation of aggregate inflation expectations is explained by changes in past inflation. However, an agent-by-agent (decomposition) based estimation of (7) shows that the explanatory power of the regression is lower for the analysts group and higher for the business and trade unions groups (see Table 5). Both the intercepts and the coefficients on lagged inflation for business and trade unions are significant at the one percent of significance. Notice that the intercept α_1 is not statistically significant meaning that the intercept of the business group ($\alpha_{i_0} + \alpha_1$) is not statistically different from that of the analysts (α_{i_0}). The estimate of α_2 is negative (-1.11) and significantly different from zero. It means that the intercept of the trade unions group ($\alpha_{i_0} + \alpha_2$) is lower than that of the analysts. Moreover, the lagged inflation slope coefficient for the analysts group (0.13) is lower than for the two other groups (0.22 for business, and 0.35 for trade unions). These findings are in line with the graphical overview and the Granger causality test. In the next section we will derive the perceived (implicit) inflation target for each agent.

⁹Notice that the OLS estimation with dummies in the intercept yields the same results as the fixed effect concept of the panel data regression.

5.3 Credibility and Implicit Inflation Targets

In this section we derive the estimates of the coefficients ρ^i and π^* in equation (5) from the reduced form estimation of (7). Notice that from (5) and (7) we have the following identification:

$$\begin{aligned}\alpha_{i_0} &= (1 - \rho^{i_0})\pi^{*i_0} \text{ and } \delta_0 = \rho^{i_0} \text{ for the analysts group} \\ \alpha_1 + \alpha_{i_0} &= (1 - \rho^{i_1})\pi^{*i_1} \text{ and } \delta_1 = \rho^{i_1} \text{ for the business people group} \\ \alpha_2 + \alpha_{i_0} &= (1 - \rho^{i_2})\pi^{*i_2} \text{ and } \delta_2 = \rho^{i_2} \text{ for the trade unions representatives group}\end{aligned}$$

Since the dummy variables version of the model in (7) cannot deal with autocorrelations in the error terms, we do the estimation by agent as in (5) in order to deal with potential autocorrelations in the error terms. Thus, for each group we have estimates of different intercepts as well as different slopes that allows us to infer their estimated perceived inflation target of the central bank by the identification:

$$\hat{\pi}^{i*} = \frac{\hat{c}^i}{1 - \hat{\rho}^i} \quad (8)$$

where \hat{c}^i is the estimated intercept of type i agent. Notice that the lower $\hat{\rho}^i$ is, the more credible the central bank is viewed by group i agents since they put less weight on past inflation and more weight on the central bank's inflation target.

Table 5 contains the results of the estimation. The first column reports the results for the analysts group, the second column for the business people, and the third column for the trade unions representatives group. Results indicate that past inflation does explain one-year ahead inflation expectations but differently across agents. Both the intercept and the coefficient on lagged inflation are significant at one percent for business and trade unions. However, the explanatory power of the regression is lower for the analysts group and relatively higher for the business and workers groups. Approximately 26% of the variation of analysts expectations are explained. Moreover, the lagged inflation slope coefficient for the analysts group (0.11) is not significantly different from zero and is lower than for the two other groups (0.22 for business, and 0.35 for trade unions). Once again, these findings corroborate with the graphical overview and the Granger causality test. First, the SARB seems to have a higher credibility among the financial analysts and experts group compare to the price setters group (business and trade unions). Thus, the hypothesis that the SARB has been successful in anchoring price setters' (business and trade unions) group expectations is not supported in that the relevant coefficients of lagged inflation are relatively high and different from zero.¹⁰ In addition, serial correlation tests reveal that the regression residuals are highly auto-correlated in the business (0.86) and trade unions (0.72) cases compared to the analysts

¹⁰The Wald test reject the hypothesis that $\rho = 0$ with a *p-value* of zero.

group case (0.34). This indicates that all information about inflation expectation is not included in lagged inflation, but can be accounted by other factors, e.g. news.

Now we turn to analyze whether there is heterogeneity in the perception of the different agents of the SARB's inflation target consistent with the expectations schemes formulated in (6). We then derive the implicit inflation target for each agent as given by (8) in Table 5. The calculated perceived inflation targets are 5.41%, 6.77%, and 6.62% for the analysts group, business people, and the trade unions respectively. Once again, these results confirm the graphical observation that the analysts group's inflation expectations are relatively well anchored although their implicit target level (5.41%) is above the mid-point of the SARB's band and near the upper bound of 6%. These are important results for a central bank, such as the SARB, that targets inflation. The results indicate that the inflation targeting regime has buy-in from the analysts but is not seen to be very credible from the perspective of unions who set wages, and firms who set prices.

More specific, we now know that the lack of anchoring of *aggregate* inflation expectations (for an analysis of aggregate inflation expectations see Kabundi and Schaling, 2013) is driven by the *price setting* side of the economy, namely by business and trade unions, as the financial analysts group's expectations are relatively well anchored. However, those expectations have no direct impact on wages or prices. Thus the SARB should pay more attention to the price setters group in its communication strategy. It seems as if these two groups do not have a proper understanding of the SARB policy framework and/or do not see it as credible. Finally, even the financial analysts group perceives the SARB's inflation target at a level near the upper bound. Thus, it means that financial analysts and experts seem to believe and/or understand the SARB policy but apparently are not convinced that the SARB is aiming for the mid-point at 4.5%. Perhaps the band is too wide and/or there is no explicit point target to steer expectations appropriately. This introduces uncertainty in predicting inflation since realised inflation can be anywhere in the band.

5.4 Expectations Trap?

In this section we analyze the empirical relationship between the SARB's optimal inflation rate and the business and workers groups inflation expectations.

In this paper optimal monetary policy implies a strategic interaction between the private sector and the monetary authorities. The central bank's optimal inflation rate as derived in (4) is a weighted average of its concern about the business cycle (as proxied by the public's inflation expectations) and the central bank's inflation target. It is interesting to understand the importance of the public's inflation expectations for the

central bank optimal inflation, that is, we want to understand how the central bank reacts to changes in public inflation expectations. To what extent does the SARB accommodate private sector inflation expectations? Our paper is related to Chari, Christiano and Eichenbaum (1998). Their basic idea is that, under discretion, policymakers can be *pushed* into pursuing inflationary policies. This can happen when the private sector, for whatever reason, expects inflation. We know from the earlier part of the paper that this definitely applies to business and labour. Under these circumstances, the central banker may find it optimal to accommodate private agents' expectations if the cost of not doing so is a severe and/or persistent loss of output. Chari *et al* refer to such a situation as one in which the economy has fallen into an *expectations trap*. In the context of our model this can be seen from the central bank's first order condition for the case where $0 < a$. Then $\pi_t < \pi_t^e$ and $z_t < 0$. In the case of full accommodation we have $\pi_t = \pi_t^e$ and $z_t = 0$.

One way to get an idea of the severity of the expectations trap is to estimate the central bank's first order condition and test whether the coefficient on expected inflation is one (the case of full accommodation).

To that end, we regress the realized CPI inflation on the average one-year ahead inflation expectations of business and trade unions. We abstract from the analysts group because we already know that their expectations are relatively well anchored. Thus, we estimate the following equation:

$$\pi_t = \frac{1}{1+a} (\pi_t^e + \epsilon_t) + \frac{a}{1+a} \pi^*$$

where π_t^e the average inflation expectation of business and trade unions, that is, $\pi_t^e = 1/2(\pi_t^{e,b} + \pi_t^{e,u})$.

Table 6 presents the results of the regression. After adjusting for autocorrelation in the residuals, we find that the intercept is not significantly different from zero and the coefficient of aggregate inflation expectations is not statistically different from one at the 1% level. When in the expectations trap, a central bank might prefer inflation to temporarily exceed the target if the latter is expected by the private sector. So, our empirical findings support the hypothesis that the SARB may be caught in an expectations trap.

Chari et al. (1998) investigate alternative institutional arrangements - which in our case have a direct bearing on the implementation of inflation targeting in South Africa - that can eliminate the possibility of expectations traps. One solution is *full commitment* on the part of the monetary authority. Then the central bank minimizes its preference function subject to the Phillips curve *and* to the public's expectations

formation equation.¹¹

This implies the following Lagrangian:¹²

$$L = E_t \left[\sum_{\tau=t}^{\infty} \left\{ \frac{\beta^{\tau-t}}{2} [-a(u_\tau)^2 - (u_\tau - x_\tau)^2] - \beta^{\tau-t+1} \mu_{\tau+1} [x_{\tau+1} - \rho u_\tau] \right\} \right]$$

where $x_t = \pi_t^e$ is the state variable, $u_t = \pi_t$ is the control, and μ_t is the Lagrange multiplier.¹³

The solution of this problem (the central bank's first order condition) is:

$$\pi_t = C \pi_t^e$$

where

$$C = \frac{1}{2} \left\{ \left[\frac{(1+a) + \beta\rho^2}{\beta\rho^2} \right] - \sqrt{\left[\frac{(1+a) + \beta\rho^2}{\beta^2\rho^4} \right] - 4\beta\rho^2} \right\}$$

and $C < \frac{1}{1+a}$, where $\frac{1}{1+a}$ is the coefficient on expected inflation in equation (4).¹⁴ In this case the (optimal) disinflation under commitment is always faster than under discretion. Now recall the equation for the agent's expectations formation process in equation (5) where if the inflation target is less credible the higher ρ , as then inflation expectations remain largely driven by the past inflation rate π_{t-1} . According to Proposition 4 of Schaling and Hoeberichts (2010) the higher ρ the lower the monetary accommodation parameter C , and therefore the *lower* the central bank's optimal inflation rate. The argument is that the higher ρ , the more leverage the central bank has over inflation expectations via past inflation.¹⁵ Now the central bank no longer treats inflation expectations as exogenous variables. It realizes that those figures are partly the *outcomes* of its own policy decisions which imply actual inflation figures. This appears to be a *subtle* difference but it is *fundamental* and is of major practical relevance. If inflation expectations are partly driven by past inflation, by reducing actual inflation quicker those expectations will be adjusted downwards by private agents closer to the official inflation target. Lower inflation expectations translate into lower wages and prices (given the mark-up) so that a virtuous cycle emerges.

¹¹We assume that the central bank has full knowledge of the process of private sector learning, or in other words we have what Gaspar, Smets and Vestin (2006) call 'sophisticated central banking'.

¹²For a zero inflation target, but results do not depend on that.

¹³Without loss of generality we have set $h = 0$, so that expectations look one period ahead.

¹⁴For a proof see Schaling and Hoeberichts (2010).

¹⁵If we assume that the private sector's expectations about the central banks's *inflation target* are formed according to the adaptive (rational) learning literature, that is $E_{t-1}\pi_t = c_{t-1} = c_{t-2} + \kappa(\pi_{t-1} - c_{t-2})$ where $\kappa \in (0, 1)$, then one get precisely the same result: a higher gain parameter is associated with less monetary accommodation. In the limit we reach the Ramsey equilibrium where $z = 0$ and $\pi = \pi^* = 0$.

Such a policy is also less costly in terms of the output cost of the disinflation than under discretion (where the central bank treats inflation expectations as given). In line with the above discussion about commitment Schaling and Hoeberichts (2010) show that a central bank may try to convince the private sector of its commitment to price stability by choosing to reduce inflation (more) quickly. They call this "teaching by doing". They find that allowing for teaching by doing effects always speeds up the *optimal* disinflation (which balances inflation *and* output) and leads to lower inflation persistence. This "speed" result also holds in an environment where private agents rationally learn about the central bank's *inflation target* using a constant gain algorithm of Kalman Filter.

6 Conclusion

In this paper we have found empirical evidence for South Africa that suggests that economic agents inflation expectations are not fully anchored by the inflation target (which would be the preferred outcome in an inflation targeting regime).

We have extended the analysis of Kabundi and Schaling (2013) who focus on *aggregate* expectations and are therefore unable to identify which economic agents, business, unions or financial analysts drove their results. In this paper we have decomposed these results and looked at those individual agents' inflation expectations based on the BER survey data. We find that business and unions perceived inflation targets lie outside the official target band. This is relevant for monetary policy as inflation expectations of business people and workers may influence each other because of the relationship between these two groups. In fact employees' wages are usually negotiated in advance and are based on expected future prices. Next, firms will incorporate any expected increase in their marginal cost in to their product prices.

As a consequence the SARB may find itself in an *expectations trap*. This is the case because inflation expectations of business and labour - as proxied by their perceived inflation targets of 6.77% and 6.62% respectively - are outside the band. Thus, when in the expectations trap, the SARB may be pushed to accommodate inflation expectations. This is in fact fully supported by our estimation of the central bank's first order condition where we find that the coefficient of aggregate inflation expectations is not statistically different from one at the 1% level.

In general, the best way out of this trap is to commit to a faster reduction of inflation which may imply moving to a more narrow band which is more or less consistent with price stability.

Finally, the SARB may need to further improve the transparency of the framework and pro-actively signal its concerns about potential inflationary pressures - and likely

responses - to unions and business. This would be another operationalization of commitment with - in the terminology of game theory - the central bank becoming the Stackelberg leader in the interaction with the private sector.

Prior to the establishment of the European Central Bank such a practice was regularly followed by the Deutsche Bundesbank, arguably one of the most successful monetary institutions in the post-World War II era.

References

- [1] Aron, J. and Muellbauer, J. (2007). "Review of Monetary Policy in South Africa since 1994," *Journal of African Economies*, 16(5): 705-744.
- [2] Aron, J., Muellbauer, J., and Smit, BW. (2004). "A Structural Model of the Inflation Process in South Africa," CSAE Working Paper 2004-08
- [3] Bomfim, A. and Rudebusch, G. (2000), "Opportunistic and Deliberate Disinflation Under Imperfect Credibility", *Journal of Money, Credit, and Banking* 32, 707-721.
- [4] Bullard, James and Eric Schaling (2009) "Monetary Policy, Determinacy, and Learnability in the Open Economy", *Journal of Money, Credit and Banking*, Vol 41, Issue 8 December.
- [5] Chari, V.V., Christiano, L.J., and Eichenbaum, M. (1998). "Expectation Traps and Discretion", *Journal of Economic Theory*, August, pp. 462–492
- [6] Clarida, R., J. Gali and M. Gertler (2000, "Monetary Policy Rules and Macroeconomic Stability: Evidence and Some Theory", *Quarterly Journal of Economics*, Vol. 115, No 1, February, pp. 147-180.
- [7] Cogley, T., Colacito, R. and Sargent, T. (2005), "Benefits from U.S. Monetary Policy Experimentation in the Days of Samuelson and Solow and Lucas", 2005 Meeting Papers, Society for Economic Dynamics.
- [8] Cukieman, A. and Gerlach, S. (2003). "The inflation bias revisited: theory and some international evidence," *Manchester School*, 71(5): 541-565.
- [9] Demertzis, M. and Viegi, N. (2008), "Inflation Targets as Focal Points", *International Journal of Central Banking*, 4(1), 55-87.
- [10] Elliott, G., Rothenberg, T. J., and Stock, J. H. (1996), "Efficient Tests for an Autoregressive Unit Root", *Econometrica*, Vol. 64, No.4 July, 813 - 836.
- [11] Evans, G., and S. Honkapohja. (2003). "Expectations and the Stability Problem for Optimal Monetary Policies." *Review of Economic*
- [12] *Studies* 70: 807-824.
- [13] Fedderke, J. and Schaling, E. (2005). "Modeling Inflation in South Africa: A Multivariate Cointegration Analysis," *South African Journal of Economics*, 73(1): 79-92.

- [14] Fedderke, J., Kularatne, C., and Mariotti, M. (2007). "Mark-up Pricing in South African Industry," *Journal of African Economies*, 16(1): 28-69.
- [15] Gaspar, V., Smets, F., and Vestin, D. (2006). "Adaptive Learning, Persistence, and Optimal Monetary Policy," *Journal of the European Economic Association*, 4(2-3): 376-385
- [16] Gumata, N., Kabundi, A., and Ndou, E. (2013). "Important Channels of Transmission Monetary Policy Shock in South Africa", SARB Working Paper 1306.
- [17] Gupta, R., Kabundi, A., and Modise, M. (2010). "Has the SARB become more effective post inflation targeting?", *Economic Change and Restructuring*, 43(3): 187-204.
- [18] Hoeberichts, M. and E. Schaling (2006). "Why Speed Doesn't Kill: Learning to Believe in Disinflation," *Paper Presented at the South African Reserve Bank Conference 'Macroeconomic Policy Challenges for South Africa', 22-24 October.*
- [19] Kabundi, A. and Ngwenya, N. (2011). "Assessing Monetary Policy in South Africa in a Data-rich Environment", *South African Journal of Economics*, 79(1): 91-107.
- [20] Kabundi, A. and Shaling, E. (2013). "Inflation and Inflation Expectations in South Africa: An Attempt at Explanation," *South African Journal of Economic*, 81(3): 346-355.
- [21] Kershoff, G.J and Smit, BW (2002), "Conducting Inflation Expectation Surveys in South Africa", *South African Journal of Economics*, 70(3): 205 - 212. King, M. (1996), "How Should Central Banks Reduce Inflation? - Conceptual Issues", *Economic Review Federal Reserve Bank of Kansas City*, Vol. 81, No 4, Fourth Quarter, pp. 25-52. Can also be downloaded from www.kc.frb.org
- [22] Kiley, M. (2008) "Monetary Policy Actions and Long-Run Inflation Expectations," FEDS Working Paper, Board of Governors, No. 2008-03.
- [23] King, M. (1996). "How Should Central Banks Reduce Inflation? - Conceptual Issues," *Economic Review Federal Reserve Bank of Kansas City*, Vol. 81, No 4, Fourth Quarter, pp. 25-52. Can also be downloaded from www.kc.frb.org
- [24] Kwiatowski, D., P.C.B. Phillips, P. Schmidt, and Shin, Y. (1992) "Testing the Null Hypothesis of Stationarity Against the Alternative of a Unit Root: How Sure Are We That Economic Time Series Have a Unit Root?" *Journal of Econometrics* 54:159-178.

- [25] Reid, M. (2012). "Inflation Expectations of the Inattentive General Public," ERSA Working Paper 278.
- [26] Sargent, T. (1999) 'The Conquest of American Inflation', Princeton University Press.
- [27] Schaling, E. (2004) "The Non-linear Phillips Curve and Inflation Forecast Targeting: Symmetric vs. Asymmetric Policy Rules," *Journal of Money, Credit, and Banking*. Part 1 June; 36(3): 361-86
- [28] Schaling, E. and M Hoerberichts (2010) "Why Speed Doesn't Kill: Learning to Believe in Disinflation," *De Economist*, 2010, Vol. 158, no. 1, pp.23-42.
- [29] Svensson, L.E.O. (1999). "Inflation targeting: Some extensions," *Scandinavian Journal of Economics*, 101(3), 337–361.
- [30] Woodford, M. (2003). *Interest and Prices: Foundations of a Theory of Monetary Policy*, Princeton: Princeton University Press

Table 1. Stationarity Test of Inflation and inflations expectations

Variable	Test Statistic	
	KPSS	PP
Aggregate		
π_t^e	0.47 ^{††}	-3.35*
π_t	0.06 [†]	-7.62*
Analysts		
π_t^e	0.26 [†]	-4.07*
Businesses		
π_t^e	-2.02	1.27*
Trade Unions		
π_t^e	1.64 [†]	-1.8

Note: π_t is the realised CPI inflation. The superscripts * and ** denote rejection of the null hypothesis of unit root at 1%, and 5% levels respectively for the PP test. whereas the superscripts †, †† denote the inability to reject the stationarity hypothesis in the KPSS test

Table 2. Granger Causality Test

Null Hypothesis	F-statistic	p-value
Aggregate		
π_t^e does not Granger cause π_t	0.47	0.628
π_t does not Granger cause π_t^e	8.76	0.00
Analysts		
π_t^e does not Granger cause π_t	1.44	0.25
π_t does not Granger cause π_t^e	0.68	0.51
Businesses		
π_t^e does not Granger cause π_t	2.58	0.09
π_t does not Granger cause π_t^e	5.71	0.00
Trade Unions		
π_t^e does not Granger cause π_t	0.24	0.79
π_t does not Granger cause π_t^e	12.39	0.00

Note: π_t^e is the two-year ahead inflation expectations and π_t realized CPI inflation

Table 3. Heterogeneity in Average Inflation Expectations $\pi_{t+4}^{e,i} = \alpha_{i_0} + \alpha_1 D_t^{i_1} + \alpha_2 D_t^{i_2}$

Parameter	Estimate
α_{i_0}	5.51* (0.13)
α_1	1.10* (0.25)
α_2	1.00* (0.27)
R^2	0.11
F-statistic	13.29*

Note: Standard errors are reported in parentheses. π_{t+4}^e is the 1 year ahead inflation expectations. *, ** denote significance at 1%, and 5% respectively. i_0 is the analysts group, i_1 the bussines group and i_2 the trade unions group

Table 4 . Heterogeneity in Slopes and Intercepts:

$$\pi_{t+4}^{e,i} = \alpha_{i_0} + \alpha_1 D_t^{i_1} + \alpha_2 D_t^{i_2} + \delta_0 \pi_{t-1} + \delta_1 D_t^{i_1} \pi_{t-1} + \delta_2 D_t^{i_2} \pi_{t-1} + u_t^i$$

Parameter	Estimate
α_{i_0}	4.71* (0.28)
α_1	-0.51 (0.48)
α_2	-1.11* (0.48)
δ_0	0.13* (0.05)
δ_1	0.30* (0.07)
δ_2	0.37* (0.08)
R^2	0.62
F-statistic	60.33

Note: Standard errors are reported in parentheses. π_{t+4}^e is the 1 year ahead inflation expectations. *, ** denote significance at 1%, and 5% respectively. i_0 is the analysts group, i_1 the bussines group and i_2 the trade unions group

Table 5. Expectations Formation and Implicit Inflation Target by Agent

Explanatory Variables	Dependent Variable: $\pi_{t+4}^{e,i}$		
	Analysts	Business	Unions
c	4.82* (0.39)	5.28* (0.57)	4.30* (0.60)
π_{t-1}	0.11 (0.08)	0.20* (0.07)	0.35* (0.09)
$ar(1)$	0.34** (0.16)	0.86* (0.04)	0.72* (0.08)
Implicit Target (π^*)	5.41	6.77	6.62
R^2	0.26	0.86	0.84

Note: Standard errors are reported in parentheses. $\pi_{t+4}^{e,i}$ is the 1 year ahead inflation expectations of type i . * , ** denote significance at 1%, and 5% respectively . $ar(1)$ is an autogressive error term.

Table 6. Optimal inflation Regression

Explanatory Variables	Dependent Variable: π_t
c	-0.33 (2.44)
π_t^e	0.95* (0.34)
$ar(1)$	0.83* (0.11)
R^2	0.83

Note: Standard errors are reported in parentheses. π_t^e is the 1 year ahead inflation expectations of business and trade unions. * denotes significance at 1%. $ar(1)$ is an autogressive error term.

Figure 1. Inflation and Inflation Expectations: Aggregate

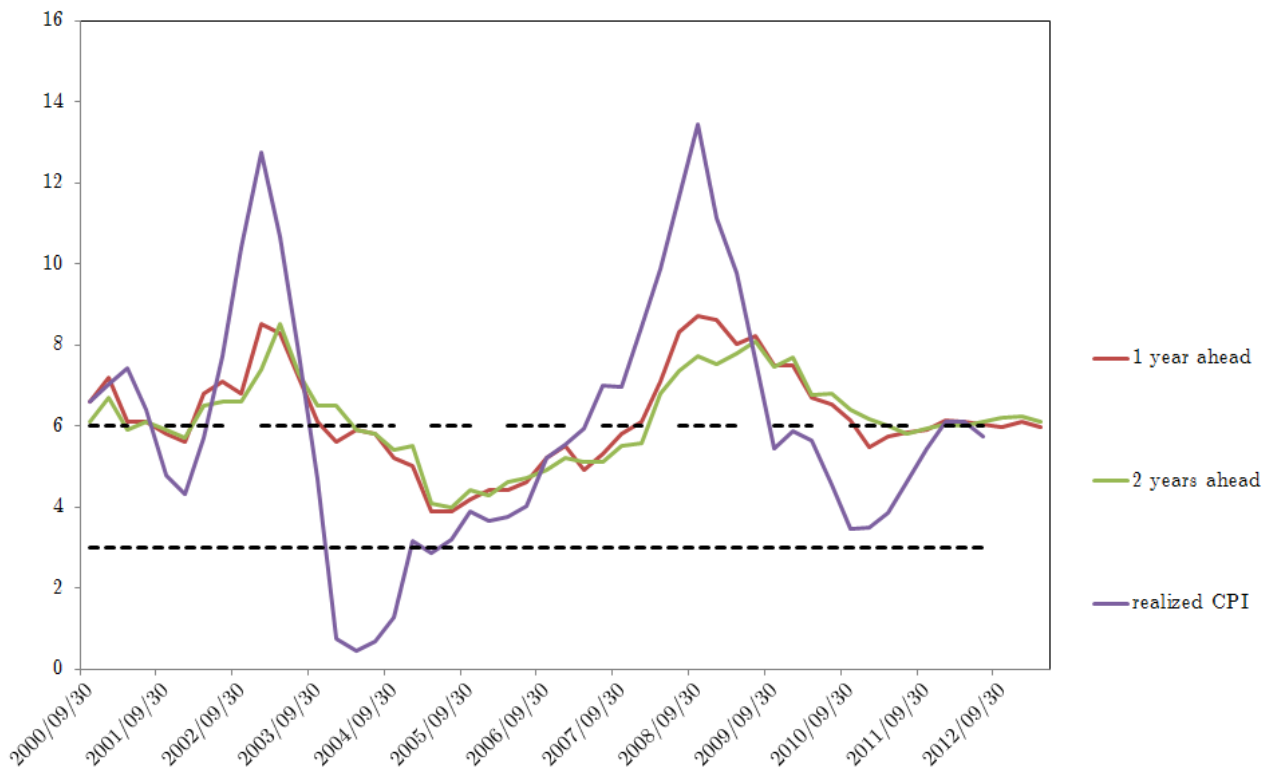
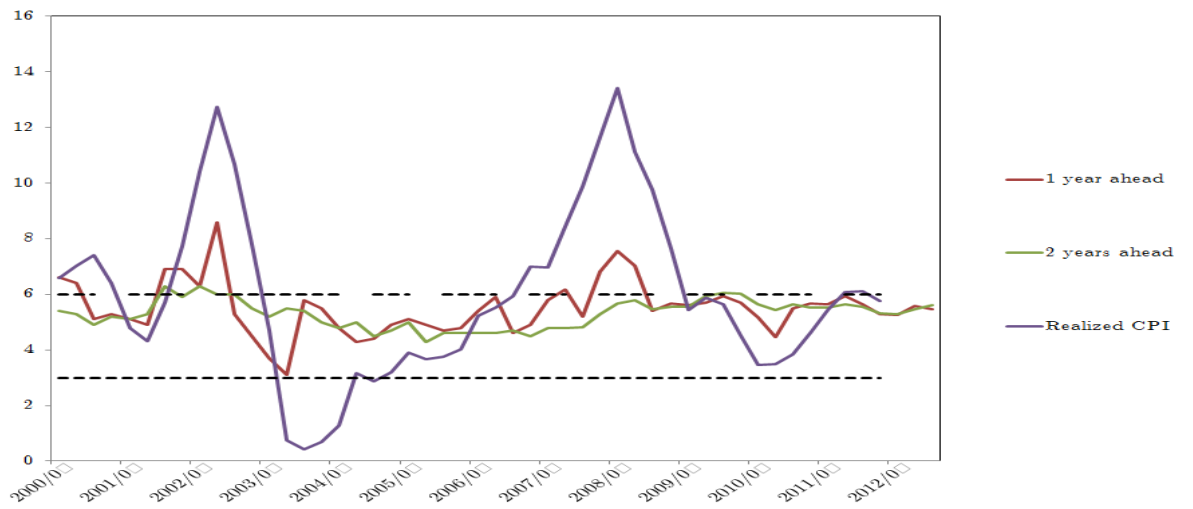
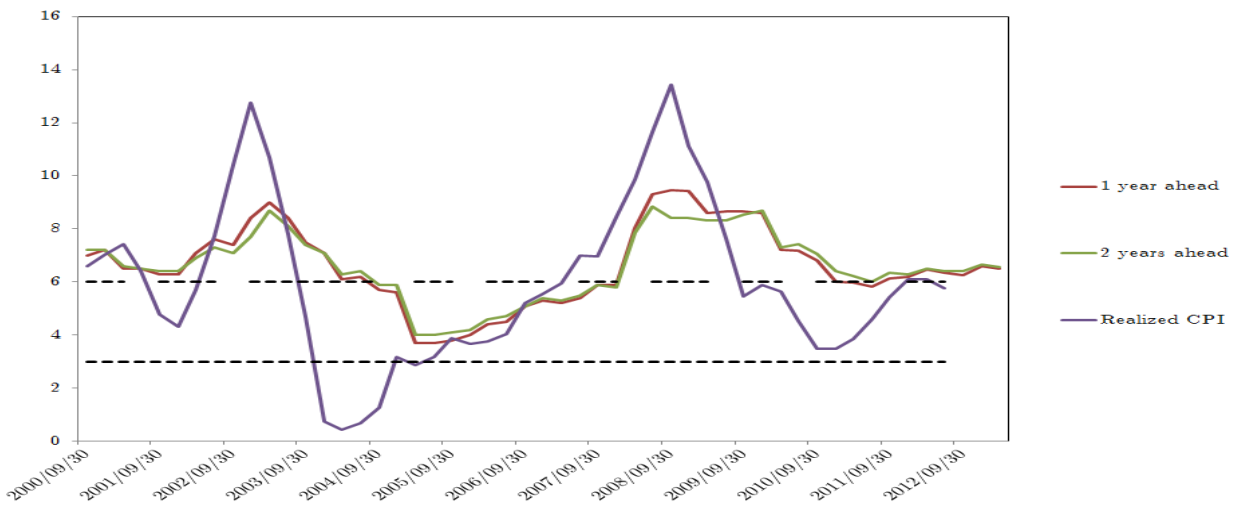


Figure 2. Inflation and Inflation Expectations of Agents
 Panel A. Analysts



Panel B. Business



Panel C. Trade Unions

