Labour Market and Monetary Policy in South Africa

Vincent Dadam and Nicola Viegi

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Vincent Dadam

University of Pretoria

Nicola Viegi

University of Pretoria and ERSA

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Abstract

This paper analyses the influence of the South African labour market on the conduct of monetary policy. Because of the weak response of wages to changes in employment, the South African Reserve Bank is confronted by an unfavourable short run unemployment-inflation trade off that complicates the implementation of the inflation targeting framework. First we provide some reduced form evidence by estimating a form of the traditional wage Phillips curve, showing the weak relationship between wage dynamics and unemployment in South Africa. We then confirm this result by presenting an estimation of a structural model of the South African economy and give a quantitative assessment of the constraint imposed by the labour market on monetary policy. Finally we interpret these results in a strategic framework, analysing the role that inflation targeting might play in either improving coordination, or worsening the interaction between trade unions and Central Bank objectives.

1

Contents

The MPC is also increasingly concerned about the inflation outlook, and the further upside risks to the forecast. Although the exchange rate remains a key factor in this regard, the possibility of a wage-price spiral should wage settlements well in excess of inflation and productivity growth become an economy-wide norm has increased. (MPC Policy Statement 17, July 2014)

1   Introduction

Unemployment is the defining characteristic of the South African economy. For the past 20 years the unemployment rate, in its narrow definition, has fluctuated around 25% without any significant and permanent reduction. Unemployment is characterized as largely young, unskilled and African and its dimension and persistence are a source of uncertainty and instability. The dimension of the problem has generated a large academic and political literature studying its determinants and characteristics (Benerjee et al, 2008, Bhorat, 2004, Casale et al, 2004). This literature see the rise of unemployment in South Africa as a combination of structural changes in labour demand, with an increase in capital intensity and skill biased technical progress, and institutional constraints on the labour supply side, especially downward rigidities of wages due to bargaining institutions and relatively high reservation wages.

What has been missing from the debate is an analysis of the consequences of these structural characteristics of the labour market at the business cycle frequencies. The South African economy response to the 2007 international financial crisis has given the strongest evidence yet of the relevance of the labour market in determining the response of the economy to external shocks. Just to give an indication of how peculiar the response of the South African economy to the financial crisis has been, figures 1 and 2 shows the GDP and employment response to the financial crisis respectively of Germany, UK, South Africa and Chile.
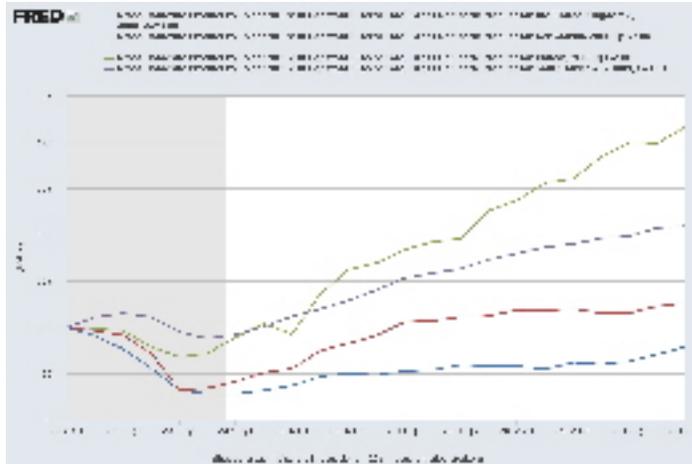
GDP 2008-2013 of selected countries
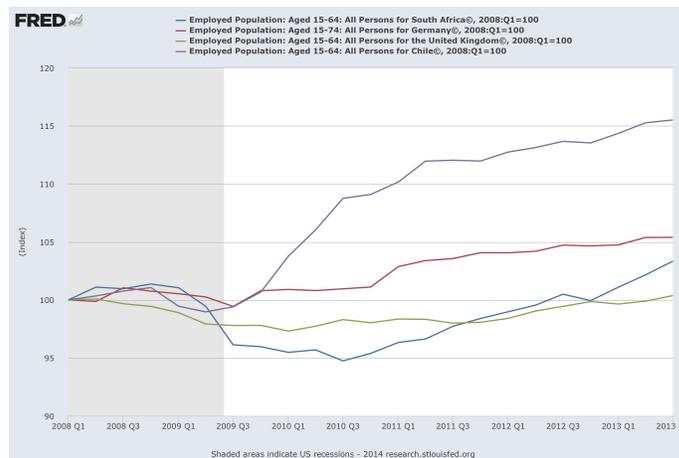
Employment 2008-2013 of selected countries

The shaded area represents the US recession period. South Africa has the best GDP performance after Chile, showing that the financial crisis had a limited impact on the South African economy. Instead the employment response has been dramatic and persistent, and much worse that any other country considered in the picture. The reason of this dismal employment performance can be found in the contemporaneous dynamic of the labour cost, which increased sharply at the beginning of the recession, as shown in figure 3

4

2008/01	2008/02	2008/03	2008/04	2009/01	2009/02	2009/03	2009/04	2010/01	2010/02	2010/03	2010/04	2011/01	2011/02

KBP7080L
Manufacturing: Unit labour cos ...

KBP7008L
Total employment in the privat ...
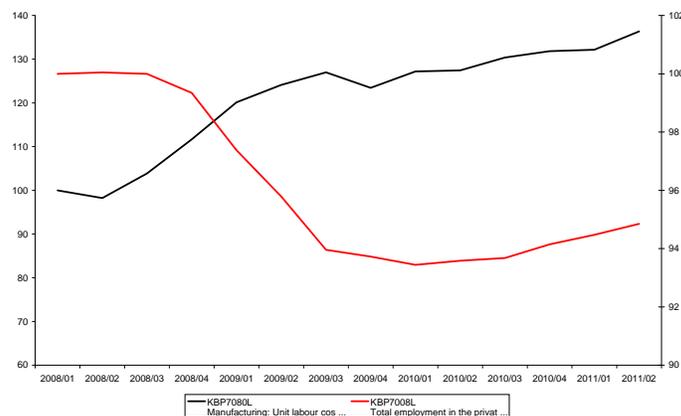
This event alighted two issues in relation to the South African economy: the first issue is that while unemployment is a large structural phenomenon, there is a large dynamic of job destruction, and to a lesser extent of job creation, that needs to be understood more clearly if we want to dent the long term structural problem in a reasonable time. This has been already highlighted by the labour market literature, in particular Banerjee et al (2008) and Kerr et all (2013) in some preliminary work on the formal economy. The second issue, and the main theme of this paper, is that wages do not respond strongly to labour market conditions, which has important implications for the efficiency of monetary policy and the working of the inflation targeting regime.

The paper is organized as follow: the next section will give a first evaluation of the responsiveness of wage to macroeconomic conditions, using a wage Phillips curve framework recently introduced by Gali (2011) in the context of a micro-founded New Keynesian model. In section 3 we will confirm some of the results of part 2 in an estimation for the South African economy of a prototype DSGE model with unemployment. We will also show in this context how the characteristics of the labour market limits the ability of the monetary policy to control the economy. In part 4 we move to a more normative analysis, framing the conflict between monetary policy objectives and labour market institutions in a strategic setting. The final part concludes and suggests further area of research.

2 Wages in South Africa

The negative relation between the rate of changes of wages and the unemployment rate has been central to our intuition about the functioning of the economy at least from the seminal article of William Phillips on "The Relation between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861-1957" (Phillips, 1958). Although most of the subsequent work concentrated on the relationship between price inflation and unemployment in a NAIRU setting, recent New-Keynesian literature (for example Erceg, Anderson and Levin, 2000, Gali, 2013 and Gali and Monacelli 2013) has refocused our attention on the nominal wage-unemployment relationship and has shown that monetary policy efficiency depends critically on the responsiveness of wages and prices to changes in aggregate demand. A change in nominal wages affects employment because of its effect on firm marginal cost and, given the monopolistic competitive market structure, on price inflation. The inflationary effect of wage increases induces a contractionary monetary response, which causes a reduction of employment. The cost of adjustment will be higher the less sensitive is wage dynamics to demand conditions. Consequently if wages are very responsive to employment conditions, monetary policy can reduce inflationary pressures on the economy by a relatively small contraction in demand. On the other hand, if wages are not very responsive to demand condition, the potential sacrifice ratio of a contractionary monetary policy can be very significant.

Given this premises, we want to evaluate the sensitivity of wage determination in South Africa to employment conditions by estimating a wage Phillips curve, as in Gali (2011), who derives a reduced form Phillips curve relationship from a microfounded model with wage and price rigidities[1]. The reduced form to be estimated is the following

$$\pi_t^w = \alpha + \gamma \overline{\pi}_{t-1}^p + \psi_0 \widehat{u}_t + \psi_1 \widehat{u}_{t-1} + \vartheta_t \tag{1}$$

where π_t^w is nominal wage inflation, $\overline{\pi}_{t-1}^p$ is the previous period price inflation, which

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[1]In appendix we present the derivation of the model and its implication in the analysis of the long run characteristics of the South African economy. In particular the model points out to an explanation of the high structural unemployment linked to a low elasticity of substitutions between jobs and a consequent high mark-up on wages.

proxies for inflation expectations, $\widehat{u}_t$ represents deviations of unemployment from the flexible price natural rate and ϑ_t is a zero mean, possibly autocorrelated error term. Equation (1) is derived assuming that the deviation of unemployment from the flexible price natural rate is well represented by a stationary AR(2) process

$$\widehat{u}_t = \phi_1 \widehat{u}_{t-1} + \phi_2 \widehat{u}_{t-2} + \varepsilon_t \tag{2}$$

The estimation of this simple system of relationships is made complex by the need to find a correct data representation of π_t^w and $\widehat{u}_t$ for South Africa. Labour market data in South Africa are notoriously not very reliable and subjected to extensive change in definition. We use a large set of different variables and different definitions of labour market conditions. The baseline specification includes, Consumer Price Index as a measure of price inflation and two alternative sources of wage data namely the remuneration in the private sector excluding non-agricultural sectors and unit labour costs in the manufacturing. Wage inflation is measured as the centred four quarter difference of the log nominal wage expressed in percentage terms. The same applies for price inflation. The cyclical unemployment measure, as difference from the mean, is really usable only from 2000Q1 to 2014Q1. To have a longer specification we need to substitute the unemployment measure with more reliable employment measures, in particular private sector employment and manufacturing employment. The private sector employment has gone though a series of revision and the data are not always comparable trough time. Nevertheless we try statistically to reduce the effect of these distortions. Manufacturing employment is the most reliable measure, but it only a proxy of the overall labour market conditions. The employment variables are de-trended using the Hodrick-Prescott filter to analyse variable unemployment as its deviation from the steady state value, while the unemployment series is demeaned of the average value of 25% unemployment rate, that implicitly we assume is the natural rate of unemployment.[2]

Before introducing the regression analysis, it is worth to have a quick look at the data to be used in the specification (1). The basic hypothesis common with the old Phillips

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[2]Data source are the South African Reserve Bank, IMF and the Saint Louis Federal Reserve Bank database.

curve specification, is that there is a negative relationship between wage inflation and unemployment. In Figure 1 we displays this relationship between for the period 2000-2014. two scatter plots of wage inflation and unemployment to check if such relationship applies in the case of South Africa.
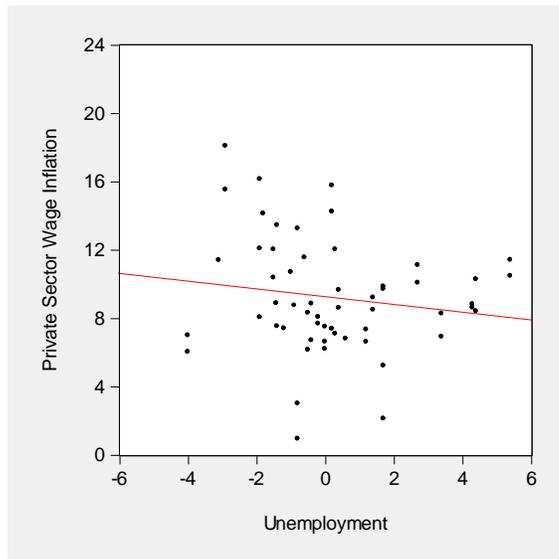
The relationship appears immediately to be quite weak. This could be due to the specific definition of unemployment used in South Africa. As argued by Banerjee (2008), a lot of the changes in the employment rate observed are counted for by change in labour participation rate. Thus a positive relationship between wage inflation and employment rate could be more revealing. Figure 1 shows the relationship between wage inflation and manufacturing employment between 1071 and 2014.
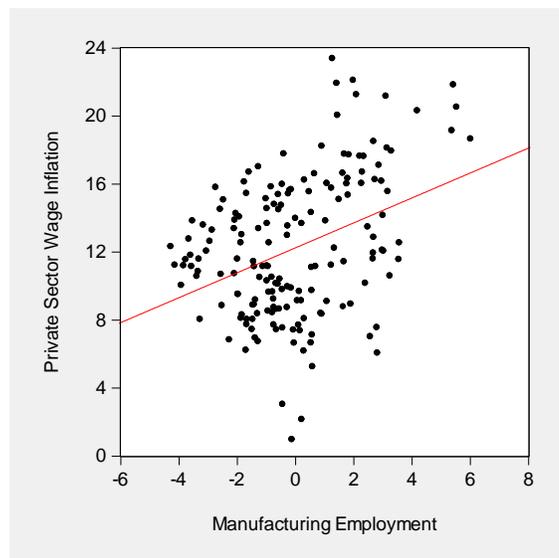
The positive relationship between wage inflation and employment seems much more promising, as is the relationship between wage inflation and total private employment. Less promising is the same relationship once view from the point of view of the inflation targeting period 2000-2014, in figure 6.
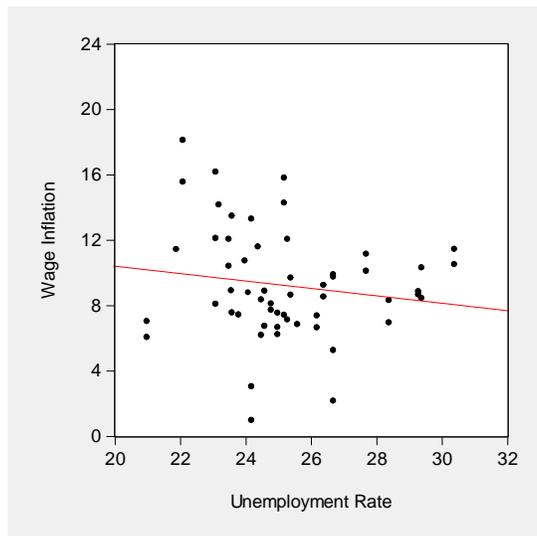
The final relationship in equation (1) is the one between wage inflation and price inflation. Historically the relationship appears very strong, as shown below
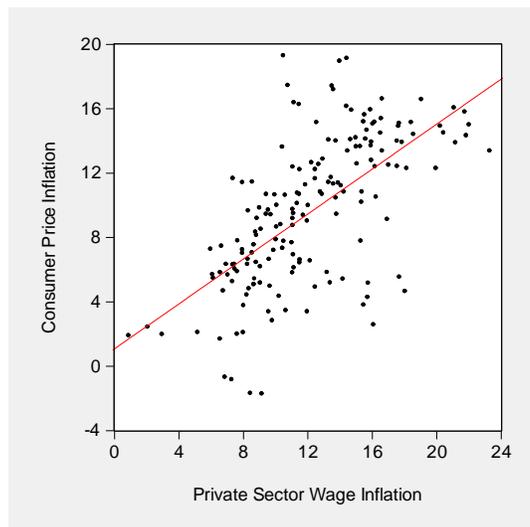
The relationship appears to weaken during the inflation targeting period, which is to be expected if monetary policy tries to insulate the overall price level from a change in the relative price of labour.
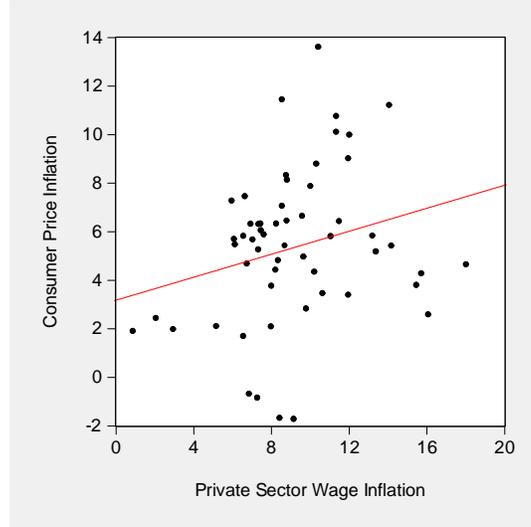
On the other hand there seems to be a strong correlation between wage inflation and inflation expectations of trade unions as recorded by the BER, a fact that gives some indication that controlling inflation expectation might still be the most direct way to control wage dynamics.
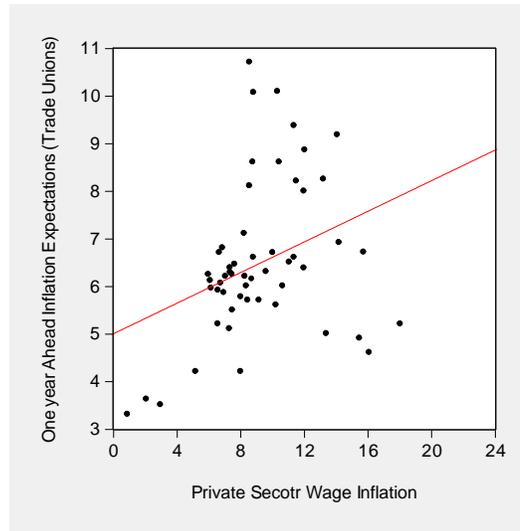
2.1 Estimation results

We report in the tables below OLS estimates of several specifications of the New Keynesian Wage Phillips Curve, each specification being a restricted version of equation (1). The standards errors are reported in brackets. In table 1, column 1 and 2 reports the traditional Phillips curve relationship between employment and wage inflation, for the whole sample

in column (1) and for the post-apartheid sub-sample in column (2).. In column (3) and (4) we report the results of introducing past inflation in the specification and finally in column (5) and (6) we report the full specification of equation (1). The relationship between wage inflation and employment is clearly weak and getting weaker in the most recent sample. Nominal wage and inflation have a strong and robust relationship which also is quantitative weaker in the second sample. .

Table 1: Estimated wage inflation: private sector wage

	(1)	(2)	(3)	(4)	(5)	(6)
	$1970 - 2014$	$1994 - 2014$	$1970 - 2014$	$1994 - 2014$	$1970 - 2014$	$1994 - 2014$
n_t	0.19*** (0.05)	0.07 (0.04)	0.13** (0.04)	0.06 (0.04)	0.18** (0.05)	0.11* (0.05)
n_{t-1}					−0.07 (0.05)	−0.06 (0.05)
π_{t-1}			0.55*** (0.05)	0.25* (0.12)	0.56*** (0.05)	0.27** (0.12)

***denotes significance at the 1% level, ** at the 5% level and * at the 10% level.

The result is largely confirmed if a different measure of change of labour cost is used. In table 2 we use the nominal unit labour cost inflation as measure of wage changes, which has the advantage to separate the change in wages by contemporaneous changes in productivity.. The results are actually more robust, and there is a stronger relationship between labour cost and employment conditions, even tough this relationship seems to become weaker in the second sample.

Table 2: Estimated wage inflation: unit labour costs

	(1)	(2)	(3)	(4)	(5)	(6)
	$1970 - 2014$	$1994 - 2014$	$1970 - 2014$	$1994 - 2014$	$1970 - 2014$	$1994 - 2014$
n_t	0.36*** (0.07)	0.23*** (0.05)	0.28*** (0.05)	0.23*** (0.05)	0.39*** (0.07)	0.31*** (0.07)
n_{t-1}					−0.15** (0.06)	−0.12*** (0.07)
π_{t-1}			0.74*** (0.07)	−0.04 (0.15)	0.75*** (0.07)	0.02*** (0.15)

***denotes significance at the 1% level, ** at the 5% level and * at the 10% level.

If we consider only the inflation targeting period, we can use the official measure of unemployment to run the canonical Phillips curve relationship. Table 3 presents these results.

Table 3: Estimated Wage inflation: private sector wage

	(1)	(2)	(3)
	$2000 - 2014$	$2000 - 2014$	$2000 - 2014$
u_t	-0.31 (0.20)	-0.33^* (0.19)	-0.06 (0.34)
u_{t-1}			-0.25 (0.34)
π_{t-1}		0.24^{**} (0.13)	0.23^{**} (0.13)

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The results are consistent with the previous analysis. The relationship between wage inflation and unemployment is significant only when inflation is added to the specification. The insignificance of the third specification is probably due to the fact that the correct specification for the unemployment rate is a stationary AR(1) model and not the assumed AR(2). Using this result, we finally substitute the inflation rate with the observed expected inflation of the Trade Union as recorded by the BER. Table 4 shows that this specification fits the data much better, highlighting the increasing importance of inflation expectations in the determination of wage inflation under the inflation targeting regime.

Table 4: Estimated Wage Inflation

	(1)	(2)	(3)
	$E\pi_t$	$E\pi_{t+1}$	$E\pi_{t+2}$
u_t	-0.37^{**} (0.18)	-0.35^{**} (0.19)	-0.37^{**} (0.18)
$E\pi$	0.73^{***} (0.23)	0.72^{***} (0.26)	0.82^{***} (0.29)
	2000Q3 - 2013 Q4		

In all cases, the analysis of the residual shows that wage inflation was particularly high just before and during the financial crisis, moderating only after 2010. Overall the estimations imply a significant wage rigidity relative to either employment of unemployment conditions, a certain sensitivity to inflation and inflation expectations. The next step is to verify these results in a structural estimation of a DSGE model with unemployment to link more directly these labour market conditions with the conduct of monetary policy

3 Wage Rigidity and the Efficiency of Monetary Policy

To give further evidence of the characteristics of the South African labour market and to illustrate the relationship between labour market dynamics and monetary policy, in this section we present an estimation for South Africa of a Dynamic Stochastic General Equilibrium Model with price rigidities, wage rigidities and unemployment, first developed by Blanchard and Gali (2010). There has been an increasing volume of research dedicated to developing models with non-Walrasian labour markets. Zanetti (2007) shows that a New Keynesian model with a non-Walrasian labour market can replicate most of the key aspects of the European business cycle. Moreover, the assumption of non-Walrasian labour market has important implication for monetary policy. In particular Blanchard and Gali (2010), Faia and Rossi (2012) and many others showed that monetary policy should consider unemployment in their targeting variables and that inflation can be a way to reduce the inefficient unemployment fluctuations induced by unions monopoly power.

Although this literature is certainly relevant for South Africa, at this stage we want only to use this modelling instrument to derive some quantitative evaluation of the level of south African labour market rigidities and to get some intuition of the constraints that these rigidities impose to monetary policy

The advantage of this approach is that we can analyse directly the relationship between labour market parameters and monetary policy efficiency by relying on a minimum number of aggregate variables. in particular we will use only four observable variables in estimating

the model: inflation, output, interest rate and manufacturing employment the development of the model we follow a growing international literature that has introduced in the basic New Keynesian framework of monopolistic competition with price and wage rigidities a labour market defined as in search model of Pissaridies. The log-linear relationships of the model are shown below, while the complete derivation can be found in Dadam and Viegi (2014).

The supply function is represneted by a Phillips curve relationship where inflation is determined by expected inflation and past, present and expected unemployment rate, as

$$\pi_t = \beta E_t \{\pi_{t+1}\} - \kappa_0 \hat{u}_t + \kappa_L \hat{u}_{t-1} + \kappa_F E_t \{\hat{u}_{t+1}\} - \lambda \Phi \gamma \hat{a}_t \tag{3}$$

where π_t is the inflation rate, $\hat{u}_t$ is the deviation of the unemployment rate from the flexible price natural rate of unemployment and $\hat{a}_t$ is a productivity indicator. The presence of unemployment directly in the Phillips curve, instead than the output gap, is due to the fact that the firm marginal cost is directly dependent on the labour market tightness. The model also derives a proportional relationship between employment $\hat{n}_t$ and unemployment

$$\hat{u}_t = -(1-u)\hat{n}_t \tag{4}$$

where u is the natural rate of unemployment. Because of the search model background, an important component of the model is the definition of labour market tightness as a function of current and lagged employment:

$$\delta \hat{x}_t = \hat{n}_t - (1-\delta)(1-x)\hat{n}_{t-1} \tag{5}$$

The demand block of the model comprises an expression for aggregate consumption, function of productivity, employment and labour market tightness,

$$\hat{c}_t = \hat{a}_t + \frac{1-g}{1-\delta g}\hat{n}_t + \frac{g(1-\delta)}{1-\delta g}\hat{n}_{t-1} - \frac{\alpha g}{1-\delta g}\delta \hat{x}_t$$

and the usual Euler equation for consumption.

$$\hat{c}_t = E_t \{\hat{c}_{t+1}\} - (i_t - E_t \{\pi_{t+1}\} - \rho$$

finally a Taylor rule specification defines the conduct of monetary policy and close the model.

$$i = \rho + \phi_\pi \pi_t + \phi_c c_t + \phi_u u_t$$

3.1 Simulation

Before providing the South Africa estimation of the model, we analyse the response of the model to a monetary policy shock to develop some intuition that will result useful in evaluating the meaning of the estimation results for South Africa. The model implies the following relationship between long term unemployment u, labour market tightness x which is defined as the ration of aggregate hires to unemployment and an exogenous separation rate δ

$$u = \frac{\delta(1-x)}{\delta(1-x)+x} \tag{6}$$

This relationship can be used to define four typologies of labour markets.

1. The first labour market is characterized by low level of entry and exit and low long term unemployment rate (Rigid-Low). In this market flows are low because a low separation rate is coupled with low level of aggregate hires but the steady state unemployment is low because aggregate hires are relative more that the exogenous separation rate. A possible example of this kind of market is central and north Europe, where job security and relatively rigid labour market rules coexist with a low level of structural unemployment. In our simulations we assume the folowing parameterization for this market $u = 0.05$, $x = 0.15$ and $\delta = 0.01$.

2. The second labour market is still a rigid labour market with low level of aggregate hires but with an higher separation rate that produces high level of structural unemployment (Rigid-High): a possible example of this kind of market is the labour market is south Europe, where a rigid labour market generate low level of job creation and high structural unemployment. In our simulation we assume the following parametrization for this labour market $u = 0.25$, $x = 0.15$ and $\delta = 0.075$. This scenario differs from the previous one on the level of steady state unemployment which we assume in this scenario to be quite high. Also, .

3. A third scenario consider a typical liberalized labour market characterized by large flows of job creation and job destruction, but with job creation dynamic dominating

the determination of a low structural unemployment (Fluid-Low): the USA are often presented as an example of this kind of labour market. To simulate this market we use the following parametization: $u = 0.05$, $x = 0.8$ and $\delta = 0.21$.

4. Finally the fourth labour market is characterized by high flow of job creation and job destruction, but where job destruction dominates the dynamic producing a high level of structural unemployment (Fluid-High): we will see in the analysis the South Africa is a good example of this kind of labour market . The parametization for this case will be the following $u = 0.25$, $x = 0.67$ and $\delta = 0.87$.

In each scenario, we simulate a monetary shock on the economy. The shock is an AR(1) processes with an autoregressive coefficient of 0.9. The general effects of the shock are in line with the standard New Keynesian DSGE model (see for instance Gali *et al*, 2010). What changes about this model is the effects on inflation and unemployment at different level of labour market rigidity. Therefore, we are only reporting the quantitative effects of a monetary shock on these two variables. We also assume that the central banker uses a simple Taylor rule with elasticity parameters taking the following standard values $\phi_\pi = 1.5$, $\phi_c = 0.5$ and $\phi_u = 0$.

Figure 1 summarises the response of inflation (left panel) and unemployment (right panel) to a monetary shock. In all four scenarios, inflation takes a long time to converge to the initial level as the shock dies out. First, let's focus on the two extremes - scenario 1 (Rigid-Low) and scenario 4 (Fluid-High). The monetary authority's instrument has barely any effect on inflation in the Fluid-High set up as inflation drops to 0.2 per cent (the lowest drop). However this low drop is compensated by a greater effect on unemployment (on the right panel). In the Rigid-Low setting on the other hand, we report a complete opposite result. In scenario 1, the results therefore show that, given the low level of steady state unemployment prevailing in the economy, the monetary authority works hard to stabilise inflation, hence the high response. This decision may come at a cost - a slight increase of about 0.28 per cent in unemployment - given there is no "divine coincidence", an expression introduced by Blanchard and Gali (2007) to characterize a situation when stabilising output (inflation) may result in volatile inflation (output). In scenario 4 - arguably the worse

16

scenario - where much has to be done on both unemployment and inflation sides, the central banker finds himself powerless in front of the inflation whereas he can only affect unemployment. To make things even worse, the choices of the central banker tend to only increase the already high level of steady state unemployment (by 1.2 per cent).

Figure 1: Impulse response functions - monetary shock
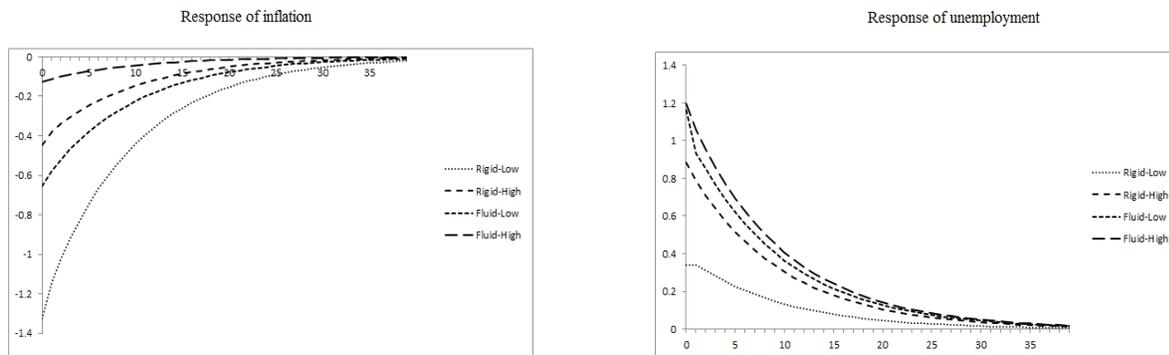
3.2 Estimation

Which kind of labour market is South Africa, and thus what is the trade-off between unemployment and inflation that the South African Reserve Bank faces? To find out we estimate the model with Bayesian methods. The model is estimated using the following quarterly variables for the period 1994-2014: inflation, output, interest rate and manufacturing employment .We use the first logarithmic difference of South Africa's Consumer Price Index (CPI) as a measure of inflation. Output is captured by real GDP. Employment is measured by the index of employment in the manufacturing sector. We analyse output and employment variables in terms of their deviation from the trends extracted by using the Hodrick–Prescott filter. We focus only on estimating parameters that are related to the labour market, calibrating the other parameters using previous South African estimation of DSGE or the international literature. Finally, we assume a steady state unemployment rate of 23 per cent. The results are reported in the table below.

Table 1: Estimation Results

Parameter description		Prior mean	Prior density	Prior mode	Post mean	Post std dev
Taylor rule weights:						
Inflation	ϕ_π	1.5	N	2.16	2.17	0.15
Output gap	ϕ_c	0.125	N	0.13	0.13	0.03
Unemployment	ϕ_u	0	N	-0.013	-0.003	0.02
Structural parameters:						
Wage rigidity	γ	0.5	B	0.95	0.86	0.25
Labour market tightnes	x	0.5	B	0.66	0.72	0.13
Elasticity of hiring cost	α	0.9	B	1	0.91	0.12
Level of hiring cost	B	0.2	B	0.0025	0.16	0.2
Persistence parameters:						
Productivity	ρ_a	0.8	B	0.98	0.81	0.2
Preferences	ρ_d	0.8	B	0.99	0.99	0.2
Labour	ρ_l	0.8	B	0.52	0.85	0.2
Monetary	ρ_m	0.8	B	0.99	0.99	0.2

Notes: Letters B and N denotes Beta and Normal distributions.

The estimation of the labour market parameters show a picture of a labour market with pervasive wage rigidities and an high level of job distruction only partly compensated by job creation. We estimate the labour market tightness index x of 0.72 implying a separation rate of 0.77. This means that South Africa has a labour market with large flows of job creation and job destruction during the business cycle, with job destruction dominating the dynamics. As shown in the simulations before, this scenario is the one that gives the worst sacrifice ratio to a monetary policy shock.

We also estimate the parameters of the Taylor rule, which indicates the dominance of the inflation objective in determining monetary policy. This just confirm what has been largely found in the literature.

Now that we have parameter estimates, we can re-calibrate the model and analyse the effect of a monetary policy shock to evaluate the sensitivity of inflation and output to

monetary policy. The impulse response of inflation and output to a monetary policy shock are shown in figure 7 below with the solid black line. The model shows a very high real response to monetary policy shock relative to the inflation response. This implies that inflation stabilization in South Africa requires a large negative employment response

Figure 7: Impulse responses - monetary policy shock
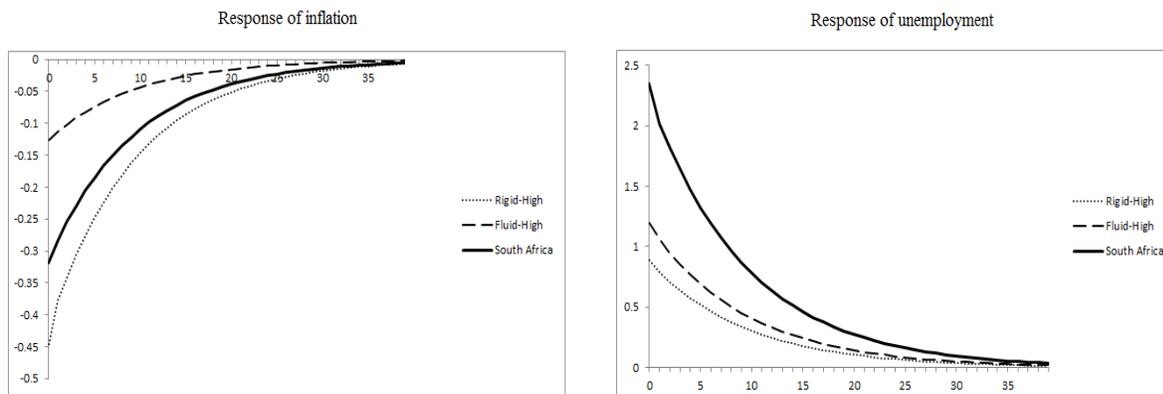
This result is consistent with our reduced form estimation in part 2. In fact, if wages are not very responsive to employment conditions, monetary policy can stabilize inflation by inducing large changes in aggregate demand which will induce large changes in employment. The feasibility of this policy will depend critically on the objective function of the Bank and on the strategic interaction between the Bank and the labour market participants.

4   Inflation Targeting and Monetary Policy Leadership

Certainly the picture presented does not conform to an institutional model where the Central Bank has policy leadership relative to labour market participants. This fact has implications for the implementation of the inflation targeting framework. As illustrated in Demertzis and Viegi (2010), inflation targeting works by providing a focal point to private sector expectations, which are the final determinant of the economic dynamics. Thus a credible monetary policy anchors inflation expectations and in doing so it constraints wage determination, fiscal policy, credit dynamics etc.. For this reason we spend a lot of time

and resources recording inflation expectations and checking if inflation expectations are anchored. The assumption is that anchoring of expectation is a sufficient signal to predict how wages and prices will be set. In South Africa we are quite satisfied that inflation expectations, although anchored at the upper bound of the target band, looks sufficiently anchored (Kabundi at al 2014) and we know that the SARB is a credible and independent institution. Nevertheless, this does not necessarily provide leadership in the policy space. Two further conditions are required: the first condition is that the objective function of the would be follower must be sensitive to the treat posed by the leader (Acocella et al, 2007). Inflation targeting is an effective framework against excessive wage demands if trade unions are either worried by the employment cost of inflation stabilization, or worried by inflation itself.

The second condition is that for the Central Bank to be leader in the policy game "there must be some incentives over and above those arising from the corresponding Nash solution" (Holly and Hughes Hallett, 1989, p. 190). The meaning of this second condition is worth considering more carefully. The leadership of the Central Bank is guaranteed only if it is incentive compatible for the trade unions to follow the Bank leadership. There must be a gain for the follower relative to the alternative option of just playing a Nash game. At the same time this also means that could be incentive compatible for the Central Bank to actually follow the leadership of the Trade Union, if this provides a better outcome that the alternative Nash solution. But if being a follower is efficient for the Bank, this is not optimal in an inflation targeting regime, because it undermines the whole premises of inflation targeting itself.

To explain these strategic choices, consider a policy game between a Central Bank, who set interest rate, and a trade union, who set nominal wages. Both variables will have an effect on aggregate employment and inflation. A reduced form model of the theoretical system analysed before would be the following:

$$n_t = r_{11}w_t + r_{12}i_t + s_{1t} \tag{7}$$

$$\pi_t = r_{21}w_t + r_{22}i_t + s_{2t} \tag{8}$$

where n_t = employment (as a deviation from its natural rate), π_t = inflation, w_t = the nominal wage, and i_t = the nominal interest rate. The r_{ij} parameters the , impact or long run multipliers depending on the interpretation we wish to use. Consequently we may expect the following sign pattern

$$r_{11} < 0, \; r_{21} > 0 \qquad \text{and} \qquad r_{22}, r_{12} < 0. \tag{9}$$

The model estimation give us an indication that in South Africa the real effects of wage and monetary policy are bigger that their effect on inflation, i.e. r_{11} and r_{12} are in absolute value greater than r_{21} and r_{22}. Finally, s_{1t} and s_{2t} are two random shocks (supply side and demand side respectively) with zero means. The time subscripts will be suppressed from now on.

We now introduce two objective functions. For the Central Bank we use the traditional quadratic specification:

$$L_B = \frac{1}{2} \left(n^2 + \delta \pi^2 \right) \tag{10}$$

where n,and π are measured as a deviation from some natural or desired outcome and The parameter δ measures the importance which the Central Bank attach to its inflation target ($\delta > 0$). The other objective function to consider is the one of the Trade Union. In the literature there is a large variety of possible Trade Union objective functions. We depart from the literature in two respects: first, we assume that inflation is not directly a concern for the Trade Union. Only employment, n,enters the objective function in a quadratic form. We also assume that the Trade Union have linear preferences in nominal wages, expressed in deviation from present wage. :

$$L_U = \frac{1}{2} \left[n^2 - \alpha w \right] \tag{11}$$

The linear expression on w implies a preference for increasing levels of nominal wages, given the starting level for inflation. Importantly α represents the strength of militancy of the trade union in trying to achieve their highest possible nominal wage. A lower α would indicate a less "militant" trade union, with lower commitment to wages at any cost

21

in term of employment. Inflation does not enter directly in the objective function of the trade union and it will be considered only in so far it affects the monetary policy response.

4.1 Policy Equilibria

The policy game illustrate above can be solved either as a non-cooperative Nash game or as two alternative Stackelberg games with the Bank being the leader or the follower in the policy game.

Nash Game

Consider the case of a fully independent Central Bank. All policies will be determined noncooperatively and may be represented by a Nash equilibrium. Minimising the loss function L_U subject to the constraints on n and π, yields an optimal reaction function for the Trade Union:

$$r_{11}^2 w + (r_{11}r_{12}) i = a - (r_{11}s_1). \tag{12}$$

Minimising L_B subject to the same two constraints, yields

$$(r_{11}r_{12} + \delta r_{22}r_{21}) w + (r_{12}^2 + \delta r_{22}^2) i = - (r_{12}s_1 + \delta r_{22}s_2) \tag{13}$$

for the Central Bank. Solving these two reaction functions together gives the Nash equilibrium

$$\begin{bmatrix} w^* \\ i^* \end{bmatrix} = \frac{1}{|A|} \begin{bmatrix} r_{12}^2 + \delta r_{22}^2 & -r_{11}r_{12} \\ -(r_{11}r_{12} + \delta r_{22}r_{21}) & r_{11}^2 \end{bmatrix} \begin{bmatrix} a - (r_{11}s_1) \\ -(r_{12}s_1 + \delta r_{22}s_2) \end{bmatrix} \tag{14}$$

where

$$|A| = \delta r_{11}^2 r_{22}^2 - \delta r_{22}r_{21}r_{11}r_{12}$$

It is easy to check that $|A| > 0$, given the assumed sign patters. This solution reveals that even in absence of shocks there is a conflict between monetary policy and trade union behavior.

- The trade union preferences impose a constant growth of nominal wages, equal to $a\frac{r_{12}^2+\delta r_{22}^2}{|A|}$.

  - The nominal wage growth is a negative function of the level of commitment of the Central Bank to the inflation target δ.

  - The nominal wage growth is positive function of the elasticity of employment to interest rate. The higher the elasticity (in absolute value) the higher the nominal wage growth because the intervention of monetary policy reduces the negative employment impact of increasing wages

  - the nominal wage growth is a nonlinear function of the elasticity of inflation to interest rate: at low level of effectiveness of monetary policy in controlling inflation, nominal wage growth faster.

- Monetary policy responds to a permanent nominal wage growth with a permanently higher nominal interest rate, equal to $a\frac{-(r_{11}r_{12}+\delta r_{22}r_{21})}{|A|}$, which is positive if $|r_{11}r_{12}| < |\delta r_{22}r_{21}|$, i.e if the bank is committed to inflation targeting (higher δ) and the nominal effect of policies is greater than their real effect. Commitment to an inflation targeting is not enough.

The Policy Equlibria with Bank Leadership

The Stackelberg solution with the Central Bank leading is necessarily a Pareto improvement over the Nash solution we get from an independent Central Bank facing a Trade Union. We can demonstrate that directly from the noncooperative solution with a fixed degree of inflation targeting δ. Since the Trade Union is the follower, it will always pick its wage demand along its optimal reaction curve - given whatever monetary policy the Bank may choose. Thus, it maintains the same reaction function as before:

$$r_{11}^2 w + (r_{11}r_{12})\,i = a - (r_{11}s_1)\,. \tag{15}$$

On the other hand, the Bank, knowing that the Trade Union will always pick w to stay on its reaction function, will pick an interest rate policy at the point where one of its

indifference contours touches that reaction function..In a sequential game, it means that the Trade Union moves first, setting the nominal wage given the policy of the Bank, and the Bank decides the instrument after wages are determined.

This will give the following combination of wages and interest rate:

$$
\begin{aligned}
w^{bl} &= \frac{r_{11}r_{22}}{(r_{11}r_{22} - r_{12}r_{21})r_{11}^2}\alpha > 0 \\
i^{bl} &= -\frac{r_{21}}{(r_{22}r_{11} - r_{21}r_{12})r_{11}}\alpha > 0
\end{aligned}
$$

The Policy Equilibria with Trade Union Leadership

A final scenario to consider is the inverse situation, where the Trade Union is the Stackelberg leader in the policy game, so that it chooses the nominal wage on the monetary policy reaction function

$$
(r_{11}r_{12} + \delta r_{22}r_{21})\, w + \left(r_{12}^2 + \delta r_{22}^2\right) i = -\left(r_{12}s_1 + \delta r_{22}s_2\right) \tag{16}
$$

This game form produces the following equilibrium wages and interest rate:

$$
\begin{aligned}
w^{bf} &= \frac{\left(r_{22}^2 + \delta r_{12}^2\right)^2}{(r_{11}r_{22} - r_{12}r_{21})^2 r_{22}^2}\alpha > 0 \\
i^{bf} &= -\frac{\left(r_{22}^2 + \delta r_{12}^2\right)\left(r_{21}r_{22} + \delta r_{11}r_{12}\right)}{(r_{11}r_{22} - r_{12}r_{21})^2 r_{22}^2}\alpha \lessgtr 0
\end{aligned}
$$

When the Bank is the follower, the direction of the reaction of monetary policy to an increase in wages will depend critically on the sensitivity of employment and inflation to the policy instruments. if $|r_{21}r_{22}| > |\delta r_{11}r_{12}|$, i.e. if the effect of the policy instruments on inflation is higher than the effect on employment, interest rate will be positive in response to an higher wage rate. On the other hand if $|r_{21}r_{22}| < |\delta r_{11}r_{12}|$, monetary policy will operate an expansionary monetary policy in reaction to a growth of nominal wage, to reduce the significant real impact of a reduction in employment induced by an increase in nominal wages.

4.2 When does Inflation Targeting Help?

Hughes Hallett and Viegi (2002) demonstrate that we can analyse the effect of inflation targeting on the policy equilibrium by analysing the effect of changes in the preference parameter δ, that represents the commitment of monetary policy to her inflation objective. A strong commitment to inflation targeting reduces wage growth in the Nash game, while the solution with the Bank as leader is invariant to the commitment to the inflation target. On the other hand, an higher value of δ increases wage growth in the case that the Bank is the follower. This case is particularly interesting because it shows that a commitment to inflation targeting can be counter-productive if the Bank is not a leader in the policy game and the trade union is not particularly worried by the negative employment effect of wage increases. A sufficient condition for the Bank to acquire leadership is for the trade union to internalize the inflation objective of the Bank. It is therefore the objective function of the trade union that is critical in determining the quality of the policy solution.

5 Conclusions

In conclusion, this paper has given a first contribution in understanding the relationship between monetary policy and labour market in South Africa. In particular we have presented three results:

firstly, South African wages do not respond strongly to demand condition, indicating large wage rigidities, low elasticity of substitutions and large wage mark-ups; secondly this type of wage formation in South Africa induces a very penalizing sacrifice-ratio for monetary policy, with low level of price elasticity to interest rate and an high level of employment elasticity; finally commitment to inflation targeting can affect wage dynamics through inflation expectations, but it might result in higher real wages and lower employment if the Bank does not assume leadership in the policy game.

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