Labour Market and Monetary Policy

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Abstract

South Africa's unemployment rate has been around the 30 per cent mark for more than 20 years. This represents the single most important characteristic of the South African economy and the most pressing problem in policy making. Although there is a significant literature looking at the unemployment issue from the point of view of the functioning of the labour market, there is no attempt in the literature and in the policy making to evaluate the effect of high structural unemployment in the transmission mechanism of macroeconomic policies in general and monetary policy in particular. This paper aims at filling that gap. We estimate a New Keynesian DSGE model with unemployment of the South African economy and we evaluate how the labour market structure affects the transmission of monetary policy. The simulation of the model shows that labour market tightness index (job finding rate) appears crucial in the transmission of the monetary shock. We find that in a fluid labour market with high steady state unemployment, the central banker's instrument has little effect on inflation which is compensated by a larger effect on unemployment. The opposite applies for a scenario where the labour market is rigid and the unemployment rate is low. Estimation results show that South African labour market is quite fluid.

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1 Introduction

With a record high fluctuating around 30 per cent over the past 20 years, South Africa's unemployment rate is one of the highest in the world. The country's employment absorption rate (40.8 per cent) is far below its BRICS partners. In fact, employment absorbs 65 per cent of the working age population in Brazil, 57 per cent in Russia, 55 per cent in India and evidently 71 per cent in China. South Africa's youth participation rate of 24.4 per cent is also below the emerging market average of 42 per cent (Blumenfeld). It is therefore with no surprise that such figures are reflected in the high level of unemployment in the country.

Given the growing interest in including the possibility of unemployment in the standard DSGE framework (see for example Gali, 2010, Blanchard & Gali, 2010) and the fact that very few of these studies account for high level of steady state unemployment, this paper investigates the effects of labour market dynamics on monetary policy. To do so, we use a New Keynesian DSGE model with unemployment following the work of Blanchard and Gali (2010). We simulate a monetary shock on four scenarios, each one of which corresponds to a specific type of labour market with an associated level of steady state unemployment rate. The labour market tightness index is key to the design of these scenarios. Also known as the job finding rate, it defines the rate at which individuals find jobs, therefore determining whether or not the labour market is fluid.

Many have looked into the South African labour market to understand unemployment and for authors like Blumenfeld, the sources of unemployment are twofold. Firstly, on the supply side the country face a lack of crucial skilled workers. This is perhaps due to the fact that black people – representing more than half of the overall population – were deliberately excluded from educational system pre-1994. Furthermore and although the government provided a huge amount of the budget to develop the educational system and skills training programmes since 1994 it has failed to make significant impact on the labour market.

Secondly, on the demand side South Africa's economy does not create jobs fast enough to absorb school leavers that enter the labour market every year (about 1.1 million each year). With the population getting younger, this problem is set to become even worse in the future. Further on the issue of job creation, the relationship between labour productivity and wages plays an important role in the willingness of private firms to hire more. As found by Klein (2012) this relationship in the long term appears quite weak in the case of South Africa; meaning the growth in real wage in the economy is not necessarily linked to labour productivity levels. In fact he finds that real wage growth in South Africa can persistently and substantially outpace labour productivity growth. This surprisingly happened during the period 2008-2010 when the economic growth slowed down and labour market conditions softened due to the international financial crisis. His findings are in line with the annual employment report of Schussler (2012) and the work of Nattrass and Seekings (2013): the cost of labour in South Africa is too high. Unskilled and semi-skilled workers - constituting the majority of the unemployed individuals - earn too much to be affordable by private sector employers, especially those operating in the manufacturing sector. Many have therefore concluded that the unemployment problem in South Africa could be self-inflected especially given the considerable amount of bargaining power attributed to workers and trade unions.

Kerr, Wittenberg and Arrow (2013) explore the job creation and destruction in South Africa to find that firms create and destroy about 20 per cent of jobs per year, therefore underlying the importance of job creation and destruction as a feature of labour demand in South Africa. In the manufacturing sector, jobs are destroyed at a slightly higher rate (10 per cent) than they are created (9 per cent). This provides evidence that manufacturing employment in South Africa is in decline. Moreover, another interesting finding is that enterprise deaths contribute of about 25 per cent of job destruction while enterprise births account for a mere 11 per cent of job creation; a result that is in line with the findings of Davis *et al* (1996) claiming that indeed, deaths contribute a significantly higher amount to destruction than births do to creation.

Lastly, Fourie (2011) presents the state of the debate on unemployment by indentifying three clusters namely a labour market cluster, a poverty and development cluster and a macro/macro-sectoral cluster.

For the labour market cluster, Fourie (2011) finds that some authors (Kingdon & Knight, 2004, Banerjee, Galiani, Levinshon, McClaren, & Woolard, 2008) support that unemployment in South Africa is mostly involuntary and that discouraged workers are part of the labour market. Also, Kingdon and Knight used the model by Layard, Nickell and Jackman (1991) to support that the labour market is segmented between the informal sector (rural) and the formal sector (urban) mainly caused by unionization. Poor work seekers from rural areas face barriers that prevent them from leaving the informal sector as they wish to enter the formal.

In the poverty and development cluster, it is perhaps with no surprise that the studies show chronic poverty has serious impact on unemployment; therefore implying a causality relationship between the two which may even be bi-directional. In fact, Leibbrandt, Bhorat and Woolard (2001) believe that unemployed are commonly found in households with no access to wage income. Furthermore, the marginalisation of the poor unemployed and poor workers significantly reduces their access to labour market, hence to employment (Du Toit, 2005). This has aggravating psychological effects on them and significantly slows down the motivation to search for jobs.

Literatures supporting the idea of the third and final cluster in the unemployment debate in South Africa are not easy to find (Fourie, 2011). This is because many have focused the research on unemployment on inter-sectoral changes or changes in specific sector (unemployment and output in the manufacturing sector for instance). To that we can add data problems which are shorter and harder to compile for unemployment. However, we can mention the work of Hodge (2009) who calculated the ratio of employment growth to economic for the period 1946-2007. He finds that economic growth leads to formal sector employment growth of only half the real GDP growth rate in South Africa (Fourie, 2011).

The rest of the paper is organised as follows. Section 1 lays down the model by presenting the household's and firm's problems. We solve the model in section 2 and present the social planner's equilibrium and the equilibriums under flexible and rigid wages. Section 3 runs the simulation by first going through the calibration and then commenting on impulse response functions. We conduct the estimation in section 4 and with the newly found parameter estimates we recalibrate the model and run the simulation again to have an idea where the South African labour market stands. Section 5 concludes.

2 The Model

2.1 Household

We assume standard preferences. There is a large number of identical households and each one is composed of a continuum of members represented by the unit interval. The household maximises the objective function given by:

$$E_0 \sum_{t=0}^{\infty} \beta^t U(C_t,\ L_t) \tag{1}$$

where $\beta \in [0, 1]$ is the discount factor, $C_t \equiv \left(\int_0^1 C_t\left(i\right)^{1-\frac{1}{\epsilon}} di \right)^{\frac{\epsilon}{\epsilon-1}}$ is the quantity consumed of final goods. ϵ denotes price elasticity. Let

$$0 \leq N_t \leq 1 \tag{2}$$

The household's utility function is of the following form:

$$U\left(C_t,\ N_t\right) \equiv logC_t - \frac{\chi}{1+\phi} {N_t}^{1+\phi} \tag{3}$$

The budget constraint they face is given by:

$$\int_0^1 P_t\left(i\right) C_t\left(i\right) di + Q_t B_t \leq B_{t-1} + \int_0^1 W_t\left(j\right) N_t\left(j\right) dj + \Pi_t \tag{4}$$

where $P_t(i)$ is the price of good i, $W_t(j)$ is the nominal wage paid by firm j, B_t denotes purchases of one-period bonds at a price Q_t, and Π_t represents a lump-sum component of income which may include dividends from ownership of firms or lump-sum taxes. Note consumption expenditures can be rewritten as $\int_0^1 P_t\left(i\right) C_t\left(i\right) di = P_t C_t$ where $P_t \equiv \left(\int_0^1 P_t(i)^{1-\epsilon} \right)^{\frac{1}{1-\epsilon}}$ is the price of final goods.

2.2 The firms

There are two types of firms in the economy. Firms producing final goods face a monopolistic competition. They do not use labour as input and are subject to nominal rigidities. Intermediate goods firms on the other hand operate in a perfectly competitive environment and use labour as input.

2.2.1 *Final goods firms*

There is a continuum of final goods firms indexed by $i \in [0,1]$, each producing a differentiated final good. They all have access to the same technology:

$$Y_t\left(i\right) = X_t(i) \tag{5}$$

where $X_t(i)$ denotes the single intermediate good used by firm i as an input.

We set prices following Calvo (1983). Each period, only a randomly selected fraction $1-\theta$ of final goods firms gets to change their prices. For the rest of the final goods producers measured by θ their price remains at the same level. Parameter $\theta \in [0,1]$ can be interpreted as an index of price rigidities. Aggregate price level satisfies the following:

$$P_t = \left(\left(1-\theta\right)\left(P_t^*\right)^{1-\epsilon} + \theta(P_{t-1})^{1-\epsilon}\right)^{\frac{1}{1-\epsilon}} \tag{6}$$

where P_t^* is the price newly set by a final goods firm at time t.

The optimal price setting rule for a firm resetting prices in period t is given by:

$$E_t\left\{\sum_{k=0}^{\infty}\theta^k Q_{t,t+k}Y_{t+k|t}(P_t^* - \mathcal{M}P_{t+k}MC_{t+k}\right\} = 0 \tag{7}$$

in which $Y_{t+k|t}$ denotes the level of output in period $t+k$ for a firm resetting price in period t, $\mathcal{M} \equiv \epsilon/(\epsilon-1)$ represents the gross mark up and MC_t is the real marginal cost for final goods firms.

2.2.2 *Intermediate good firms and labour market frictions*

We assume a continuum of identical, perfectly competitive firms, represented by the unit interval and indexed by j that produces intermediate goods. All firms have access to the same production function of the form:

$$X_t\left(i\right) = A_t N_t(j) \tag{8}$$

Variable A_t represents the state of technology, which is assumed to be common across firms and varies exogenously over time. More precisely, $a_t \equiv \log A_t$ follows an AR(1) process with autoregressive coefficient ρ_a and variance σ_a^2.

Employment in firm j evolves according to:

$$N_t\left(j\right) = \left(1-\delta\right)N_{t-1}\left(j\right) + H_t(j) \tag{9}$$

where $\delta \in (0,1)$ is an exogenous separation rate, and $H_t(j)$ represents the measure of workers hired by firm j in period t. Note that new hires start working in the same period they are hired. This assumption deviates from the standard one in the search and matching model in which a one period lag before a hired worker becomes productive is required. However, it is consistent with conventional business cycle models in which employment is not a predetermined variable.

There is a pool of jobless individuals (available for hire) in the beginning of period t given by U_t (Blanchard & Gali, 2010). At all time, individuals are either employed or willing to work, depending on the conditions prevailing in the labour market. The assumption of full participation therefore holds. Thus,

$$U_t = 1 - N_{t-1} + \delta N_{t-1} = 1 - (1-\delta)N_{t-1} \tag{10}$$

Among those unemployed at the beginning of period t, a measure $H_t \equiv \int_0^1 H_t(j)\,dj$ are hired.

Aggregate hiring evolves according to:

$$H_t = N_t - (1-\delta)N_{t-1} \tag{11}$$

where $N_t \equiv \int_0^1 N_t(j)\,dj$ represents aggregate employment.

We now introduce labour market frictions to the model in the form of cost per hire represented by G_t which we assume to be exogenous to individual firms. However it depends on aggregate factors including the labour market tightness index represented by $x_t \in [0,1]$ and given by:

$$x_t \equiv \frac{H_t}{U_t} \tag{12}$$

The aforementioned simply means that only workers in the unemployment pool at the beginning of the period can be hired ($H_t \leq U_t$). Also known as job finding rate, x_t captures the probability of getting hired in period t. We will come back on this index later on when we introduce the scenarios implied by the proposed study.

Note that hiring costs for an individual firm are given by $G_t H_t(j)$, expressed in terms of the CES bundle of goods. G_t is increasing in labour market tightness and more formally:

$$G_t = A_t B x_t^{\alpha} \tag{13}$$

where $\alpha \geq 0$ and B is a positive constant. For convenience, let $g_t \equiv B x_t^{\alpha}$. It follows that:

$$G_t = A_t g_t.$$

This formulation means that vacancies are immediately filled by paying the hiring cost; which diverges from the Diamond-Mortensen-Pissarides search and matching model of unemployment in which the hiring cost is uncertain. Since the aim of the proposed study is not explaining vacancies, the approach we choose will therefore be the one by Blanchard and Gali (2010) which is, as they pointed it out, very simple.

2.3 The equilibrium

2.3.1 *The social planner equilibrium*

We assume a benevolent social planner who solves the problem facing technological constraints and labour market frictions present in the decentralized economy. He internalises the effects of changes in the labour market tightness on hiring costs and the resource constraint.

Since there is symmetry in preferences and technology, efficiency requires that identical quantities of goods be consumed and produced, meaning $C_t\,(i) = C_t$ for all $i \in [0, 1]$. Also, labour market participation has no cost, but instead it has a social benefit since it decreases hiring costs. The social planner always chooses an allocation with full participation. This necessarily does not imply full employment since both a disutility and increases in hiring costs come as a result of higher employment.

The social planner therefore maximises (1) subject to (2) and the aggregate resource constraint given by:

$$C_t = A_t(N_t - Bx_t^{\alpha} H_t) \tag{14}$$

After solving, the optimality condition for the social planner's problem is given by:

$$\chi C_t N_t^{\phi} \leq A_t - (1+\alpha)\, A_t B x_t^{\alpha} + \beta(1-\delta)E_t \left\{ \frac{C_t}{C_{t+1}} A_{t+1} B x_{t+1}^{\alpha} (1 + \alpha\,(1 - x_{t+1})) \right\} \tag{15}$$

Thus, the marginal rate of substitution between labour and consumption (on the left hand side) is equal to or less than the marginal rate of transformation between the same labour and consumption (on the right hand side). The marginal rate of transformation has two distinct terms. The first one represents the additional output generated by a marginal employed worker whereas the second term captures the savings in hiring costs resulting from the reduced hiring needs in period $t + 1$.

2.3.2 *Equilibrium under flexible prices and wage determination*

Price setting

P_t denotes the price index associated with C_t, P_t^I is the price of the intermediate good and W_t represents the real wage in terms of the bundle of final goods.

Intermediate goods producers are price takers and their profit maximisation suggest that for all t, the real marginal revenue product of labour equals the real marginal cost. Thus,

$$\left(\frac{P_t^I}{P_t}\right) A_t = W_t + G_t - \beta(1-\delta)E_t \left(\frac{C_t}{C_{t+1}} G_{t+1}\right) \tag{16}$$

On the other hand, profit maximisation by final goods producers requires $P_t = \mathcal{M} P_t^I$ for all t.

Using (16) and reorganising gives:

$$Bx_t^{\alpha} = \left(\frac{1}{\mathcal{M}} - \frac{W_t}{A_t}\right) + \beta(1-\delta)E_t \left(\frac{C_t}{C_{t+1}} \frac{A_{t+1}}{A_t} B x_{t+1}^{\alpha}\right) \tag{17}$$

Solving forward and the result shows that labour market tightness depends on the expected discounted stream of marginal profits generated by an additional hire. Marginal profit depends, in turn, on the ratio of the wage to productivity.

Determination of Wage

The presence of labour market frictions generates a surplus associated with established employment relationships. The wage determines how that surplus is divided between workers and firms. In this section we present two ways of determining wage namely flexible and sticky wages. Under flexible wages, all wages are renegotiated and adjusted every period. On the other hand under sticky wages, only a fraction of firms can adjust their nominal wages in any given period.

Flexible wages

We determine flexible wages using Nash bargaining techniques. Each firm negotiates with its workers over their individual compensation. The value of an employed member to a household is given by:

$$\mathcal{V}_t^N = W_t - \chi C_t N_t^{\phi} + \beta E_t \left\{ \frac{C_t}{C_{t+1}} \left[\left(1 - \delta \left(1 - x_{t+1}\right)\right) \mathcal{V}_{t+1}^N + \delta (1 - x_{t+1})\ \mathcal{V}_{t+1}^U \right] \right\} \tag{18}$$

$\mathcal{V}_t^U$ is the value of an unemployed member to a household and is given by:

$$\mathcal{V}_t^U = \beta E_t \left\{ \frac{C_t}{C_{t+1}} \left[x_{t+1}\ \mathcal{V}_{t+1}^N + (1 - x_{t+1})\ \mathcal{V}_{t+1}^U \right] \right\} \tag{19}$$

From an established employment relationship, the household's surplus is given by $\mathcal{S}_t^H \equiv\ \mathcal{V}_t^N -\ \mathcal{V}_t^U$ and can be written as:

$$\mathcal{S}_t^H = W_t - \chi C_t N_t^{\phi} + \beta (1 - \delta) E_t \left\{ \frac{C_t}{C_{t+1}} (1 - x_{t+1}) \mathcal{S}_{t+1}^H \right\} \tag{20}$$

On the other hand and again from an established employment relationship, the firm's surplus, represented by $\mathcal{S}_t^F$, is given by:

$$\mathcal{S}_t^F = A_t B x_t^{\alpha} = G_t \tag{21}$$

meaning any currently employed individual can be immediately substituted with an unemployed one just by paying the hiring cost.

The Nash bargain must satisfy:

$$\mathcal{S}_t^H = \vartheta \mathcal{S}_t^F \tag{22}$$

where ϑ is the relative bargaining power of workers. By combining this condition with 20 and 21, we obtain the following wage schedule:

$$W_t = \chi C_t N_t^{\phi} + \vartheta \left(A_t B x_t^{\alpha} - \beta (1 - \delta) E_t \left\{ \frac{C_t}{C_{t+1}} (1 - x_{t+1}) A_t B x_{t+1}^{\alpha} \right\} \right) \tag{23}$$

Therefore, given that workers have some bargaining power ($\vartheta > 0$) and that labour market frictions are present ($B > 0$), the bargained wage equals to the marginal rate of substitution plus an additional term reflecting labour market conditions. This additional term is an increasing function of current labour market tightness (given that when associated with an existing relationship, it raises the firm's surplus) but is a decreasing function of expected future hiring costs ($G_{t+1} = A_t B x_{t+1}^{\alpha}$) and the probability of not finding a job if unemployed next period given by $1 - x_{t+1}$ (since these two terms lower wage today by increasing the continuation value to an employed worker).

By combining (17) (which gives the wage consistent with the price setting) and (23) (giving the wage consistent with Nash bargaining), we obtain the following new equilibrium:

$$\chi C_t N_t^{\phi} = \frac{A_t}{\mathcal{M}} - (1+\vartheta) A_t B x_t^{\alpha} + \beta(1-\delta) E_t \left\{ \frac{C_t}{C_{t+1}} A_t B x_{t+1}^{\alpha} (1 + \vartheta (1 - x_{t+1})) \right\} \tag{24}$$

The real wage is given by:

$$W_t = \left(\frac{1}{\mathcal{M}} - (1 - \beta(1-\delta)) B x^{\alpha} \right) A_t \tag{25}$$

According to this flexible design, wages are highly responsive to productivity movements. However empirical studies show a different outcome. This result has led authors (Shimer, 2005, Hall, 2005) to account for real wage rigidities to explain small movements in the wage that match large movements in unemployment.

Real wage rigidities

Formalising real wage rigidities remains a question open to research. Thus, for simplicity, let's assume like Blanchard and Gali (2010) a wage schedule of the form:

$$W_t = \Theta A_t^{1-\gamma} \tag{26}$$

in which $\gamma \in [0,1]$ is an index of real wage rigidities, and Θ is a positive constant which we assume to take the value $\Theta \equiv \left(\left(\frac{1}{\mathcal{M}} \right) - (1 - \beta(1-\delta)) B x^{\alpha} \right) A^{\gamma}$, with A representing the unconditional mean of A_t. Note that for $\gamma = 0$ (flexible wages) this wage schedule equals to the Nash-bargained wage.

By combining (26) with (17), we derive the last equilibrium condition, namely the equilibrium consistent with real wage rigidities, which is given by:

$$\Theta A_t^{-\gamma} = \frac{1}{\mathcal{M}} - B x_t^{\alpha} + \beta(1-\delta) E_t \left\{ \frac{C_t}{C_{t+1}} \frac{A_{t+1}}{A_t} B x_{t+1}^{\alpha} \right\} \tag{27}$$

Rearranging and solving forward:

$$B x_t^{\alpha} = \sum_{k=0}^{\infty} (\beta(1-\delta))^k E_t \left\{ \frac{C_t}{C_{t+1}} \frac{A_{t+1}}{A_t} \left(\frac{1}{\mathcal{M}} - \Theta A_{t+k}^{-\gamma} \right) \right\} \tag{28}$$

This equation highlights the importance of the role played by labour market tightness in an economy with labour market frictions and real wage rigidities. Given that wages are not fully flexible, labour market tightness and, by implication, movements in employment and unemployment, depend on current and anticipated productivity.

2.4 Log Linearization

In order to illustrate the equilibrium dynamics we first define the real marginal cost which we assume to evolve according to P_t^I/P_t. Combining the profit maximisation condition of intermediate goods producers given by (16) with the wage schedule in equation (26) gives the following setting for real marginal cost:

$$MC_t = \Theta A_t^{-\gamma} + Bx_t^{\alpha} - \beta(1-\delta)E_t\left\{\frac{C_t}{C_{t+1}}\frac{A_{t+1}}{A_t}Bx_{t+1}^{\alpha}\right\} \tag{29}$$

One can easily detect that real marginal cost depends on labour market frictions (captured by hiring cost parameters B and α) and on real wage rigidities (measured by the rigidity index γ).

Lower case variables with hats represent log deviations of the corresponding upper case variables from their steady state values.

After log-linearizing equations (6) and (7) around a zero inflation steady state (Gali & Gertler, 1999), the following expression for inflation is given:

$$\pi_t = \beta E_t\left\{\pi_{t+1}\right\} + \lambda\widehat{mc}_t \tag{30}$$

in which $\lambda \equiv (1-\beta\theta)(1-\theta)/\theta$

Log linearizing and rearranging equation (29), real marginal cost takes the following form:

$$\widehat{mc}_t = \alpha g\mathcal{M}\hat{x}_t - \beta(1-\delta)g\mathcal{M}E_t\left\{(\hat{c}_t - \hat{a}_t) - (\hat{c}_{t+1} - \hat{a}_{t+1}) + \alpha\hat{x}_{t+1}\right\} - \Phi\gamma\hat{a}_t \tag{31}$$

in which $\Phi \equiv \frac{\mathcal{M}W}{A} = 1 - (1-\beta(1-\delta))g\mathcal{M} < 1$.

It then follows that real marginal cost is positively related to labour market tightness and negatively (given $\gamma > 0$) to productivity. The more rigid is real wage, or the more persistent the productivity process, the larger the effect of productivity on real marginal cost (and in turn, on inflation).

We derive an expression for labour market tightness as a function of current and lagged employment from equation (12) which takes the following form:

$$\delta\hat{x}_t = \hat{n}_t - (1-\delta)(1-x)\hat{n}_{t-1} \tag{32}$$

From equation (14), an expression for consumption is obtained:

$$\hat{c}_t = \hat{a}_t + \frac{1-g}{1-\delta g}\hat{n}_t + \frac{g(1-\delta)}{1-\delta g}\hat{n}_{t-1} - \frac{\alpha g}{1-\delta g}\delta\hat{x}_t \tag{33}$$

Finally, from the consumer's first order conditions, we obtain the following:

$$\hat{c}_t = E_t\left\{\hat{c}_{t+1}\right\} - (i_t - E_t\left\{\pi_{t+1}\right\} - \rho) \tag{34}$$

in which $\rho \equiv -log\beta$.

We now move on to derive the Philips curve relation between inflation and unemployment implied by the framework of the proposed study. Substituting (32) in (33)gives:

$$\hat{c}_t = \hat{a}_t + \xi_0 \hat{n}_t + \xi_1 \hat{n}_{t-1} \tag{35}$$

in which $\xi_0 \equiv (1 - g(1+\alpha))/(1-\delta g)$ and $\xi_1 \equiv (g(1-\delta))(1+\alpha(1-x))/(1-\delta g)$.

Substituting this expression, along with (32), in (31) gives this new expression for real marginal cost:

$$\widehat{mc}_t = h_0 \hat{n}_t + h_L \hat{n}_{t-1} + h_F E_t \{\hat{n}_{t+1}\} - \Phi\gamma\hat{a}_t \tag{36}$$

in which

$$h_0 \equiv \left(\frac{\alpha g \mathcal{M}}{\delta}\right)\left(1 + \beta(1-\delta)^2(1-x)\right) + \beta(1-\delta) g\mathcal{M}(\xi_1 - \xi_0)$$

$$h_L \equiv -(\alpha g\mathcal{M}/\delta)(1-\delta)(1-x) - \beta(1-\delta) g\mathcal{M}\xi_1$$

$$h_F \equiv -\beta(1-\delta) g\mathcal{M}((\alpha/\delta) - \xi_0)$$

By replacing this expression in equation (30), and given $\hat{u}_t = -(1-u)\hat{n}_t$, the following Philips curve giving the relation between inflation and unemployment is obtained:

$$\pi_t = \beta E_t\{\pi_{t+1}\} - \kappa_0 \hat{u}_t + \kappa_L \hat{u}_{t-1} + \kappa_F E_t\{\hat{u}_{t+1}\} - \lambda\Phi\gamma\hat{a}_t \tag{37}$$

in which $\kappa_0 \equiv \lambda h_0/(1-u)$, $\kappa_L \equiv -\lambda h_L/(1-u)$ and $\kappa_F \equiv -\lambda h_F/(1-u)$. This Philips curve highlights the negative relationship between inflation and both the level and the change in the unemployment rate.

Again, using the relation between employment and unemployment given by $\hat{u}_t = -(1-u)\hat{n}_t$, equation (32) becomes:

$$(1-u)\delta\hat{x}_t = -\hat{u}_t + (1-x)(1-\delta)\hat{u}_{t-1} \tag{38}$$

which gives the relation between labour market tightness and both current and lagged unemployment rates. It plays an important role in the design of the four scenarios implied by the proposed study. To start up, we consider two labour markets. The first one is characterised by labour market high flows (implying high values of δ and x) and low unemployment duration. The other is considered to have low flows (low level of δ and x) and relatively high steady state unemployment. We define the first labour market as fluid whereas the second one is more rigid. The fluid labour market has a small $(1-x)(1-\delta)$ given in (38) while this value is larger for the rigid labour market. Thus, relative labour market tightness moves more with the negative of the change in the unemployment rate; consequently, changes in unemployment lead to large relative changes in the flows. On the other hand, in the fluid labour market with low steady state unemployment, changes in unemployment lead to small relative changes in the flows, thus to small relative changes in labour market tightness. The other two scenarios are a fluid labour market with high unemployment duration and a sclerotic labour market with low unemployment duration.

The equilibrium is therefore characterised by the following set of equations (to which we add the processes of the shocks and the central banker's instrument is added):

1. The Philips curve relation between inflation and unemployment:

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

2. The relation between unemployment and employment:

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

3. The expression of labour market tightness as a function of current and lagged employment:

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

4. The expression for consumption:

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

5. The first order condition for the consumer:

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

6. The central banker's instrument:

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

3 Simulation

3.1 Calibration

Each period corresponds to a quarter. Parameters describing preferences take common values. Thus, $\beta = 0.99$, $\phi = 1$ and $\epsilon = 6$. This implies a value of 1.2 for the mark up. Nakamura and Steinsson (2008) estimate a median price duration between 8 and 12 months. Therefore, $\lambda = 1/12$. Since no hard evidence on the degree of real wage rigidities is existent, we assumed that $\gamma = 0.5$. to α we assign the value of 1. The level of hiring cost takes the following value $B = 0.12$.

Given the relationship between unemployment, labour market tightness and the separation rate $u = \frac{\delta(1-x)}{\delta(1-x)+x}$, we assume four scenarios as explained in section 4.1:

1. Scenario 1 (Rigid-Low): a rigid labour market with low steady state unemployment rate with $u = 0.05$, $x = 0.15$ and $\delta = 0.01$. Here we assume an economy with low steady state unemployment. We define a labour market where it is hard for unemployed individuals to find a job and once they have got it, they hold on to it for a while and do not lose it easily. The flows in the labour market are therefore low.

2. Scenario 2 (Rigid-High): a rigid labour market with high steady state unemployment rate with $u = 0.30$, $x = 0.15$ 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, the separation rate is only slightly bigger.

3. Scenario 3 (Fluid-Low): a fluid labour market with low steady state unemployment rate with $u = 0.05$, $x = 0.8$ and $\delta = 0.21$. In this scenario, an unemployed individual has a high chance of finding a job but also letting it go is quite easy (compared to scenario 1).

4. Scenario 4 (Fluid-High): a fluid labour market with high steady state unemployment with $u = 0.30$, $x = 0.67$ and $\delta = 0.87$. An unemployed individual in this economy has a relatively high probability of getting hired. However, he would lose the job fairly easy. Although the flows are high in this labour market, a huge amount of individuals in this scenario is left without jobs.

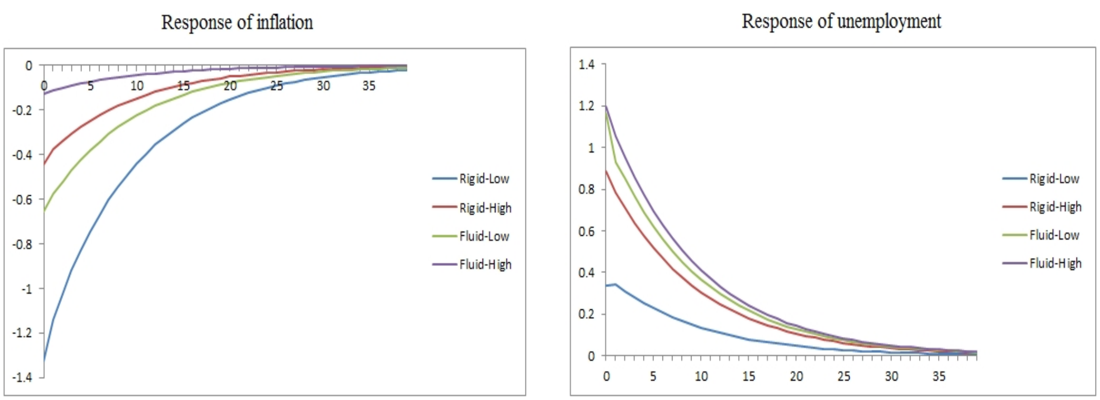
In each scenario, we simulate a monetary shock on the economy. The shock is an AR(1) processes with an autoregressive coefficient of 0.9. The general effects of the shock are in line with the standard New Keynesian DSGE model (see for instance Gali *et al*, 2010). What changes about this model is the 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 $\phi_u = 0$.

3.2 Impulse responses

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 Fluid - High 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 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).

We also find interesting results in scenario 2 (Rigid-High) and 3 (Fluid-Low). Inflation response is less at the moment of impact in scenario 2 (a drop of about 0.4 per cent) compared to scenario 3. The same results apply to the response of unemployment as seen in the right panel of Figure 1 where we find a higher response in scenario 3.

Figure 1: Impulse response functions



4 Estimation

We estimate the model with the followings as observable variables: inflation, output, interest rate and employment. The quarterly data covers the period 1994:01 to 2011:03. We use the first logarithmic difference of South Africa's Consumer Price Index (CPI) as a measure of inflation. Since the difference between the use of GDP deflator and CPI (as a measure of inflation) in the data is very little, we decided it would be best to stick with CPI since it captures the cost of living faced by consumers of a nation. 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 which we do using the Hodrick–Prescott filter. We focus only on estimating parameters that are related to the labour market. 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

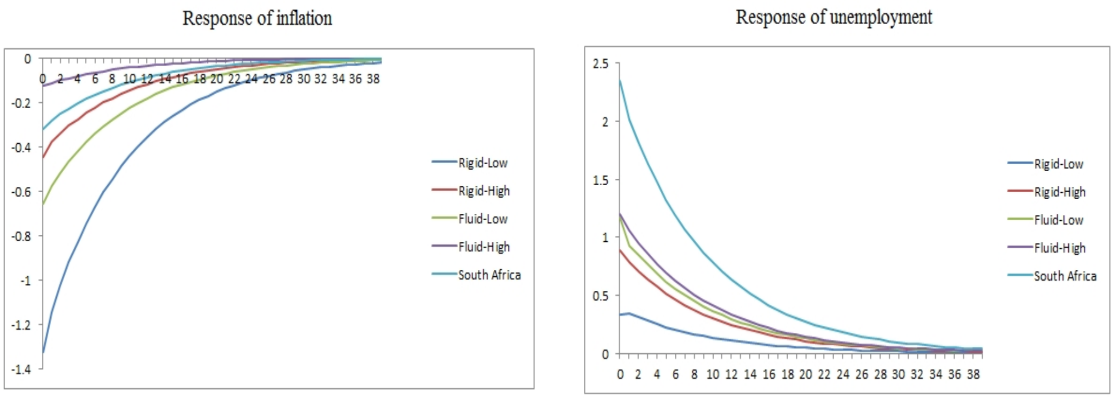
Notes: Letters B and N denotes density distributions and are respectively defined as Beta and Normal distributions.

We first focus our attention on the job finding and separation rates. We find a labour market tightness index of 0.72 implying a separation rate of 0.77. This puts South Africa in the neighbourhood of scenario 4 (Fluid labour market associated with a high level of steady state unemployment) which is perhaps, as mentioned already, the worst possible scenario. Further we find a high wage rigidity of 0.95 which is quite high compared to Blanchard and Gali's (2010) calibration of 0.5. This result shows that wages in the South African manufacturing sector vary little and when it does vary, it is mostly after a workers' strike occurred (often triggered by trade and workers unions).

The posterior estimate of the Taylor rule weight on unemployment indicates that the South African monetary authority barely cares about unemployment when setting interest rate. The Taylor rule parameter estimates for inflation and output are in the neighbourhood of the findings of Gupta (2013). Speaking of such results, Gupta (2013) argues this perhaps is a reflection of a fairly pragmatic approach pursued by the South African Reserve Bank in the setting of interest rate in response to inflation while also taking into consideration the developments in output. All persistence parameters (except the labour one) are high; which is in line with prior expectations.

Now that we have parameter estimates using South African data, we turn to re-calibrate the model and run the simulation again to see where the country stands between the four scenarios. The results show that inflation in the case of South Africa tends to be more responsive when compared to scenario 4 (Fluid-High). Unemployment on the other hand when we use South African data depicts the highest response. We conclude that South Africa has a quite fluid labour market associated with a high steady state level of unemployment. Figure 2 summarises the responses.

Figure 2: Impulse responses



5 Conclusions

This paper attempts to understand how the dynamics in the labour market affect the way monetary policy is conducted. We do so by designing four scenarios that differ in terms of labour market fluidity and level of steady state unemployment. We first conduct a simple simulation of the model to analyse the dynamic effects of a monetary shock on inflation and unemployment. We focus on the two extremes namely scenario 1 (Rigid-Low) and scenario 4 (Fluid-High) to find that in scenario 4, the central banker's instrument has little effect on inflation which is compensated by a larger effect on unemployment. The opposite applies for scenario 1. Next we conduct an estimation using South African data and focusing on the manufacturing sector. Our findings confirm our expections of South African labour market being fluid as we find a relatively high job finding rate of about 0.72, implying a separation rate of 0.77. Having found new parameter estimates, we re-calibrate the model and the impulse responses to conclude that the labour market in South Africa is fluid and faces a high level of unemployment.

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