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Chapter 1

Introduction

Unemployment is the defining characteristic of the South African economy. For the last 20 years the unemployment rate, in its narrow definition, has fluctuated around 25 percent without any significant and permanent reduction. Unemployment is largely young, unskilled and African and its dimension, and persistence is 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 sees 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 2008 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 show the GDP and employment response to the financial crisis respectively of Germany, the United Kingdom, South Africa and Chile.

Figure 1: GDP performance of selected countries

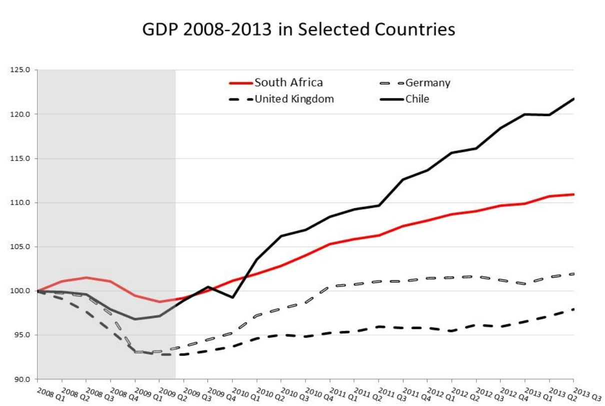
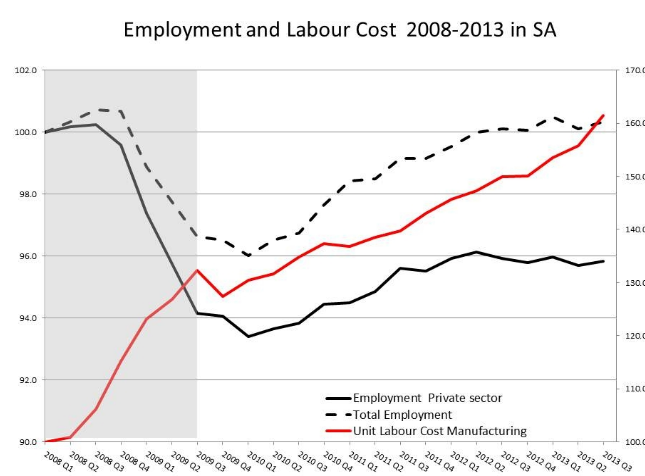


Figure 2: Employment performance of selected countries

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 economy. Instead the employment response has been dramatic and persistent, and much worse than 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.

Figure 3: South African employment and unit labour cost



This event highlighted 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 by Banerjee *et al* (2008) and Kerr *et al* (2013) in some preliminary work on the formal economy. The second issue 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.

Given this economic environment and by observing South African data, this thesis begins with the following simple question: what is the relationship between the labour market structure and the ability of the monetary authority to keep control of macroeconomic dynamics? Answering this question leads to an analysis with a threefold aim. First of all, we investigate the empirical evidence of wage rigidities especially in the private sector. Secondly, we analyze the repercussions of the existence of such rigidities in wages on the conduct of monetary policy in South Africa. Finally, we introduce public sector dynamics in an environment where the labor market is dominated by the abundance of low skilled labour and the scarcity of skilled workers, to assess the impact public employment on the South African labour market.

This thesis has three main chapters. Chapter 2 begins by evaluating, at an aggregate level, the responsiveness of wages to macroeconomic conditions using a wage Phillips curve framework in the context of a microfounded New Keynesian model. We then assess wage formation at a sectoral level by linking wage formation and price determination by the firms as we introduce the reservation wage. The analysis shows the following results. At an aggregate level, wages in South Africa do not respond strongly to demand conditions. This is a clear indication of the existence of large wage rigidities, low elasticity of substitution and large wage mark-ups. These results are confirmed at a sectoral level. Moreover, we find the presence of an error correction term in the wage equation when we compare the South African labour market with US and European ones. This finding suggests that unobservable variables have an impact on wage dynamics. In particular, frictions including the sizeable bargaining power of trade unions, stringent market regulations and the considerable size of the informal sector play a significant role in explaining for the existence of the error correction term in the South African wage equation. We also observe a strong response of wages to labour productivity, output prices and employment in the community, social and personal services sector. It is important to highlight that this sector consists mainly of public firms.

The rigidity of wages is investigated further in chapter 3 to assess the implications of this finding in terms of monetary policy. Therefore we use a New Keynesian DSGE model with unemployment as we simulate the responsiveness of unemployment and inflation to a monetary shock. The chapter also takes into account the dynamics generated by job destruction and creation rates which is an important feature of the labour market in South Africa. This is captured through the labour market tightness index introduced by Blanchard and Gali (2010). The results show that the labour market structure significantly impacts the transmission mechanism of monetary policy. In essence, we find that in an economy with a fluid labour market and a high rate of steady state unemployment (a familiar feature of the South African labour market), the central banker's instrument has little effect on inflation which is however compensated by a larger response in unemployment. This therefore suggests that the monetary authority faces a trade-off between stabilizing unemployment and inflation. The penalizing sacrifice ratio arising from this trade-off is further emphasized by a low level of price elasticity to interest rate and a high level of employment elasticity. An estimation of the model reveals a picture of a labour market in South Africa dominated by wage rigidities and consistently large flows in the form high job destruction and job creation rates. The former dominating the dynamics.

A potential explanation to the remarkably strong response of wages to market conditions in the public sector as observed in chapter 2, is perhaps the fact that the sector is largely skilled workers intensive. Given that there is an existential shortage of skilled labour in the economy, and the fact that the public sector has been expanding since the 2008 financial crisis, while private firms faced arduous times, chapter 4 explores the potential labour market effects of public employment and its contribution in partly explaining wage rigidities in the private sector. We therefore use a DSGE model with two sectors of a labour market composed of skilled and unskilled workers, following the framework first designed by Gomes (2013). In particular, we assess in this chapter the impact of a positive public sector wage shock on selected variables of the model. For comparison purposes, we also report the effects of a positive private sector productivity shock. The findings show that an increase in private sector productivity produces more desirable results with an increase in unemployment for both the skilled and unskilled workers which in turns translate into a decrease in overall unemployment. An increase in public wages on the other hand mainly crowds out private skilled labour which the firms react to by substituting it with low skilled workers. Ultimately, the positive public wage shock raises overall unemployment as the number of skilled unemployed individuals queueing for public jobs increases. The effects are more pronounced when the bargaining power of unskilled workers is raised. Furthermore, by assuming that productivity efficiency is lower in the public sector, a public sector wage increase leads to more skilled individuals moving to the public sector which has now become more attractive given the public wage premium. This public wage premium incintivizes workers in the private sector to demand higher wages, regardless of the position of the economy in the business cycle. This often results in job shedding in the private sector, particularly during recession. Indeed, such wage increases are not necessarily linked to increases in labour productivity but rather, they find their sources in the sizeable bargaining power of trade unions in wage settlements.

Chapter 2

Estimation of a New Keynesian Wage Phillips Curve

Abstract

This chapter estimates a New Keynesian Wage Phillips Curve for South Africa to investigate the responsiveness of nominal wages to labour market conditions. The estimation is based on a New Keynesian model with staggered nominal wages setting, where all variations in hired labour input is taking place at the extensive margin. First we estimate the model using aggregate data from 1971 to 2013. Aggregate estimation results show that private sector nominal wages are not very responsive to employment conditions, while they also reveal a certain sensitivity to inflation and quite a good correlation with inflation expectations. On the other hand, the relationship between nominal wage inflation and price inflation is quite strong and robust for the whole sample. However, it becomes quantitatively weak for the inflation targeting period. In that period, trade unions inflation expectations are instead strongly correlated with nominal wage inflation.

In the second part of the chapter we assess the response of nominal wages to employment, labour productivity and output prices, given the reservation wage, using a panel of nine industrial sectors over the period 1970- 2013. The findings confirm that nominal wage inflation has consistently outpaced the growth in productivity, even after correcting for price inflation, and that employment conditions had little effect on wage dynamics. We also test for the possibility that the dynamic of wages is anchored by an underlined reservation wage to investigate the presence of an error correction term in the wage equation for South Africa.

The overall picture that comes out from the analysis is that of a wage formation mechanism that is very insensitive to overall macroeconomic conditions.

2.1 Introduction

The negative relation between the rate of change 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 Non-Accelerating Inflation Rate of Unemployment (NAIRU) setting, relatively recent New-Keynesian literature (for example Gordon 1997, Staiger *et al*, 1997, Erceg *et al*, 2000, Gali, 2010, Blanchard and Gali, 2010, 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 conditions, the potential sacrifice ratio of a contractionary monetary policy can be very significant.

Given these premises, this chapter, for the first part, revisits the original findings of Phillips (1958) for the South African economy following the staggered nominal wage setting model introduced by Erceg *et al* (2000). The staggered nominal wage is modelled in a way symmetric to the price setting following Calvo (1983) as in standard versions of the New Keynesian framework to derive what Gali (2011) refers to as the New Keynesian Wage Phillips Curve. The second part of this chapter investigates wage rigidities even further at a sectoral level using data from nine industries in South Africa. We also take into account the labour productivity growth and the reservation wage.

The overall findings suggest that wages in the economy do no respond strongly enough to demand conditions, therefore indicating large wage rigidities, low elasticity of substitution and large wage markups. These results are further emphasized at a sectoral level. Moreover, we find the presence of an error correction term in the South African wage equation, which is an indication that other factors including considerable bargaining power of trade unions, rigoruous market regulations and a sizeable informal sector have an important impact on wage dynamics.

By simply observing scatterplots of wage inflation and the unemployment rate for the US economy during 1964Q1 - 2009Q3, Gali (2011) reveals the absence of a stable negative relation between the two variables which has led some authors using similar graphs to conclude of the empirical failure of the Phillips curve (Ball 1994, Eliasson, 2001, Mankiw, 2001, Olafsson, 2006). This was first observed in the 1970s when both inflation and unemployment increased simultaneously due to the oil price shock. However by restricting the scatterplots to the post 1984 period, the inverse relationship is indeed confirmed. Therefore, Gali (2011) uses the staggered nominal wage model by Erceg *et al* (2000) to derive and estimate a New Keynesian Wage Phillips Curve for the US economy. Overall, the results show a negative and significant coefficient on current and lagged unemployment; thus confirming the predicted theory. In fact, the wage equation derived in this model accounts reasonably well for the strong negative comovement between wage inflation and unemployment for the past two decades in the US despite the fact that such a model does not perhaps provide an accurate description of the US labour market.

The South African labour market on the other hand presents features that are unusual by international standards. For instance, high and persistent unemployment rates do not prevent the real cost of labour to rise as one would expect the opposite to take place (Fedderke, 2012). Indeed as reported in the introduction of this thesis, a clear evidence of this statement occurred in the aftermath of the 2008 financial crisis, when the labour cost grew at a consistent pace while job losses in the manufacturing sector were rapid and sustained as a result of that external shock. This therefore suggests the presence of rigidities in the South African labour market that prevent the price of labour and goods from adjusting well enough, which in turns results in high levels of unemployment. As Fedderke (2012) finds, there is evidence suggesting that the economy is characterized by strong rigidities in both the labour and output markets. Essentially, these rigidities generate constraints on the real cost of the labour to adjust freely so that labour demand may increase and the market may clear.

The presence of rigidities in the labour market in South Africa finds its source in both demand and supply sides of labour.

Typically, on the supply side, market segmentation, high reservation wages and the mismatch of skills mainly contribute to the failure of markets to clear. Regarding labour market segmentation, Kingdon and Knight (2004, 2006a, b) argue that the labour market in South Africa is segmented between formal and informal sectors. They find that wages in the formal sectors are sticky and therefore prevent the market from clearing, given the significant number of involuntary unemployed and those who have been discouraged in their search for employment. Furthermore, Moll (1993) and Hofmeyr (2000) identify a segmentation between unionized and non-unionized labour market where wage rigidities are present in the unionized market given the level of bargaining power of trade unions in wage settlements. By combining the findings of these authors, Casale and Posel (2002, 2003) and Heintz and Posel (2008) structure the labour market between unionized formal, non-unionized formal and informal segments. Fedderke (2012) argues that in that way, the South African labour market is not unusual. However, the peculiarity of this case arises from the structural nature of the high and persistent rate of unemployment and the levels of wage differentials between segments - often referred to as the skill wage premium.

Adding on the rigidities arising from the supply side, Bertrand *et al* (2003), Dinkelman (2004) and Klasen and Woolard (2005) conclude that reservation wages - an issue we deal with in the second part of this chapter - are too high which significantly impede labour market participation. Finally on the issue of skills mismatched - which we discuss more extensively in chapter 4 - with most economic sectors pacely moving toward greater skills intensity in terms of their employment structure (Bhorat and Hodge, 1999, Banerjee et al 2008, and Rodrik, 2008), it appears the education system in South Africa fails to provide the labour market with the skilled workers it crucially needs. This has consequences in terms of labour market rigidities as this failure to close the gap between skilled and low skilled workers significantly reduces the probability of adequate labour market clearance. The other important implication is that because the participants in the labour market are unable to send adequate signals, labour is often mispriced (Fedderke, 2012). Indeed, with the level of productivity low, the cost of labour is deemed too high (Schussler, 2012, Nattrass & Seekings, 2013). This point leads to the evaluation of rigidities in the labour market emanating from the demand side.

Fedderke (2012), amongst many others in the literature, have argued that authorities should respond to high and persistent levels of unemployment in South Africa by cutting down the price of labour enough to clear the labour market. It therefore appears that labour mispricing is possibly an important characteristic of labour market conditions in the economy, judging by the wide range of evidence supporting that claim. The author reports employment trends and real remuneration per employee in the Gold and Uranium Mining sector to find compelling evidence that increases in real labour costs since the 1980s have been closely related to a significant process of labour shedding in the same sector. Furthermore and by contrast, Fedderke (2012) reports that during periods of declines in real labour costs, one could observe a slight increase in the growth rate of employment in the sector. The findings are in line with results from other mining sectors (Fedderke and Pirouz, 2002). This point is further emphasized if one would take into account the growth of labour productivity and its relationship with real labour cost growth. Indeed, low rates of correlation between labour productivity and real labour remuneration growth rates are often associated with sluggish employment growth (Fedderke and Mariotti 2002).

Burger and Markinkov (2006) presents an overview of the literature on the Phillips curve studies in South Africa, which covers early works including Krogh (1967), Gallaway *et al* (1970), Truu (1975) and Levin and Horn (1987); and more recent studies amongst which, Nell (2000), Hodge (2002) and Fedderke and Schaling (2005). However, most of these studies focus on the relationship between the change in the price level and the output gap (or in some cases, the deviation of unemployment from its natural rate). Our study in this chapter on the other hand, as stated earlier, revisits the original relationship between (un)employment and the change in the level of wages in South Africa given the presence of rigidities prevailing in the labour market and the weak correlation between labour productivity and wages growth rates; which we expect to have significant repercussions in terms of employment growth.

We structure the rest of the chapter as follows. Section 2 explores the historical development of the Phillips curve literature in South Africa while Section 3 derives the model following Gali (2011) as we move from a basic set up first introduced by Erceg *et al* (2000) to an extension of the framework, and derive the equation that will later be estimated. Section 4 gives a glance at the data first and then comments on the empirical results. Section 5 is a sectoral analysis of the responsiveness of nominal wage to output price, labour productivity and employment given the reservation wage. Section 6 concludes.

2.2 The Phillips curve in the South Africa literature

This section presents an overview of historical developments regarding the Phillips curve in South Africa. As reported by du Plessis and Burger (2006), evidence of early contributions regarding this topic in the country stretches all the way back to the 1970s and includes works of Hume (1971), Strydom and Steenkamp (1976), Strebel (1976), etc. These studies have in common the fact that they all followed closely the framework of Phillips (1958) in investigating the trade-off between nominal wages and unemployment. As the authors highlight, the main drawback about the application of this framework for South Africa was the inaccuracy of the measure of unemployment, which promptly led authors to move away from unemployment to rather focus on output gap. Therefore, in doing so, Truu (1975) and Strydom and Steenkamp (1976) find a significant trade-off between output gap and inflation but only when the sample is restricted to the 1960s.

This consequently raised the question of the presence of the Phillips curve in South Africa. More importantly, if this presence is then justified, the form that it takes was another relevant interrogation. Indeed one thing certain about the South African literature regarding the Phillips curve is mainly how to reconcile theory and empirical realizations. Du Plessis and Burger (2006) essentially emphasize that this ambiguity has divided researchers on the topic into two factions. A first group of authors (Strebel, 1976, Nell, 2000, and Burger and Marinkov, 2006) essentially focused on non linear specifications in an attempt to at least replicate and identify in the business cycle periods when the trade-off between inflation and output gap associated with the Phillips curve might have held. On the other hand, a second group adopted a then unorthodox approach by abandoning the hope of including a demand effect in the inflation equation for South Africa, either explicitly (Pretorius and Small, 1994) or rather implicitly (Fedderke and Schaling, 2005).

Although the original Phillips curve estimated in 1958 captures the relationship between wage inflation and unemployment, subsequent studies have directed the focus more toward a relationship between price inflation and unemployment, or between price inflation and output gap as commonly found in the literature. The way to estimate the equation therefore merely involves traditionally regressing the change in the level of prices on a measure of output gap for a first group of researchers, or regressing the change in the price level on the deviation of unemployment from its natural rate, for a second group. Studies from both research factions can be found in the South African literature. For instance, Hodge (2002) belongs to the latter while works similar to the one by Nell (2000) falls into the former category of researchers. Both studies found puzzling results using South African data. Indeed, Hodge (2002) only finds evidence of a relationship between first differences of inflation and growth, whereas Nell (2000) could only reconcile theory and data during periods of accelerating inflation when the economy overheats. This has therefore led to criticism of the traditional way of estimating the equation, and early works as Gordon (1990) already argued the traditional approach generates biased results.

Gordon (1997) therefore introduced a triangular model which has the novelty of controlling for inertia effects, output levels, and the rate of change in output effects. He finds relevant results for various European countries, the US and Japan. After exploring how Gordon (1997) departs from the then mainstream literature, Burger and Marinkov (2006) applies the model to South Africa. Furthermore, building on the findings of Nell (2000), the authors split their measure of output gap into two to accommodate for periods when the economy overheats and for times when economic activities are relatively weak. They find that a triangular approach for the Phillips curve applies in South Africa only to a certain extent. Indeed, the authors find evidence of inertia effects but output level and output rate of change effects are clearly absent. Interestingly, when accounting for the unit labour cost, Burger and Marinkov (2006) find a statistically significant parameter in all of their regressions. Therefore, the authors essentially suggest that further research regarding labour market effects on South African inflation should be investigated. This finding in itself, provides the motivation for this chapter.

As suggested earlier, we follow closely the framework of Gali (2011) and use a model that accounts for price inflation, wage inflation and (un)employment. This allows us to essentially investigate the role played by rigidities in prices and wages in the optimal response of monetary policy to shocks. This approach of estimating the Phillips curve by taking into account wage rigidities is particularly interesting given that the South African literature in this particular subject mainly focuses on price inflation dynamics alone. Very few studies (Gallaway, *et al*, 1970, Strydom and Steenkamp, 1976, and Levin and Horn, 1987) have focused on the wage inflation in the past.

The framework introduced by Gali (2011) is briefly laid off in the next section. He reformulates the standard New Keynesian wage equation by incorporating a staggered wage setting model - similar to the price setting introduced by Calvo (1983) - to derive a dynamic relation between wage inflation and unemployment.

2.3 The Model

2.3.1 The basic Model

This model assume indivisible labour with all the variations in hired input taking place in the form of variations in employment.

There is a large representative household with a continuum of members represented by the unit square and indexed by a pair $(i, j) \in [0,1] \times [0,1]$. The first dimension (indexed by $i \in [0,1]$) represents the type of labour in which a given household member is specialized. The second dimension on the other hand (indexed by $j \in [0,1]$) defines his disutility from work. This disutility is given by $\chi_t j^{\varphi}$ if he is employed, zero otherwise. $\varphi \geq 0$ defines the elasticity of the marginal disutility of work and $\chi_t > 0$ is an exogenous preference shifter which we also refer to as a labour supply shock given the impact it has on labour supply.

Following Merz (1995), Gali (2011) define a utility that is logarithmic in consumption. Further, there is full risk sharing among household members. Therefore, the household period utility corresponds to the integral of its members' utilities and is given by the following:

$$U(C_t, \{N_t(i)\}, \chi_t) \equiv \log C_t - \chi_t \int_0^1 \int_0^{N_t(i)} j^{\varphi} dj di$$
$$= \log C_t - \chi_t \int_0^1 \frac{N_t(i)^{1+\varphi}}{1+\varphi} di,$$

where C_t denotes household consumption and $N_t(i)$ is the fraction of members specialized on type i labour who are employed in period t.

The household seeks to maximize:

$$E_0 \sum_{t=0}^{\infty} \beta^t U(C_t, \{N_t(i)\}, \chi_t),$$

subject to the following budget constraint:

$$P_tC_t + Q_tB_t \leq B_{t-1} + \int_0^1 W_t(i)N_t(i)di + \Pi_t \tag{2.1}$$

where P_t is the price of the consumption bundle, $W_t(i)$ is the nominal wage for labour of type i, B_t denotes purchases of a nominally riskless one-period bond at a price Q_t, and Π_t is a lumpsum component of income which may include dividends from ownership of firms.

As mentioned earlier, Gali (2011) introduces wage rigidities in the model assuming the formalism of Calvo (1983). Therefore, workers supplying a labour service of specific type get to reset their nominal wage with probability $1-\theta_w$ each period. This probability is independent across labour types. In addition, it is not affected by the time that has gone by since last the wage was reset. Another fraction of workers θ_w keep their wage unchanged in any given period. θ_w is therefore defined as the natural index of nominal wage rigidities. Once the wage has been set, the quantity of workers employed is determined unilaterally by firms, with households willingly meeting that demand by sending its specialized workers with the lowest work disutility. It is important to note however that the wage remains above the disutility of work for a marginal worker.

Workers reoptimize their wage in period t choosing a wage W_t^* that maximizes the household utility as opposed to their own individual utility, subject to a sequence of isoelastic demand schedules for their labour type and the usual sequence of household flow of budget constraint. The following first order condition is therefore derived and written as:

$$\sum_{k=0}^{\infty}(\beta\theta_w)^k E_t \left\{ \frac{N_{t+k|t}}{C_t} \left(\frac{W_t^*}{P_{t+k}} - \mathcal{M}^w MRS_{t+k|t} \right) \right\} = 0,$$

where $N_{t+k|t}$ denotes the quantity demanded in period $t+k$ of a labour type whose wage is being reset in period t, $MRS_{t+k|t} \equiv \chi_{t+k} C_{t+k} N_{t+k|t}^{\varphi}$ is the relevant marginal rate of substitution between consumption and employment in period $t+k$, and finally $\mathcal{M}^w \equiv \epsilon_w/(\epsilon_w - 1)$ is the desired or flexible wage markup, with ϵ_w denoting the constant wage elasticity of demand for services of each labour type.

After log-linearizing the above optimality condition around a zero inflation steady state, and using lower case letters to indicate the log of the corresponding variable, the following approximate wage setting rule is obtained:

$$w_t^* = \mu^w + (1 - \beta\theta_w) \sum_{k=0}^{\infty} (\beta\theta_w)^k E_t \left\{ mrs_{t+k|t} + p_{t+k} \right\} \tag{2.2}$$

where $\mu^w \equiv \log \mathcal{M}^w$.

In absence of nominal rigidities ($\theta_w = 0$) we have $w_t^* = w_t = \mu^w + mrs_t + p_t$, implying a constant markup μ^w of the wage w_t over the price-adjusted marginal rate of substitution $mrs_t + p_t$. When nominal rigidities are present on the other hand, new wages are set as a constant markup μ^w over a weighted average of current and expected future price-adjusted marginal rates of substitution.

Assuming $mrs_t \equiv c_t + \varphi n_t + \xi_t$ denote the economy's average log marginal rate of substitution, where $\xi_t \equiv \log \chi_t$, therefore:

$$mrs_{t+k|t} = mrs_{t+k} + \varphi(n_{t+k|k} - n_{t+k}) = mrs_{t+k} - \epsilon_w \varphi(w_t^* - w_{t+k}) \tag{2.3}$$

Log-linearizing the expression for aggregate wage index around a zero inflation steady state gives:

$$w_t = \theta_w w_{t-1} + (1 - \theta_w) w_t^* \tag{2.4}$$

By combining (2.1) and (2.4) the baseline wage inflation equation is obtained:

$$\pi_t^w = \beta E_t \left\{ \pi_{t+1}^w \right\} - \lambda_w (\mu_t^w - \mu^w) \tag{2.5}$$

where $\pi_t^w \equiv w_t - w_{t-1}$ denotes wage inflation, $\mu_t^w \equiv w_t - p_t - mrs_t$ is the average wage markup and $\lambda_w \equiv \frac{(1-\theta_w)(1-\beta\theta_w)}{\theta_w(1+\epsilon_w\varphi)} > 0$.

Wage inflation therefore depends positively on expected one period ahead wage inflation and negatively on the deviation of the average wage markup from its desired value. By solving (2.5) forward:

$$\pi_t^w = -\lambda_w \sum_{k=0}^{\infty} \beta^k E_t \left\{ \left(\mu_{t+k}^w - \mu^w \right) \right\} \tag{2.6}$$

which means that wage inflation is proportional to the discounted sum of expected deviations of current and future average wage markups from their desired levels. More intuitively, if average wage markups are below their desired level, workers that have a chance to reset their wage will tend to adjust it upward thus generating positive wage inflation, and *vice versa*.

In the literature, the estimated version of the above generally allow for automatic indexation to price inflation of the wages that are not reoptimized in any period. However, following Gali (2011) we assume the indexation rule given by:

$$w_{t+k|t} = w_{t+k-1|t} + \gamma\overline{\pi}^{p}_{t+k-1} + (1-\gamma)\pi^{p} + g \tag{2.7}$$

for $k = 1, 2, 3...$, where $w_{t+k|t}$ denotes the period $t+k$ log wage for workers who last reoptimized their wage in period t (with $w_{t|t} \equiv w^{*}_{t}$), $\overline{\pi}^{p}$ is the measure of price inflation to which wages are indexed, π^{p} is the steady state price inflation, and g is the rate of growth of productivity (and real wages) in the steady state. In that case the following wage inflation equation can be derived:

$$\overline{\pi}^{w}_{t} - \gamma\overline{\pi}^{p}_{t-1} = \alpha + \beta E_t\left\{\pi^{w}_{t+1} - \gamma\overline{\pi}^{p}_{t}\right\} - \lambda_w\left(\mu^{w}_{t} - \mu^{w}\right) \tag{2.8}$$

where $\alpha \equiv (1-\beta)((1-\gamma)\pi^{p} + g)$.

2.3.2 Extension of the model

By taking current labour market conditions as given and using household welfare as a criterion, a household member will find it optimal to participate in the labour market in period t if and only if:

$$\frac{W_t(i)}{P_t} \geq \chi_t C_t j^{\varphi}$$

The real wage prevailing in the worker's trade must be above his disutility from working (expressed in terms of consumption).

Thus the marginal supplier of type i labour denoted by $L_t(i)$, is implicitly given by:

$$\frac{W_t(i)}{P_t} = \chi_t C_t L_t(i)^{\varphi}$$

By taking the log and integrating over i, we obtain:

$$w_t - p_t = c_t + \varphi l_t + \xi_t \tag{2.9}$$

where $l_t \equiv \int_0^1 l_t(i)di$ denotes the model's implied aggregate participation or labour force, $w_t \equiv \int_0^1 w_t(i)di$ is defined as the average wage.

Gali (2011) defines the unemployment rate u_t as follows:

$$u_t \equiv l_t - n_t \tag{2.10}$$

By combining (2.9) and (2.10) with the expression for the average wage markup given by $\mu_t^w \equiv (w_t - p_t) - (c_t + \varphi n_t + \xi_t)$, the following linear relationship between the wage markup and the unemployment rate can be written as:

$$\mu_t^w = \varphi u_t \tag{2.11}$$

The natural rate of unemployment, u_t^n is defined as the rate of the unemployment that would prevail in the absence of nominal wage rigidities. Therefore assuming a constant desired wage markup, it follows that u_t^n is constant and given by:

$$u^n = \frac{\mu^w}{\varphi} \tag{2.12}$$

Consequently, the unemployment is a consequence of worker's market power (the wage being above their perfectly competitive level). Unemployment fluctuations on the other hand result from the slow adjustment of wages.

Combining (2.5), (2.11) and (2.12) gives the following New Keynesian Phillips Curve:

$$\pi_t^w = \beta E_t \left\{ \pi_{t+1}^w \right\} - \lambda_w \varphi (u_t - u^n) \tag{2.13}$$

By combining equations (2.8) and (2.11) the following augmented New Keynesian Wage Phillips Curve implied by Gali (2011) is obtained:

$$\pi_t^w = \alpha + \gamma\overline{\pi}_{t-1}^p + \beta E_t\left\{\pi_{t+1}^w - \gamma\overline{\pi}_t^p\right\} - \lambda_w\varphi\left(u_t - u^n\right) \tag{2.14}$$

It is important to note that even though equation (2.13) shows a relationship between wage inflation and the unemployment rate, it differs from the original Phillips curve first uncovered by Phillips (1958). First off, equation (2.13) is a microfounded structural relationship between wage inflation and unemployment. Therefore, the steepness of the slope of equation (2.13) is decreasing in wage rigidity to the point that as wages approach full flexibility, the curve becomes vertical. Secondly, equation (2.13) defines wage inflation as a forward looking variable which is in contrast with the static and contemporaneous nature of the original Phillips curve in which expectations play no role.

Next we turn to define a reduced form representation for the New Keynesian Wage Phillips Curve which we intend to estimate using South Africa data. By assuming that unemployment follows a stationary AR(2) process, we can formally write:

$$\widehat{u}_t = \phi_1\widehat{u}_{t-1} + \phi_2\widehat{u}_{t-2} + \varepsilon_t \tag{2.15}$$

where $\widehat{u}_t = u_t - u^n$ and ε_t is white noise. By combining (2.15) and (2.14) the following wage inflation is obtained:

$$\pi_t^w = \alpha + \gamma\overline{\pi}_{t-1}^p + \psi_0\widehat{u}_t + \psi_1\widehat{u}_{t-1} \tag{2.16}$$

where

$$\psi_0 \equiv -\tfrac{\lambda_w\varphi}{1-\beta(\phi_1+\beta\phi_2)},$$

$$\psi_1 \equiv -\tfrac{\lambda_w\varphi\beta\phi_2}{1-\beta(\phi_1+\beta\phi_2)}$$

Equation (2.16) is therefore estimated in the next section.

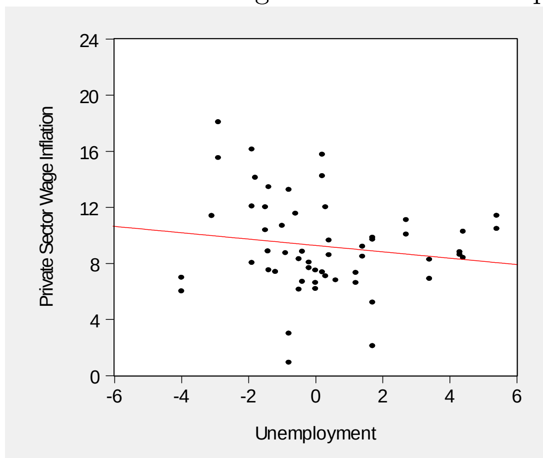
2.4 Empirical results

2.4.1 Data

Labour market data in South Africa are notoriously not very reliable and subjected to extensive change in definition. Our quarterly data covers the period 1970Q1-2013Q4. 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, and unit labour costs in the manufacturing. Wage inflation is measured as the centered four quarter difference of the log of nominal wage expressed in percentage terms. The same applies for price inflation. The cyclical unemployment, measured 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 through a series of revision and the data are not always comparable through time. Nevertheless we try statistically to reduce the effect of these distortions. Manufacturing employment is the most reliable measure, but it is only a proxy of the overall labour market conditions. The employment variables are de-trended using the Hodrick-Prescott filter to analyze variable employment as its deviation from the steady state value, while the unemployment series is demeaned of the average value of 23 percent unemployment rate, that implicitly we assume is the natural rate of unemployment. Data sources include the South African Reserve Bank, Quantec and the Saint Louis Federal Reserve Bank database.

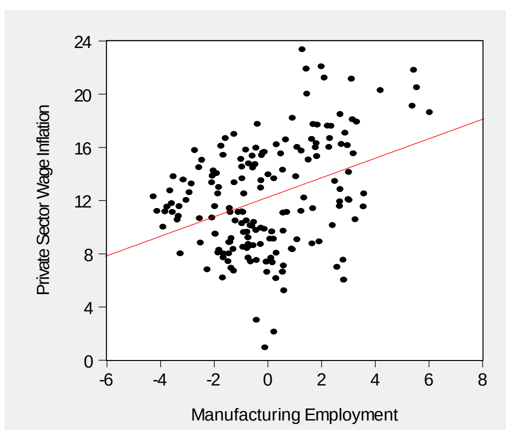
Before commenting on the regression analysis, it is worth to have a quick look at the data to be used in estimating specification (2.16). The basic hypothesis common with the old Phillips curve specification is that there is a negative relationship between wage inflation and unemployment. In figure 1 we display this relationship between for the period 2000-2014 in two scatter plots of wage inflation and unemployment to check if such a relationship applies in the case of South Africa.

Figure 1: Private sector wage inflation and unemployment



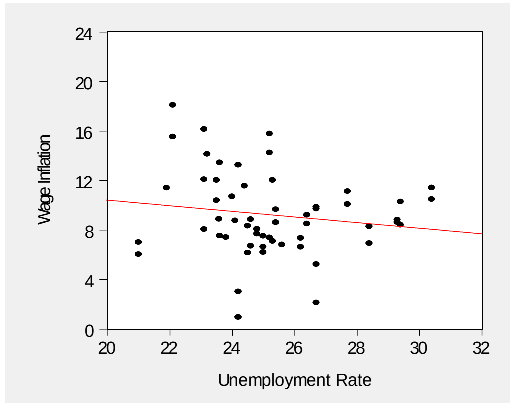
The relationship appears immediately to be quite weak. This could be due to the specific definition of unemployment used in South Africa. As argued by Banerjee (2008), a lot of the changes in the employment rate observed are counted for by the change in labour participation rate. Thus a positive relationship between wage inflation and employment rate could be more revealing. Figure 2 shows the relationship between wage inflation and manufacturing employment between 1971 and 2014.

Figure 2: Private sector wage inflation and manufacturing employment



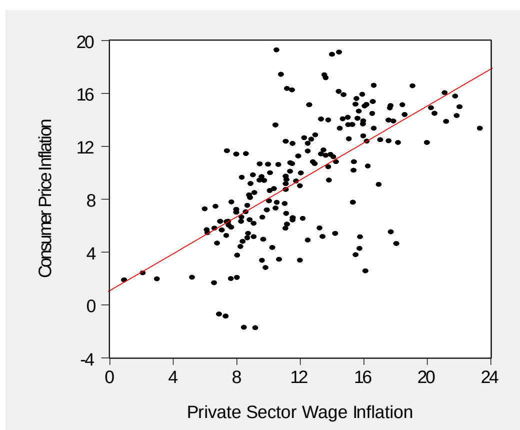
The positive relationship between wage inflation and employment seems much more promising, as is the relationship between wage inflation and total private employment. Less promising is the same relationship once viewed from the inflation targeting period 2000-2014, in figure 3.

Figure 3: Wage inflation and unemployment 2000-2013



The final relationship in equation (2.16) is the one between wage inflation and price inflation. Historically the relationship appears very strong, as shown below:

Figure 4: CPI inflation and private sector wage inflation

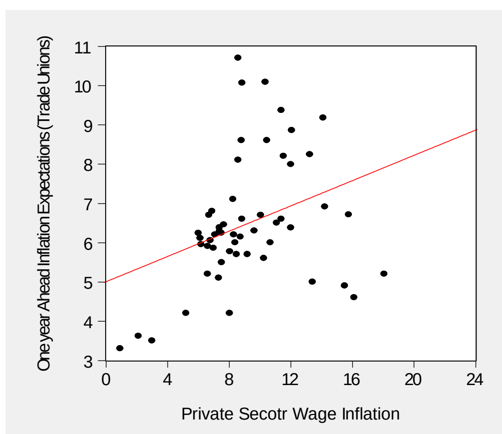


The relationship appears to weaken during the inflation targeting period, which is to be expected if monetary policy tries to insulate the overall price level from a change in the relative price of labour.

Figure 5: CPI inflation and private sector wage inflation 2000-2013

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 expectations might still be the most direct way to control wage dynamics.

Figure 6: One year ahead trade unions inflation expectations and private sector wage inflation



2.4.2 Estimation results

We report in the tables below OLS estimates of several specifications of the New Keynesian Wage Phillips Curve, each specification is a restricted version of equation (2.16). The standard 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 to capture inflation expectations, and finally in column (5) and (6) we report the full specification of equation (2.16). 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 results are largely confirmed if a different measure of the change in labour cost is considered. In table 2 we use the nominal unit labour cost inflation as measure of wage, which has the advantage to separate the growth in wages from contemporaneous changes in productivity. The results are actually more robust, and there is a stronger relationship between labour cost and employment conditions, even though 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)

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

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 perhaps 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 unions 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			

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

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 estimation results imply a significant wage rigidity relative to either employment or unemployment conditions, with 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, an issue tackled in chapter 3. For now however, in the next section of this chapter we conduct a sectoral analysis where we investigate the responsiveness of wages to output prices given the level of labour productivity and the reservation wage.

2.5 A sectoral analysis of wage responsiveness to employment conditions

Economic theory suggests that there is a positive link between wage and labour productivity. Essentially, when output per worker rises, this creates an incentive for firms to increase their demand for workers which ultimately results in an increase in workers compensation. This theory is backed up by empirical evidence in countries including Israel (Lavi and Sussman, 2001), Australia (Kumar *et al*, 2009), the United States (Strauss and Wohar, 2004), as well as South Africa (Fallon, 1992, Fallon and da Silva 1994, Wakeford, 2004, and Klein, 2012). Most of these studies however conclude of a weak link between wage and labour productivity as far as the South African labour market is concerned. The absence of a strong relationship between these two variables has direct implications for firms' profitability, which in turns may have acute repercussions in terms of job creation, and finally, in terms of unemployment. This has often been highlighted in the literature as an explanation for the severe job shedding the economy witnessed in the aftermath of the 2008 financial crisis.

Furthermore, it is important to note that the weak link between wage and labour productivity can be explained by the presence of noises of macroeconomic and/or institutional nature. Klein (2012) for instance argues that the presence of these factors may create a wedge between the two variables which may explain why gains in labour productivity are not fully translated to wage increases. The main factors highlighted in his study include price and wage rigidities, labour adjustment costs, and other structural factors (market regulations, entry restrictions, etc.). Bentolila and Sain-Paul (2003) emphasize on the bargaining power of workers in wage settlements as an important player in weakening the relationship between labour productivity and wage. In this chapter, we focus on the role played by reservation wages.

Very few studies in the South African literature focus on the impact of reservation wages on the functioning of the labour market. Rankin and Roberts (2010) highlight two studies regarding the subject. Although these studies (Kingdon and Knight, 2001, and Nattrass and Walker, 2005), along with the recent work of Levinsohn and Pugatch (2010) focus on the role of reservation wages in explaining youth unemployment, our study in this section diverges from the available literature in the sense that the focal point here is to investigate the link between reservation wages and labour productivity in explaining the existence of wage rigidities at a sectoral level.

2.5.1 A simplified model

We begin the lay off of our model following Blanchard and Katz (1999) with a textbook Phillips curve equation of the following form:

$$(w_t - w_{t-1}) = a_w + (p_{t-1} - p_{t-2}) - \beta u_t + \epsilon_t \tag{2.17}$$

where p and w are respectively logarithms of the price level and the nominal wage, u is the unemployment rate, a_w is a constant and ϵ is an error term. We assume as usual that the lagged inflation term given by $(p_{t-1} - p_{t-2})$ is a proxy for expected current inflation which we may also write as $(p_t^e - p_{t-1})$. After reorganizing equation (2.17), it takes the following familiar form:

$$(w_t - p_t^e) = a_w + (w_{t-1} - p_{t-1}) - \beta u_t + \epsilon_t \tag{2.18}$$

In essence, the empirical wage equation implies that the expected log real wage depends on the lagged log real wage and the unemployment rate. Intuitively, a low unemployment rate leads to an increase in the expected real wage, and *vice versa*.

However, most theories of the natural rate of unemployment imply in contrast a negative relationship between the level of wages and unemployment if both the reservation wage and the level of productivity are taken into account. Such a wage curve (Blanchflower and Oswald, 1994, Blanchard and Katz, 1999) intuitively suggests that given the reservation wage, the tighter the labour market, the higher the real wage. Under some simplifying assumptions, models of efficiency wage (Shapiro, 1984) or bargaining (Mortensen & Pissarides, 1994) deliver a representation of a wage relation of the following form:

$$(w_t - p_t^e) = \mu b_t + (1 - \mu) y_t - \beta u_t + \epsilon_t \tag{2.19}$$

where b_t is the log of reservation wage, y_t is the log of productivity and μ is a parameter ranging from 0 to 1. The above relationship simply means that the expected real wage depends on both the reservation wage - which is basically the wage if unemployed - and on the level of productivity.

A quick look at the wage Phillips curve (2.18) and the theoretical wage relation nested in (2.19) reveals two striking differences. First off, the reservation wage and the level of productivity are absent in the wage Phillips curve but present in the wage curve. Second and as stated earlier, the Phillips curve shows the relation between the change in real wage and unemployment whereas the theoretical wage curve is the relation between the level of real wage and unemployment given the reservation wage and the level of productivity. Blanchard and Katz (1999) gives an extensive discussion of the determinants of the reservation wage which will help them establish the conditions under which the wage Phillips curve and the theoretical wage relation can be reconciled.

Given that the reservation wage by definition is the wage an individual receives when unemployed, it therefore depends first of all on the generosity of unemployment benefits and other forms of support the same unemployed individual can expect to receive if jobless. Therefore, it follows that the institutional dependence of unemployment benefits on previous wages suggest that the reservation wage will move with lagged wages. It seems logical then to assume that workers' aspirations in job search and wage bargaining would very likely be shaped by previous earnings. Further, Blanchard and Katz (1999) argue that the reservation wage depends on the utility of leisure, in other words what an unemployed individual does with his or her time. The utility of leisure may include home production and earning opportunities in the informal sector. Consequently, increases in productivity in the informal market and home production are closely related to those in the formal sector. Finally, the reservation wage depends also on non labour income. Thus, productivity increases lead to equal proportional increases in labour and non labour income.

It therefore seems logical to assume that the reservation wage depends on both productivity and lagged wages. Following Blanchard and Katz (1999) and for the sake of simplicity, we may write:

$$b_t = a + \lambda(w_{t-1} - p_{t-1}) + (1 - \lambda)y_t \tag{2.20}$$

where a is a constant and λ is a parameter lying between 0 and 1. By substituting this expression for the reservation wage in the wage relation given by (2.19), we obtain:

$$(w_t - p_t^e) = \mu a + \mu\lambda(w_{t-1} - p_{t-1}) + (1 - \mu\lambda)y_t - \beta u_t + \epsilon_t \tag{2.21}$$

Looking at the above equation, it appears the theoretical wage relation in (2.21) is consistent with the Phillips curve representation given by (2.18) if and only if $\mu\lambda = 1$. In other words, the wage relation and the Phillips curve specifications can be reconciled only if the following two conditions are simultaneously satisfied: (a) there is no direct effect of productivity on wages given the reservation wage ($\mu = 1$) and second, there is no direct effect of productivity on the reservation wage ($\lambda = 1$). The strong performance of a standard wage Phillips curve specification on US data suggests that $\lambda\mu = 1$ may be a reasonable approximation for the US labour market as suggested by Blanchard and Katz (1999). On the other hand, the authors argue that the same findings do not apply for the European labour market. The striking difference between the empirical wage and unemployment relation in the US and Europe is a well known fact. In the current case however, the presence of an error correction term in the European and its absence in the US wage equation is at the core of the debate. We suspect the same error correction term may be present in the South African wage equation as well. The question for debate is however, what is the magnitude of the South African error correction term relative to the European labour market?

Before indulging into the discussion about the differences between the three economies, lets begin by rewriting (2.21) into:

$$(w_t - w_{t-1}) = \mu a + (p_t^e - p_{t-1}) - (1 - \mu\lambda)(w_{t-1} - p_{t-1} - y_{t-1}) + (1 - \mu\lambda)\Delta y_t - \beta u_t + \epsilon_t \tag{2.22}$$

Wage inflation depends on expected inflation, the unemployment and an error correction term defined as the difference between the lagged real wage and lagged productivity. An estimation of equation (2.22) shows that the coefficient on the error correction term for the US labour market is close to zero with point estimates that are wrong signed, small and insignificant. On the other hand, in most European and various OECD countries, the error correction term comes in with a significant and right signed coefficient which is on average around 0.25. Blanchard and Katz (1999) discuss what could possibly explain the difference between European and US labour markets.

Intuitively, the difference between the labour markets lies on the direct effect of productivity on wages ($1-\mu=0$ for the US and $1-\mu>0$ for Europe) and the direct effect of productivity on reservation ($1-\lambda=0$ in the US and $1-\lambda>0$ in Europe). This simply means that firstly, in Europe, unions play a greater role in wage settings. Further, stringent hiring and firing regulations in Europe may cause wage setting to behave differently compared to the US. This therefore provides evidence that productivity has more pronounced and direct effects on wages in Europe than in the US (Abowd *et al*, 1998). Secondly, the importance of the underground economy for the unemployed in Europe may also be a significant factor to take into account to differentiate the two labour markets.

Given these arguments, one may come to the conclusion that the South African labour market may be similar to the European one given the resemblance in terms of high bargaining power of workers, rigorous market regulations and a sizeable informal sector. This therefore provides the motivation for investigating the existence of an error correction term for the South African labour market.

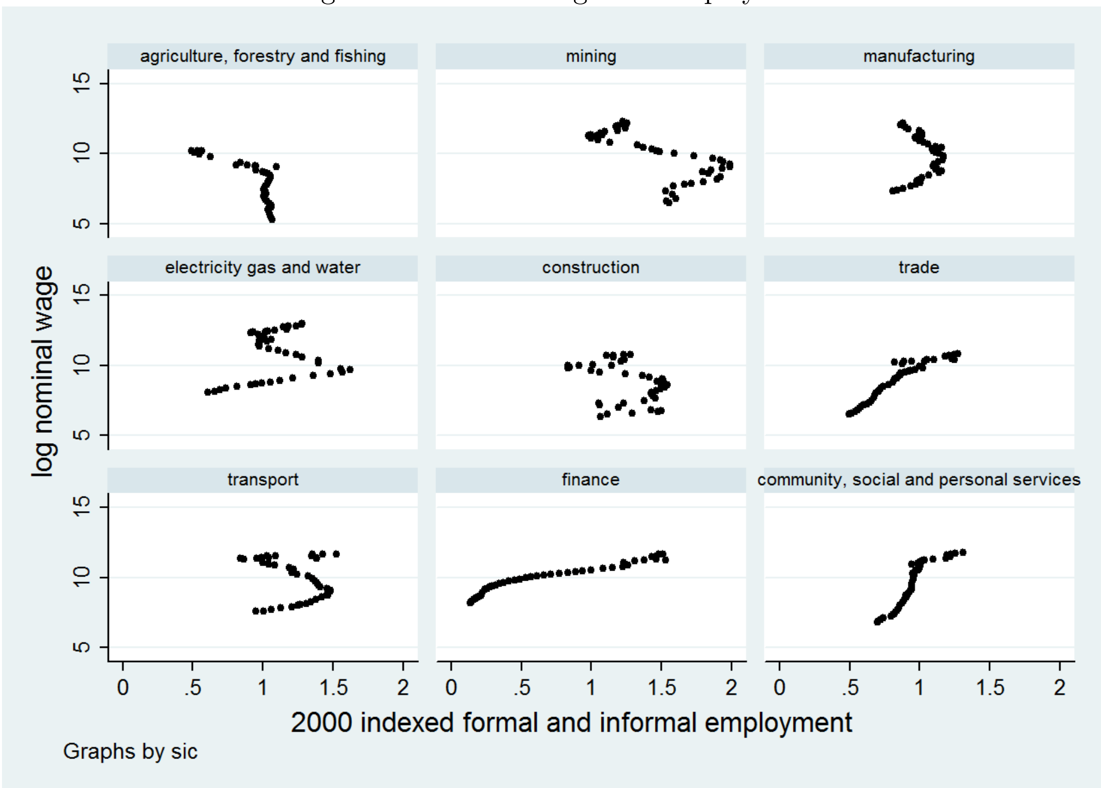
2.5.2 Empirical Study

Data

We use a panel of nine industrial sectors including: agriculture, forestry and fishing, mining, manufacturing, electricity, gas and water, construction, trade, transport, finance, and community, social and personal services. The annual data covers the period 1970 to 2013. Nominal wage is captured by the nominal remuneration per employee by sector. We use output price by sector as a measure of variable price whereas, and for the same reasons mentioned earlier, *i.e.* the crucial lack of data, we rely on 2000 indexed employment data. We take into account both formal and informal measures of employment per sectors. Finally labour productivity is captured by the 2005 indexed labour productivity per sector.

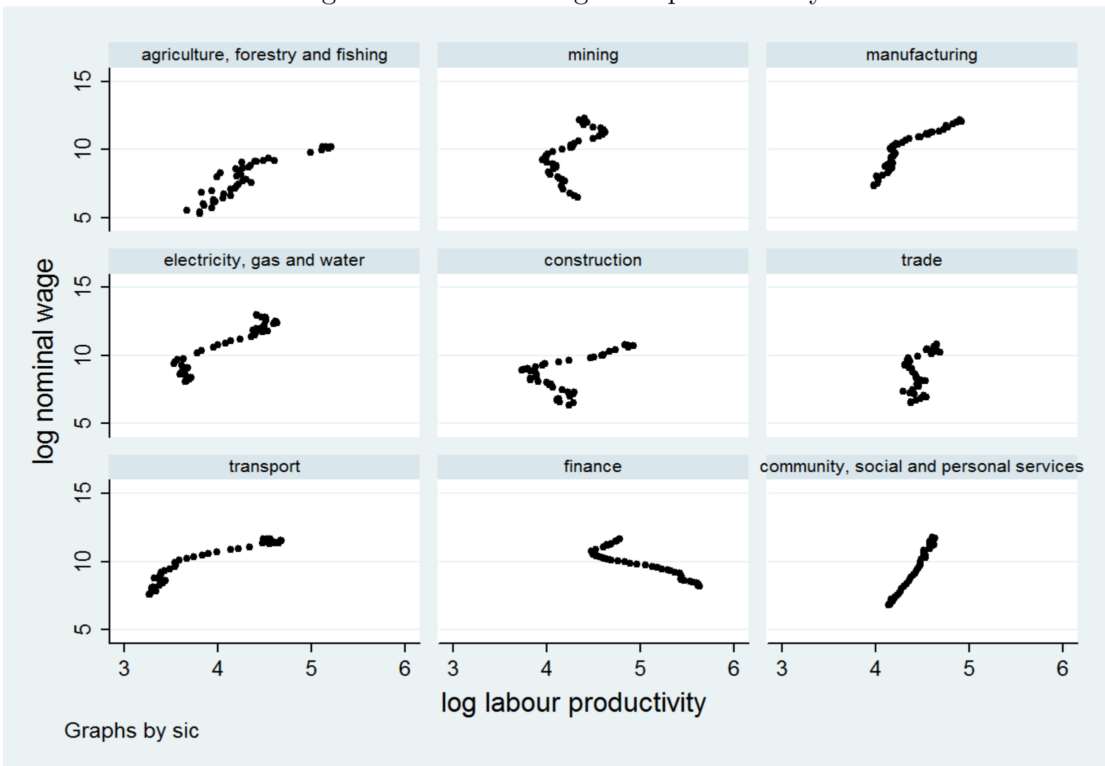
Before discussing the empirical results, we begin with a quick look at the data.

Figure 7: Nominal wage and employment



The correlation between nominal wage and employment appears positive throughout, although the relationship is weak and relatively inconclusive in the case of the agriculture, forestry and fishing sector. We observe a strong positive correlation for the trade and community, social and personal services sectors. These two sectors are predominantly composed of public sector firms.

Figure 8: Nominal wage and productivity



The figure above reveals at first glance that the correlation between wages and labour productivity is relatively weak and positive across sectors. This is perhaps explained by the rising of earning equalities since the abolishment of the Apartheid regime, and to some extend by measurement issues. Also we cannot rule out an increase in output prices relative to the price of other goods and services workers purchase in the markets. Essentially, a wage increase forces firms to increase the price of products they sell in the market in an apparent attempt to pass that increase in the cost of production through to the workers. The sector that stood out however is the community, social and personal services sector where we observe a remarkably strong positive correlation between wages and labour productivity.

Empirical results

We estimate our model using pool mean group estimation techniques which is suitable for nonstationary heterogenous panels. We essentially investigate the existence of a long run relationship between nominal wages, output price and labour productivity, and the presence of an error correction term in the South African wage equation. Variables in the short run includes nominal wage, output price, labour productivity and employment in both formal and informal sectors. Furthermore, it is important to highlight that in the equation we estimate, the coefficient on unemployment comes with a negative sign, which suggest an inverse relationship between real wage and unemployment. Since the measure for unemployment is unreliable, we use employment data instead as mentioned in the data description section. This explains for the negative sign on the coefficient estimate for employment in the results. This however should be interpreted as a positive relationship since the sign on β in equation (2.22) is already negative. The overall results are reported in the table below:

Table 5: Pool mean group estimates

	$d.\ln nw$	
	lnp	0.95^{***} (0.018)
	$\ln prod$	0.97^{***} (0086)
SR		
	ec	-0.113^{***} (0.028)
	$d.\ln p$	0.301^{***} (0.075)
	$d.\ln prod$	0.363^{***} (0.097)
	$d.emp$	-0.326^{***} (0.057)
***denotes significance at the 1% level		

'd' denotes the first difference. $\ln nw$: log nominal wage; $\ln prod$: log labour productivity, $\ln p$: log output price; emp 2000 indexed formal and informal employment; SR: short run; ec: error correction term

Our expectation of the existence of an error correction term in the wage equation for South Africa is confirmed. The coefficient is right signed and significant but is however lower than the findings of Blanchard and Katz (1999) of 0.25 for the European market. This finding therefore has some implications in terms of certain features of the South African labour market, which suggests there are some unobservable variables that may affect wages. Some of these features are similar to those found in the European labour market. In particular, the sizeable bargaining power of trade unions, rigorous market regulations and the considerable size of the informal sector all play a significant role in explaining the existence of the error correction term in the South African wage equation.

In the long run we find the coefficients on price and labour productivity to be very close to 1, which is in line with prior expectations. In the short run on the other hand, these coefficients are quantitatively smaller and remain significant. The coefficient estimates of price, labour productivity and employment are all right signed and significant. However the values we find are also all quantitatively small. This suggests that the weak response of wages to market conditions can therefore also be confirmed at the sectoral level. Intuitively, if increases in wages are not correlated with the rise in labour productivity growth, then a negative shock will inevitably lead to considerable job shedding and a reduction in employment, ultimately translating into a rise in unemployment. Additionally, increases in wages often results into a rise in inflationary pressures, which the monetary authority can only offset by inducing large contractions in demand.

The table below shows the pool mean estimates by industrial sectors.

Table 6: Pool mean group estimates per sectors

d.lnnw	1	2	3	4	5	6	7	8	9
SR									
ec	-0.165^{**}	-0.231^{***}	-0.143^{**}	-0.166^{**}	-0.112^{*}	-0.146^{*}	0.059^{*}	-0.054	-0.062^{*}
	(0.061)	(0.038)	(0.061)	(0.077)	(0.064)	(0.077)	(0.031)	(0.054)	(0.036)
d.lnp	0.327^{*}	-0.076	0.364^{**}	0.075	0.352^{*}	0.456^{***}	0.345^{**}	0.163	0.704^{***}
	(0.172)	(0.061)	(0.171)	(0.124)	(0.192)	(0.095)	(0.131)	(0.101)	(0.098)
d.lnprod	0.029	0.149	0.185	0.539^{**}	0.152	0.189	0.582^{**}	0.502^{**}	0.935^{**}
	(0.086)	(0.215)	(0.146)	(0.264)	(0.175)	(0.138)	(0.187)	(0.156)	(0.281)
d.emp	-0.608^{***}	-0.468^{**}	-0.391^{**}	-0.034	-0.223^{*}	-0.431^{**}	-0.326^{*}	-0.231	-0.219
	(0.174)	(0.157)	(0.155)	(0.217)	(0.126)	(0.157)	(0.178)	(0.153)	(0.215)

***denotes significance at the 1% level, ** at the 5% level and * at the 10% level. 'd' denotes the first difference. $\ln nw$: log nominal wage; $\ln prod$: log labour productivity, $\ln p$: log output price; $empif$: 2000 indexed formal and informal employment; SR: short run; ec: error correction term. 1: Agriculture; 2: Mining; 3:Manufacturing; 4: Electricity; 5: Construction; 6: Trade; 7: Transport; 8:Finance; 9:Community, social and personal services

For the first six sectors, the coefficient on the error correction term is right signed and significant. On the other hand, in the last three columns, we report coefficients that are significant but wrong signed (transport), insignificant but right signed (finance) and significant and right signed but very small (community, social and personal services). The mining sector stands out with an error correction term coefficient close to the European market. The coefficient on employment keeps the right sign and is significant throughout except for electricity, construction, and community, social and personal services sectors. It is important to note that this coefficient estimate is relatively close to the value found in the previous section, except for the agriculture sector where wages and employment display a rather strong correlation.

Regarding the response of wages to labour productivity, we find that to be insignificant for sectors including agriculture, mining, manufacturing, construction, and trade. The coefficient estimates for labour productivity for sectors we find statistically significant are mostly in line with the literature. For instance, Klein (2012) reports an average value of 0.45 for non agricultural sectors. This is an indication that labour productivity does not fully translate into an increase in wages. Therefore as discussed earlier, there are other factors involved that may account for this weak response of wages to increase in labour productivity. The community, social and personal services sector however is a very appealing exception, which confirms prior expectations after the first glance at the data. We argue that this is a sector predominantly skilled workers intensive which may explain why there appears to be a strong link between wages and labour productivity when we take into account the reservation wage.

2.6 Conclusion

This chapter estimates a New Keynesian Wage Phillips Curve for the South African labour market. We first begin by estimating a model with staggered nominal wage following Erceg, *et al* (2000) using aggregate quarterly data from 1970Q1 to 2013Q4. Overall, the results are in line with economic theory but the difference between accounting for the whole sample and focusing on post apartheid era alone appears significant. Typically, we find that wage inflation and employment have a weak relationship, which becomes even weaker with the most recent sample. Further, nominal wage inflation and price inflation have a strong and robust relationship which again becomes quantitatively weaker in the second sample (post Apartheid era). These results are confirmed when we use unit labour cost as a measure of wage inflation.

Secondly, we turn to investigate, at a sectoral level, the responsiveness of nominal wage to output price, labour productivity and employment, given the reservation wage. Our findings confirm prior expectations of the presence of an error correction term in the wage equation for the South African labour market;

with a significant and right signed coefficient of 0.113. This coefficient is smaller relative to the finding of the European labour market. Nevertheless, the existence of the error correction term in the wage equation confirms that certain features of the labour market contribute to the rigidities of wages. These features include a considerable bargaining power of trade unions, strict hiring and firing regulations and a sizeable informal sector. It is important to highlight that despite these rather interesting findings, a better understanding of the determinants of reservation wages for South Africa may be required. Indeed most of the studies in the available literature focus mainly on the impact of the reservation wage on explaining youth unemployment, rather than assessing its contribution to the weak response of wages to labour market conditions.

Overall, for the first section, the results reveal a decent evaluation of the South African labour market at an aggregate level despite the crucial lack of data we face in this investigation. This forces us for instance to use employment data instead of the ideal choice that would have been unemployment. Nonetheless, we draw conclusions that are mostly in line with available South African literature; *i.e.* wages are not very responsive to labour market conditions which suggest that there exists other factors that prevent a better response. This raises questions in terms of the conduct of monetary policy given the current environment. Therefore, we assess the implications of wage rigidities on the conduct of monetary policy in the next chapter. Furthermore, in the second section, the curious case of the community, social and personal services (which is dominated by public sector firms) sparked interrogations given the strong responses of labour productivity and prices to wages. *A priori,* we suspect that an explanation of such results is perhaps because of the fact that the sector is mainly skilled workers intensive. Given the scarcity of skilled workers in the South African labour market, this may have implications on private sector firms decisions. Consequently, we discuss the effects of public employment on the South African labour market in chapter 4.

Chapter 3

Monetary Policy in an Economy with High Structural Unemployment

Abstract

This chapter builds up on one of the main findings of chapter 2, that is, wages are weakly responsive to market conditions. In particular, we explore the implications of labour market frictions on monetary policy. We use a DSGE model with unemployment following Blanchard and Gali (2010) to essentially assess how the type of labour markets impacts monetary policy responses to shocks. The findings mainly suggest that stabilizing inflation may lead to high and persistent fluctuations in unemployment. Furthermore, the sacrifice ratio appears to be the highest when the labour market is characterized by high flows and a high level of steady state unemployment. The estimation results using South African data reveals a picture of a labour market with pervasive wage rigidities and large flows in the labour market, with high levels of job creation and job destruction rates. It is important to highlight that in the South African case, job destruction rates dominate the dynamics.

3.1 Introduction

The unemployment rate in South Africa has been fluctuating around 25 percent for the past two decades which makes it one of the highest in the world. The country's employment absorption rate (40.8 percent) is far below its BRICS partners. In fact, employment absorbs 65 percent of the working age population in Brazil, 57 percent in Russia, 55 percent in India, and 71 percent in China. South Africa's youth participation rate of 24.4 percent is also below the emerging market average of 42 percent (Blumenfeld). Moreover, further labour market frictions also contribute to the structural nature of the unemployment in South Africa. Amongst such frictions, we pay selective attention to the main conclusion of the previous chapter, *i.e.* the weak response of wages to market conditions. In particular, the focal point of this chapter is with regard to the implications of the appropriate monetary policy response to shocks in the presence of wage rigidities in the economy of South Africa. This is particularly interesting because most of the literature in the country has focused less on such implications in terms of monetary policy.

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 thus 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) in which they assess the impact of labour market frictions (wage rigidities in particular) on monetary policy. We simulate a monetary policy shock in 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 the labour market is fluid or sclerotic.

Various works in the South African literature have focused on the functioning of the labour market to essentially study unemployment and for authors like Blumenfeld, the sources of unemployment are twofold. Firstly, on the supply side the country faces a crucial lack of skilled workers. This is perhaps due to the fact that the African community – representing more than half of the overall population – was at the time, deliberately excluded from educational systems pre-1994 because of the regime in place. 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 a significant impact on the labour market.

Secondly, on the demand side South Africa's economy does not create jobs sufficiently fast enough to absorb school leavers entering 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. In addition to 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. We discussed this issue more intensively in the previous chapter. 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 the author finds that the 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. Low skilled 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 *et al* (2013) explore job creation and destruction dynamics in South Africa to find that firms create and destroy about 20 percent of jobs per year, therefore underlying the importance of job creation and destruction as a feature of the labour demand in South Africa. In the manufacturing sector, jobs are destroyed at a slightly higher rate (10 percent) than they are created (9 percent). This provides evidence that manufacturing employment in South Africa is in decline. Moreover, another interesting finding is that enterprise deaths contribute for about 25 percent of job destruction while enterprise births account for a smaller rate of 11 percent 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 identifying three clusters namely a labour market cluster, a poverty and development cluster and a macro/macro-sectoral cluster. These clusters essentially constitute labour frictions that in the end contribute to the high and persistent rate of unemployment in the economy.

In particular regarding the labour market cluster, Fourie (2011) finds that some authors (Kingdon & Knight, 2004, Banerjee *et al*, 2008) support that unemployment in South Africa is mostly involuntary and that discouraged workers should be accounted as part of the labour market. Furthermore, Kingdon and Knight used the model by Layard *et al* (1991) to support that the labour market is segmented between an informal sector (rural) and a 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 one.

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 bidirectional. In fact, Leibbrandt *et al* (2001) believe that the unemployed individuals are commonly found in households with no access to wage income. Moreover, the marginalization 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 further significantly slows down the motivation to search for jobs.

The literature supporting the idea of the third and final cluster in the unemployment debate in South Africa is 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 growth 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 organized as follows. Section 2 assess the impact of wage rigidities in the conduct of monetary policy while section 3 lays down the model by presenting and solving both the household's and the firm's problems. We consider in this section the social planner's equilibrium and the equilibriums under flexible and rigid wages. Section 4 simulates the model by first going through the calibration and then commenting on impulse response functions. We estimate the model in section 5 using bayesian techniques and we interpret the historical decomposition of the observable variables used in the estimation. Section 6 focuses on the estimation analysis by first interpreting the impulse response functions for South Africa generated from our estimation exercise in the previous section; and secondly by focusing on the welfare analysis. Section 7 concludes.

3.2 Wage rigidities, bargaining power and monetary policy

Early studies of labour market dynamics, which were essentially based on a search and matching framework developed by Diamond, Mortensen and Pissarides (see Mortensen, 2011 for a review of the setup), failed to reconcile theoretical labour market behaviour with observed moments. The same applies to early New Keynesian works that did not account for frictions in the labour market in terms of wage rigidities and persistent unemployment. The myth of the *divine coincidence* (Blanchard and Gali, 2007) was thus introduced. In particular, this would mean for central bankers that stabilizing inflation would result into negligible undesirable fluctuations in unemployment (output gap). Subsequent New Keynesian models introduced nominal wage rigidities essentially based on the work of Erceg *et al* (2000), a framework we used in the previous chapter, to show the empirical failure of the *divine coincidence*. Indeed, there appears to be a trade-off between the stabilization of inflation and that of unemployment, which in itself means the existence of a sacrifice ratio monetary authorities around the world face.

It is therefore logical to assume that frictions in the labour market - that may, amongst other factors, explain for the structural nature of unemployment in countries like South Africa - are important to take into account when we want to analyze the functioning of monetary policy. Amongst the frictions, the role played by nominal (Binyamini, 2013, Gertler *et al*, 2008, Christiano *et al*, 2011) and real (Faia, 2008, Blanchard and Gali, 2010, Gali, 2010) wages has gained much more attention in the recent literature. Indeed in the presence of these imperfections, which renders the conduct of monetary policy a difficult task, most of these studies maintain that it is of the utmost importance to design an optimal policy response. Along these lines of thoughts, Thomas (2008) argues that a central banker under real wage rigidities loses most of its leverage over real wage. Moreover, Binyamini (2013) argues that the presence of nominal wage rigidities reduces the optimal unemployment-inflation ratio. In particular, nominal wage rigidity increases the sacrifice ratio, therefore increasing the level of employment that has to be sacrificed in order to achieve a stable inflation. In an economy with already high structural unemployment, this may appear a difficult objective to complete. Thus, the author suggests an optimal policy consisting of allowing for small fluctuations in unemployment at the expense of larger inflation fluctuations. This may not however be ideal in the wake of rising inflationary pressures.

Further on the optimal monetary policy in the presence of wage rigidities, Blanchard and Gali (2010) suggest an optimal response depending on whether the labour market is fluid (the United States market) or sclerotic (the European market). First of all, the authors argue that under flexible wages, targeting inflation appears to be the best policy response as it allows for unemployment to be stabilized as well. However, when real wages are less responsive to market conditions, stabilizing inflation in response to a positive productivity shock may lead to large and inefficient movements in unemployment. They further emphasize that in a sclerotic labour market, where separation and hiring rates are low, the persistence of unemployment is even higher. In conclusion, monetary policy response should therefore differ depending on the type of labour market, for efficiency purposes. Assuming such an optimal policy that strikes the balance between two extremes - a constant unemployment policy and a strict inflation targeting policy - Blanchard and Gali (2010) find that, even though the fluctuations are quantitatively smaller relative to the extreme policies, there is a non negligible cost to achieving smoother unemployment which is a persistently higher inflation. Furthermore, they show that the optimal policy rule is somehow 'tougher' on inflation for the fluid market (the US) relative to the sclerotic one (continental Europe), given the larger costs inflicted in the form of a much more persistent rise in unemployment.

The data for South Africa shows large dynamics of job destruction and job creation rates which may well arguably contribute to the high level of structural unemployment in the economy; given that job destruction rates are qualitatively higher than creation rates. The estimation of the proposed model - as shown later on in this chapter - confirms our prior expectations of a fluid labour market for South Africa. Keeping in mind the findings of Blanchard and Gali (2010) in terms of optimal policy for fluid and sclerotic labour markets, the South African case is a peculiar one in that it shares features of both markets (US and continental Europe). The unemployment rate is as high as in the case of some European countries but the market displays high flows in terms of job creation and destruction rates in a way relatively similar to the US labour market. This therefore has implications in terms of the best policy response to shocks, tailored for the South African economy. In particular, one would expect the central banker in South Africa to be facing a greater sacrifice ratio compared to US and European markets, given the weak response of wages to market conditions. In essence, when inflationary pressures begin to rise, targeting a smoother inflation may come indeed costly in the form of an undesirable increase in structural unemployment, given the absence of the *divine coincidence* primarily caused by labour market frictions.

To close this section, we assess the role played by inefficient unemployment fluctuations induced by trade unions' monopoly power as a potential obstacle to the conduct of monetary policy in general and the implications for the implementation of the inflation targeting framework in South Africa in particular. As illustrated in Demertzis and Viegi (2008), 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, and so forth. For this reason, lots of time and resources are spent recording inflation expectations and checking if inflation expectations are well anchored. The assumption is that the anchoring of expectations 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, look sufficiently anchored (Kabundi *at al*, 2014) and we know that the South African Reserve Bank 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 threat posed by the leader (Acocella *et al*, 2008). 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). 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 union to follow the central bank's 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 it could be incentive-compatible for the central bank to actually follow the leadership of the trade unions, if this provides a better outcome than the alternative Nash solution. But if being a follower is efficient for the central bank, this is not optimal in an inflation targeting regime because it undermines the whole premise of inflation targeting itself.

Further findings suggest that a strong commitment to inflation targeting reduces wage growth in the Nash game, while the solution with the central bank as the leader is invariant to the commitment to the inflation target. On the other hand, a commitment to inflation targeting can be counterproductive if the central bank is not a leader in the policy game and the trade union is not particularly worried by the negative employment effects of wage increases. A sufficient condition for the central bank to acquire leadership is for the trade union to internalize the inflation objective of the central bank. It is therefore the objective function of the trade union that is critical in determining the quality of the policy solution.

3.3 The Model

We follow closely the model by Blanchard and Gali (2010) in this chapter. As praised by the authors themselves, it is a simple framework which we later estimate using South African data. For now however, we begin the lay off of the model by presenting the representative household's problem.

3.3.1 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 maximizes the objective function given by:

$$E_0 \sum_{t=0}^{\infty} \beta^t U(C_t,\ L_t) \tag{3.1}$$

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

$$0 \leq N_t \leq 1 \tag{3.2}$$

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

$$U\left(C_t,\ N_t\right) \equiv logC_t - \frac{\chi}{1+\phi} {N_t}^{1+\phi} \tag{3.3}$$

The budget constraint they face is given by:

$$\int_0^1 P_t\left(i\right) C_t\left(i\right) di + Q_t B_t \leq B_{t-1} + \int_0^1 W_t\left(j\right) N_t\left(j\right) dj + \Pi_t \tag{3.4}$$

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.

3.3.2 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.

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:

$$Y_t\left(i\right) = X_t(i) \tag{3.5}$$

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:

$$P_t = \left((1-\theta)\left(P_t^*\right)^{1-\epsilon} + \theta (P_{t-1})^{1-\epsilon}\right)^{\frac{1}{1-\epsilon}} \tag{3.6}$$

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:

$$E_t \left\{ \sum_{k=0}^{\infty} \theta^k Q_{t,t+k} Y_{t+k|t} (P_t^* - \mathcal{M} P_{t+k} MC_{t+k} \right\} = 0 \tag{3.7}$$

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.

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:

$$X_t\left(i\right) = A_t N_t(j) \tag{3.8}$$

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 an autoregressive coefficient ρ_a and a variance σ_a^2.

Employment in firm j evolves according to:

$$N_t\left(j\right) = \left(1-\delta\right) N_{t-1}\left(j\right) + H_t(j) \tag{3.9}$$

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,

$$U_t = 1 - N_{t-1} + \delta N_{t-1} = 1 - (1-\delta)N_{t-1} \tag{3.10}$$

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:

$$H_t = N_t - (1-\delta)N_{t-1} \tag{3.11}$$

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:

$$x_t \equiv \frac{H_t}{U_t} \tag{3.12}$$

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 the job finding rate, x_t captures the probability of getting hired in period t. We will further elaborate on this index later on when we introduce the scenarios that will be simulated in this chapter.

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:

$$G_t = A_t B x_t^{\alpha} \tag{3.13}$$

where $\alpha \geq 0$ and B is a positive constant. For convenience, let $g_t \equiv Bx_t^{\alpha}$. 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 in this chapter is not explaining vacancies, the approach we choose will therefore be the simple framework introduced by Blanchard and Gali (2010).

3.3.3 The equilibrium

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 internalizes 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 produced and consumed, 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 maximizes (3.1) subject to (3.2) and the aggregate resource constraint given by:

$$C_t = A_t(N_t - Bx_t^{\alpha} H_t) \tag{3.14}$$

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

$$\chi C_t N_t^{\phi} \leq A_t - (1+\alpha) A_t B x_t^{\alpha} + \beta(1-\delta) E_t \left\{ \frac{C_t}{C_{t+1}} A_{t+1} B x_{t+1}^{\alpha} (1 + \alpha(1 - x_{t+1})) \right\} \tag{3.15}$$

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 $t+1$.

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 maximization suggest that for all t, the real marginal revenue product of labour equals the real marginal cost. Thus,

$$\left(\frac{P_t^I}{P_t}\right) A_t = W_t + G_t - \beta(1-\delta)E_t\left(\frac{C_t}{C_{t+1}}G_{t+1}\right) \tag{3.16}$$

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

Using (3.16) and reorganizing gives:

$$Bx_t^\alpha = \left(\frac{1}{\mathcal{M}} - \frac{W_t}{A_t}\right) + \beta(1-\delta)E_t\left(\frac{C_t}{C_{t+1}}\frac{A_{t+1}}{A_t}Bx_{t+1}^\alpha\right) \tag{3.17}$$

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:

$$\mathcal{V}_t^N = W_t - \chi C_t N_t^{\phi} + \beta E_t \left\{ \frac{C_t}{C_{t+1}} \left[(1 - \delta (1 - x_{t+1})) \mathcal{V}_{t+1}^N + \delta (1 - x_{t+1}) \ \mathcal{V}_{t+1}^U \right] \right\} \tag{3.18}$$

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

$$\mathcal{V}_t^U = \beta E_t \left\{ \frac{C_t}{C_{t+1}} \left[x_{t+1} \ \mathcal{V}_{t+1}^N + (1 - x_{t+1}) \ \mathcal{V}_{t+1}^U \right] \right\} \tag{3.19}$$

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:

$$\mathcal{S}_t^H = W_t - \chi C_t N_t^{\phi} + \beta (1 - \delta) E_t \left\{ \frac{C_t}{C_{t+1}} (1 - x_{t+1}) \mathcal{S}_{t+1}^H \right\} \tag{3.20}$$

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

$$\mathcal{S}_t^F = A_t B x_t^{\alpha} = G_t \tag{3.21}$$

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

The Nash bargain must satisfy:

$$\mathcal{S}_t^H = \vartheta \mathcal{S}_t^F \tag{3.22}$$

where ϑ is the relative bargaining power of workers. By combining this condition with (3.20) and (3.21), we obtain the following wage schedule:

$$W_t = \chi C_t N_t^{\phi} + \vartheta \left(A_t B x_t^{\alpha} - \beta(1-\delta) E_t \left\{ \frac{C_t}{C_{t+1}} (1 - x_{t+1}) A_t B x_{t+1}^{\alpha} \right\} \right) \tag{3.23}$$

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 (3.17) (which gives the wage consistent with the price setting) and (3.23) (giving the wage consistent with Nash bargaining), we obtain the following new equilibrium:

$$\chi C_t N_t^{\phi} = \frac{A_t}{\mathcal{M}} - (1+\vartheta) A_t B x_t^{\alpha} + \beta(1-\delta) E_t \left\{ \frac{C_t}{C_{t+1}} A_t B x_{t+1}^{\alpha} (1 + \vartheta (1 - x_{t+1})) \right\} \tag{3.24}$$

The real wage is given by:

$$W_t = \left(\frac{1}{\mathcal{M}} - (1 - \beta (1-\delta)) B x^{\alpha} \right) A_t \tag{3.25}$$

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

Formalizing 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:

$$W_t = \Theta A_t^{1-\gamma} \tag{3.26}$$

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 $\Theta \equiv \left(\left(\frac{1}{\mathcal{M}}\right) - (1-\beta(1-\delta))\, Bx^{\alpha}\right) A^{\gamma}$, 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 (3.26) with (3.17), we derive the last equilibrium condition, namely the equilibrium consistent with real wage rigidities, which is given by:

$$\Theta A_t^{-\gamma} = \frac{1}{\mathcal{M}} - Bx_t^{\alpha} + \beta(1-\delta)E_t\left\{\frac{C_t}{C_{t+1}}\frac{A_{t+1}}{A_t}Bx_{t+1}^{\alpha}\right\} \tag{3.27}$$

Rearranging and solving forward:

$$Bx_t^{\alpha} = \sum_{k=0}^{\infty}(\beta(1-\delta))^k E_t\left\{\frac{C_t}{C_{t+1}}\frac{A_{t+1}}{A_t}(\frac{1}{\mathcal{M}} - \Theta A_{t+k}^{-\gamma})\right\} \tag{3.28}$$

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.

3.3.4 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 maximization condition of intermediate goods producers given by (3.16) with the wage schedule in equation (3.26) gives the following setting for real marginal cost:

$$MC_t = \Theta A_t^{-\gamma} + Bx_t^{\alpha} - \beta(1-\delta)E_t\left\{\frac{C_t}{C_{t+1}}\frac{A_{t+1}}{A_t}Bx_{t+1}^{\alpha}\right\} \tag{3.29}$$

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).

From this point on, note that lower case variables with hats represent log deviations of the corresponding upper case variables from their steady state values. After log-linearizing equations (3.6) and (3.7) around a zero inflation steady state (see Gali and Gertler, 1999), the following expression for inflation is given:

$$\pi_t = \beta E_t \{\pi_{t+1}\} + \lambda \widehat{mc}_t \tag{3.30}$$

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

Log linearizing and rearranging equation (3.29), the real marginal cost takes the following form:

$$\widehat{mc}_t = \alpha g \mathcal{M} \hat{x}_t - \beta (1-\delta) g \mathcal{M} E_t \{(\hat{c}_t - \hat{a}_t) - (\hat{c}_{t+1} - \hat{a}_{t+1}) + \alpha \hat{x}_{t+1}\} - \Phi \gamma \hat{a}_t \tag{3.31}$$

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 to productivity (given $\gamma > 0$). 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 (3.12) which takes the following form:

$$\delta \hat{x}_t = \hat{n}_t - (1-\delta)(1-x)\hat{n}_{t-1} \tag{3.32}$$

From equation (3.14), the following expression for consumption is obtained:

$$\hat{c}_t = \hat{a}_t + \frac{1-g}{1-\delta g}\hat{n}_t + \frac{g(1-\delta)}{1-\delta g}\hat{n}_{t-1} - \frac{\alpha g}{1-\delta g}\delta \hat{x}_t \tag{3.33}$$

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

$$\hat{c}_t = E_t \{\hat{c}_{t+1}\} - (i_t - E_t \{\pi_{t+1}\} - \rho) \tag{3.34}$$

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

We now move on to derive the Phillips curve relation between inflation and unemployment implied by the framework of the proposed study. Substituting (3.32) in (3.33) gives:

$$\hat{c}_t = \hat{a}_t + \xi_0 \hat{n}_t + \xi_1 \hat{n}_{t-1} \tag{3.35}$$

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 (3.32), in (3.31) gives this new expression for real marginal cost:

$$\widehat{mc}_t = h_0 \hat{n}_t + h_L \hat{n}_{t-1} + h_F E_t \{\hat{n}_{t+1}\} - \Phi\gamma\hat{a}_t \tag{3.36}$$

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 (3.30), and given $\hat{u}_t = -(1-u)\hat{n}_t$, the following Phillips curve giving the relation between inflation and unemployment is obtained:

$$\pi_t = \beta E_t \{\pi_{t+1}\} - \kappa_0 \hat{u}_t + \kappa_L \hat{u}_{t-1} + \kappa_F E_t \{\hat{u}_{t+1}\} - \lambda\Phi\gamma\hat{a}_t \tag{3.37}$$

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 Phillips 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 (3.32) becomes:

$$(1-u)\,\delta\hat{x}_t = -\hat{u}_t + (1-x)(1-\delta)\hat{u}_{t-1} \tag{3.38}$$

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 characterized 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 (3.38) 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 characterized by the following set of equations:

1. The Phillips 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:

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

6. The central banker's instrument:

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

3.4 Simulation

3.4.1 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 $B = 0.12$.

Before providing the South Africa estimation of the model, the response of the model to a monetary policy shock is analyzed to develop some intuition that will turn out useful in evaluating the meaning of the estimation results for South Africa. The model implies the following relationship between long-term unemployment, labour market tightness, and an exogenous separation rate: $u = \frac{\delta(1-x)}{\delta(1-x)+x}$.

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

The first type of labour market is characterized by a low level of entry and exit and a low long-term unemployment rate (rigid-low). In this market, flows are low because a low separation rate is coupled with a low level of aggregate hires. Regardless, the steady state unemployment is low because aggregate hires is relatively higher than 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 simulation, we assume the following parameterization for this market: $u = 0.05$, $x = 0.15$ and $\delta = 0.01$.

The second type of labour market is still a rigid labour market with a low level of aggregate hires, but with a higher separation rate that produces a high level of structural unemployment (rigid-high). A possible example of this kind of market is the labour market in south Europe, where a rigid labour market generates a low level of job creation and high structural unemployment. In our simulation, we assume the following parameterization for this labour market: $u = 0.30$, $x = 0.15$ and $\delta = 0.075$.

The next scenario displays large flows in terms of job creation and destruction rates, where the job creation rates dominate the dynamics, which in turn translate into a low steady state unemployment (fluid-low). The United States is often presented as an example of this kind of labour market. To simulate this market we use the following parameterization: $u = 0.05$, $x = 0.8$ and $\delta = 0.21$.

Finally, the fourth type of labour market is characterized by high flows of job creation and job destruction, but where job destruction rates dominate the dynamics, therefore generating a high level of structural unemployment (fluid-high). We see in the analysis that South Africa is a good example of this kind of labour market. The parameterization for this case will be the following: $u = 0.30$, $x = 0.67$ and $\delta = 0.87$.

3.4.2 Impulse responses

In each scenario, we simulate the responses to a monetary shock. The shock is an AR(1) process 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 $\phi_\pi = 1.5$,

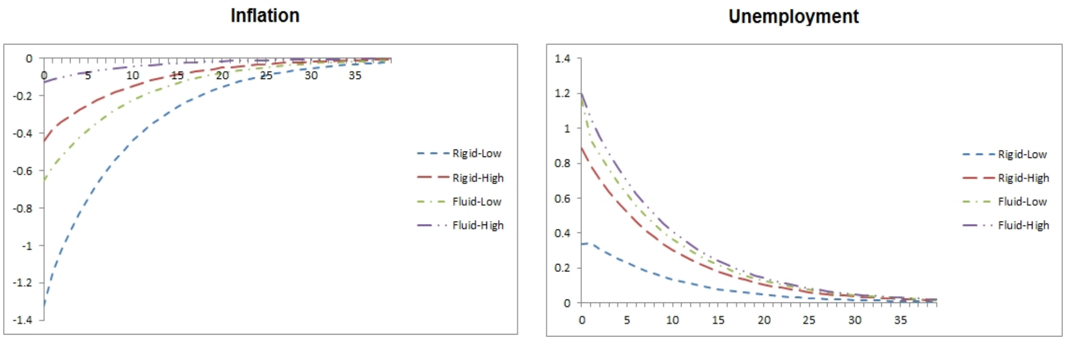
$\phi_c = 0.5$ and $\phi_u = 0$.

Figure 1 summarizes the response of inflation (left panel) and unemployment (right panel) to a monetary shock. In all four scenarios, inflation and unemployment both takes a considerable amount of time before converging to their steady state values as the shock dies out. First off, we focus on the two extremes, *i.e.* scenario 1 (Rigid-Low) and scenario 4 (Fluid-High). In the Fluid-High set up, we report a weak response of inflation to the central banker's instrument as it drops to about 0.2 percent (the lowest drop). However this low drop is compensated by a greater effect on unemployment (on the right panel). Indeed, unemployment in this scenario shows the highest increase (1.2 percent). By contrast, the Rigid-Low setting shows a complete opposite result. In this scenario, the results therefore suggest that, given the low level of steady state unemployment prevailing in the economy, the monetary authority appears to have a difficult task achieving its objective of a stable inflation, hence the high response. An objective that may turn out costly in the form of a slight increase of about 0.28 percent in unemployment, given there is no *divine coincidence* as originally stated.

It therefore appears that between these two extreme scenario, the Fluid-High design displays the most undesirable performance. Although we confirm the existence of trade-off in both scenarios, between achieving a stable inflation or a less fluctuating unemployment, the sacrifice ratios between completing these two objectives appears higher in the fluid labour market with high levels of steady state unemployment. Indeed, in a sclerotic labour market with low unemployment (scenario 1), the monetary authority can offset the effects of inflationary pressures with small perverse effects on unemployment. On the other hand, when the labour market is fluid and unemployment is high (as it is the case in scenario 4), achieving stable prices when inflationary pressures arise results in further increases in an already high unemployment rate.

We also find interesting results in scenario 2 (Rigid-High) and 3 (Fluid-Low). In particular, the cost of stabilizing inflation in the form of higher unemployment rates at the moment of impact, is higher in a fluid labour market with low steady state unemployment (scenario 3) relative to a sclerotic labour market with high steady state unemployment (scenario 2).

Figure 1: Impulse response functions - monetary shock



The responses of unemployment and inflation to productivity, demand and labour shocks are reported in the appendix.

3.5 Estimation and historical decomposition

3.5.1 Estimation results

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 observable variables are: inflation, output, interest rate and employment. The quarterly data covers the period 1994Q01 to 2011Q03. 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 ideal to stick with CPI to best capture 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 analyze output and employment variables in terms of their deviation from the trends which we do so 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 percent. 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 tightness	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

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

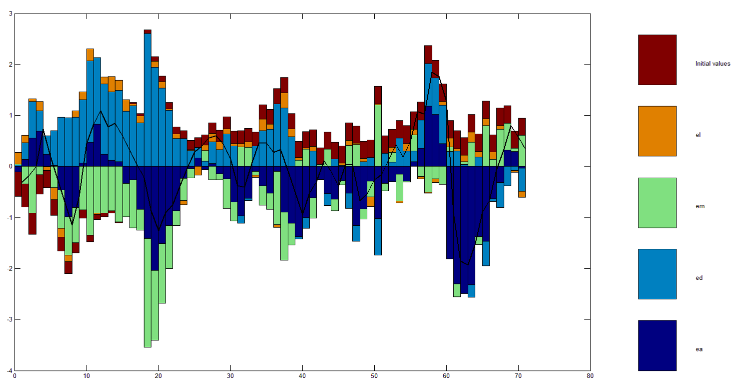
The estimation of the labour market parameters show a picture of a labour market with pervasive wage rigidities and a high level of job destruction rates only partly compensated by job creation rates. We estimate the labour market tightness index at 0.72, implying a separation rate of 0.77. This thus implies that South Africa has a labour market with large flows of job creation and job destruction rates 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 confirms what has been largely found in the literature.

Another aspect of the estimation results is that it allows to conduct a historical decomposition analysis of the performance of each observable variable. The findings are discussed in the next section.

3.5.2 Historical decomposition

This section essentially reports the contribution of each shock in explaining the fluctuations in the observable variables used for the estimation, namely the variables capturing output, inflation and employment. We begin by exploring the output in figure 2.

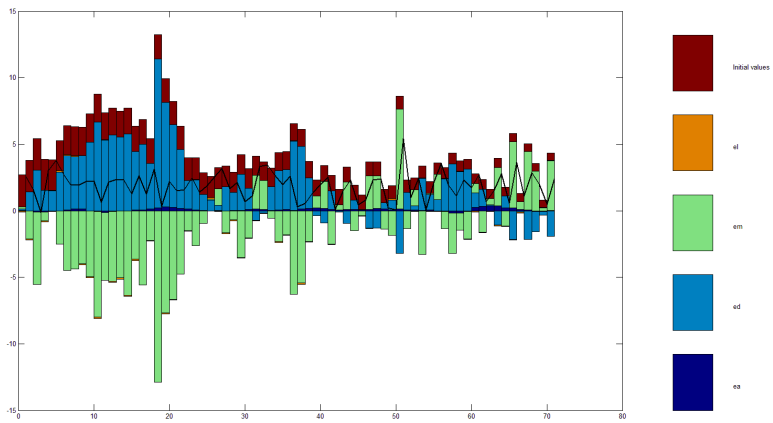
Figure 2: Historical decomposition - Output



Notes: el: Labour shock, em: Monetary shock, ed: Preference shock, ea: Productivity shock , Initial values: variation that is not explained by the model

The variation in the beginning of the period (early 1994) is dominated by a demand shock. This can be explained by the fact the country was experiencing some changes in consumption and production habits with the international sanctions being lifted, consequence of the abolishment of the Apartheid regime. Overall, the productivity shock explains for much of the variations in output. For instance, during the financial crisis - this occurs around the 60th period in the figure above - the massive decline in output that the country experienced was mostly the result of a productivity shock.

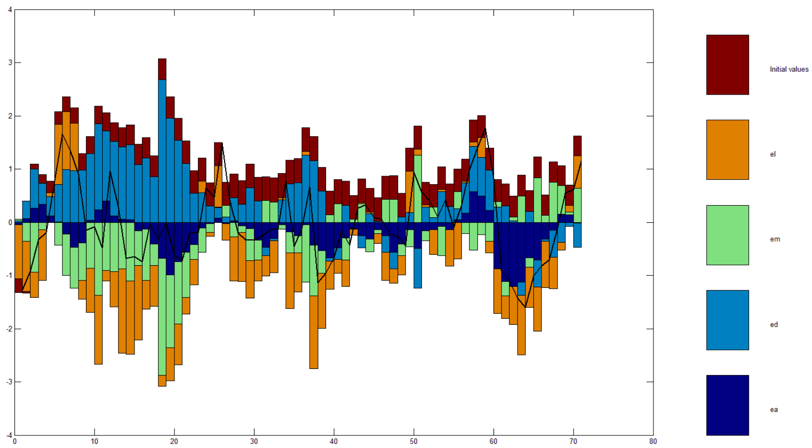
Figure 3: Historical decomposition - Inflation



Notes: el: Labour shock, em: Monetary shock, ed: Preference shock, ea: Productivity shock , Initial values: variation that is not explained by the model

Figure 3 depicts the historical decomposition for inflation. As expected, demand and monetary policy shocks dominate the dynamics and the productivity shock almost does not contribute at all in explaining the variation in inflation - which one could easily find to be peculiar. However, the dominance of demand and monetary policy shocks could have a tentative of explanation. In fact, the change in consumption and production habits attributed to the end of the Apartheid regime as mentioned earlier, had to be accommodated for by the monetary authority. This perhaps explains why in this case, demand and monetary policy shocks evolve in opposite directions and in almost the same proportion. Indeed, the central bank had to offset the perverse effects resulted from the demand shock through its instrument.

Figure 4: Historical - Employment



Notes: el: Labour shock, em: Monetary shock, ed: Preference shock, ea: Productivity shock , Initial values: variation that is not explained by the model

Finally, we report the historical decomposition of employment in figure 4. For the same reasons already mentioned, we find again that demand and monetary shocks account for most of the changes in employment to which we notice the slight contribution of a productivity shock. The contribution of a labour shock can be explained by the fact that the large proportion of individuals that was deliberately excluded from the labour market during the Apartheid regime was now available for hire. The problem here however was that most of individuals available for hire were low skilled workers. Fast forwarding to the recent financial crisis - around the 60th period in the figure - we find that the decline in employment is explained by productivity and labour shocks. In fact, the crisis caused production to slow down and consequently, firms resorted to reducing the costs of production in the form of labour shedding.

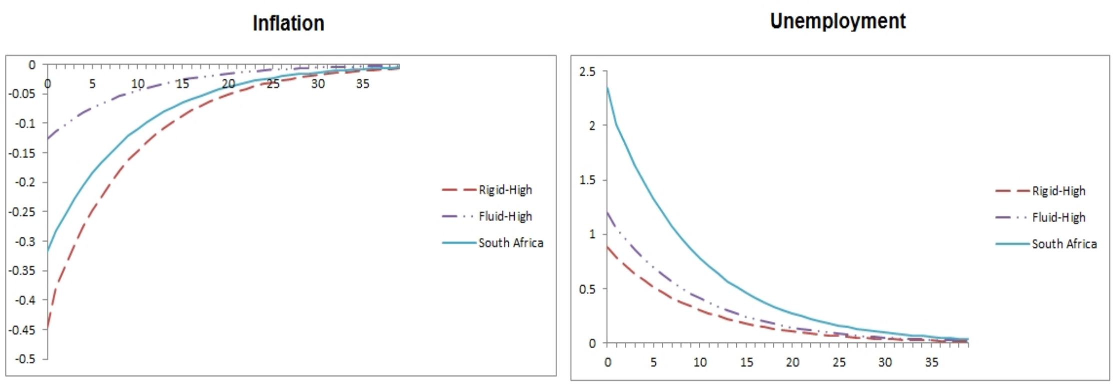
3.6 Estimation analysis

The estimation results allow us to move forward and further complete two exercises. First off, we re-parameterize the model and run a simulation to assess the response of inflation and unemployment to a monetary shock in a South African setting. The second exercise consists of a welfare analysis in which we calculate optimal parameters of the Taylor rule that induces the lowest welfare loss borne by the central banker. We discuss these two points in the next subsections.

3.6.1 Impulse response function for South Africa

This section compares the responses of inflation and unemployment for South Africa to a monetary shock, relative to the performance of scenarios that display high level of steady state unemployment. The impulse responses are reported in the figure below.

Figure 5: Impulse responses - monetary policy shock



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. In particular, this result is consistent with our reduced-form estimation in chapter 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 in turn will induce large changes in employment. It is however crucial for this policy to be achievable to take into account the objective function of the central bank and the strategic interaction between the central bank and labour market participants (particularly the trade unions). Indeed, as discussed earlier, three conditions must be satisfied for the inflation targeting regime to be successfully implemented in an environment dominated by pervasive wage rigidities. First, the central bank must be a credible and independent institution for successfully anchored inflation expectations. Second, the inflation targeting regime can only be effective against wage if trade unions worry about the penalizing cost of employment due to inflation stabilization. Finally, it is imperative for the central bank to be the leader of the policy game for an efficient and optimal outcome, given that in the case of trade unions as leader, negative employment effects of wage increases will most likely not remain the particular concern. Therefore, for the feasibility of a central bank as a leader to be effective, the trade unions must internalize in their objective function the inflation objective of the central bank.

3.6.2 Welfare analysis

We now turn to compare the welfare losses borne by the central banker associated with each scenario considered thus far. We have assumed for each scenario that the central bank follow a simple Taylor as first uncovered by Taylor (1993). Therefore, the weights on inflation, output gap and unemployment are respectively set to their standard values given by $\phi_\pi = 1.5$, $\phi_c = 0.5$, and $\phi_u = 0$. The optimized Taylor rule generates optimal values of ϕ_π, ϕ_c, and ϕ_u that will significantly reduce welfare losses for each scenario relative to the case when the central banker follows the simple Taylor rule. For the South African case, we initially assume the Taylor rule parameters obtained from the estimation, where we find that the central banker is a lot tougher on inflation relative to the four theoretical scenarios. Therefore, $\phi_\pi = 2.17$, $\phi_c = 0.13$, and $\phi_u = 0$.

These optimal parameters are calculated such that it minimizes the following loss function:

$$L = \sum_{t=0}^{\infty} \beta^t \left(\pi_t^2 + u_t^2\right)$$

Note that this is for illustration purposes only and that the numbers generated by this exercise are purely theoretical. We use this loss function for simplicity reasons and to emphasize on the fact that an environment dominated by pervasive and rigid wages, high flows in labour market, and a high structural unemployment, induces the highest loss to a monetary policy that is committed to inflation targeting. For an extended discussion on welfare loss functions and optimal monetary policy, refer to Woodford (2003) and Gali (2008) amongst other. The table below summarizes the results for the optimized Taylor rule.

Table 2: Optimized Taylor rule parameters

	Rigid -Low	Rigid - High	Fluid - Low	Fluid - High	South Africa
ϕ_π	1.66	1.56	1.6	1.56	1.59
ϕ_c	0.34	0.44	0.39	0.44	0.4
ϕ_u	-0.92	-0.87	-1.48	-0.98	-1.05

The optimized Taylor rule significantly reduces the weight on inflation for South Africa, while in an apparent trade-off, it also suggests that unemployment should be explicitly targeted in the central banker's instrument for efficiency purposes. This is the case for the four original scenarios as well, while the values for the weight on inflation and output gap remain relatively in the vicinity of those nested in the simple Taylor rule. Most of the Taylor rule literature suggests however that either unemployment or output gap be targeted, but not both at the same time. This is simply because in most cases, considering either of the two yields the same objective. Indeed, deviations of unemployment from its natural rate are equivalent to output deviations from its potential. Therefore, if the unemployment rate is managed by policymakers to match its natural rate, the output gap will be nonexistent and there will thus be no rising inflationary pressures. The result from our exercise however suggests that both output gap and unemployment should be targeted by the monetary authority. We argue that the framework adopted in this chapter explains for this unorthodox finding. In particular, we use a model with unemployment which suggests in addition to variations in inflation and output gap, further fluctuations in unemployment could well be a source of welfare losses.

We can now formally compare the welfare losses borne by the central banker associated with the South African setup. Both the optimized and the estimated Taylor rules are taken into account. On top of the losses due to a monetary shock, we further account for losses generated by productivity and preference shocks. The table below summarizes the results.

Table 3: Loss Comparison

	South Africa	
	Estimated TR	Optimized TR
Monetary shock	26.32	0.04
Productivity shock	6.5	1.79
Preference shock	27.39	1.74

Notes: TR: Taylor Rule

Overall, the findings suggest that the South African case displays the worse possible level of welfare loss (the results for the other scenarios are reported in the appendix). This therefore confirms prior expectations and implies that a fluid labour market with less responsive wages to market conditions and high structural unemployment generate the highest sacrifice ratio in terms of the forgone opportunity of achieving a less fluctuating inflation. This indeed results in undesirable and persistent variations in unemployment. We further find that a policy that targets inflation, output gap and unemployment - in this case the optimized Taylor rule - significantly and considerably reduces the welfare loss associated with each shock. The reduction is remarkable in the South African case, particularly for monetary and preference shocks - two shocks that have been predominant in the economy since 1994 and the abolishment of the Apartheid regime as discussed in the historical decomposition section.

3.7 Conclusion

One of the main findings of chapter 2 of the thesis is the weak response of wages to market conditions, which we find to be the case at both sectoral and aggregate levels. In this chapter, we investigate the implications of that finding in terms of the conduct of monetary policy. In particular, we use the framework first developed by Blanchard and Gali (2010) who take into account the effects of labour market frictions on monetary policy. First off, we find that indeed when accounting for frictions in the labour market in the form of wage rigidities or stringent labour market regulations, there is no *divine coincidence*. In essence, this means stabilizing inflation does not automatically result into a less fluctuating unemployment (output gap), and *vice versa*.

Furthermore, we also assess whether optimal monetary policy response should be tailored according to the type of labour market. We account for four typologies of labour markets that differ in terms of fluidity, which is determined according to job creation and destruction rates dynamics. The findings show that in a sclerotic labour market with low rates of steady state unemployment, the central banker is capable of offsetting the effects of inflationary pressures with little undesirable fluctuations in unemployment. By contrast, in the scenario with a fluid labour market and high levels of unemployment, achieving stable prices when inflation pressures start to materialized typically leads to a further increase in unemployment. In addition, this scenario displays the highest sacrifice ratio in response to a monetary shock.

Finally, we estimate the model using bayesian methods with South African data to assess the type of labour market that applies to the economy and the kind of the trade-off the South African Reserve

Bank faces. The results first confirm the finding in chapter 2 of pervasive wage rigidities. Moreover, the estimation also displays a picture of a labour market with large flows of job creation and destruction rates during the business cycle. It is important to highlight that the job destruction rates dominate the dynamics. By recalibrating the model using new parameter estimates, the simulation shows that the central banker in South Africa can only stabilize inflation by inducing large changes in aggregate demand, which in turns will induce large changes in (un)employment, given that wages are not very responsive to economic conditions.

One of the major drawbacks of this study, and a recurring theme in this thesis, is the lack of data for the estimation. Because the data for unemployment is only usable from the early 2000's as mentioned in the previous chapter, ultimately we had to rely on the index of manufacturing employment to proxy for the behaviour of general employment in this study. Moreover, a line for further research would be to extend the model into an open economy DSGE framework to take account of the dynamics originated from the outside world. We deliberately decided not to do so as we instead chose to pursue a different path and investigate the labour market effects of public employment in the next chapter. Our decision was mainly influenced by the strong response of wages to market conditions in industrial sectors dominated by public sector firms (especially the community social and personal services sector) as we find in chapter 2. Furthermore, given the shortage of skilled workers in South Africa and provided that the public sector is mainly skilled workers intensive, we were curious what implications it would have for private sector employment, especially if one were to consider the public wage premium. We discuss this further in chapter 4.

3.8 Appendix A

MATHEMATICAL DERIVATIONS

Optimal allocation of consumption expenditure

The household faces the following problem

Minimizing

$$\int_0^1 P_t(i)C_t(i)di$$

Subject to

$$C_t = \int_0^1 \left(C_t(i)^{\frac{\epsilon-1}{\epsilon}}di\right)^{\frac{\epsilon}{\epsilon-1}}$$

Also $P_t \equiv \left(\int_0^1 P_t(i)^{1-\epsilon}\right)^{\frac{1}{1-\epsilon}}$

Setting up the Lagrangian

$$L = \int_0^1 P_t(i)C_t(i)di + \lambda\left[C_t - \int_0^1 \left(C_t(i)^{\frac{\epsilon-1}{\epsilon}}di\right)^{\frac{\epsilon}{\epsilon-1}}\right] = 0$$

First order condition

$$\frac{\partial L}{\partial C_t(i)} = P_t(i) - \lambda\left[\frac{\epsilon-1}{\epsilon}\frac{\epsilon}{\epsilon-1}C_t(i)^{\frac{\epsilon-1}{\epsilon}-1}\int_0^1 \left(C_t(i)^{\frac{\epsilon-1}{\epsilon}}di\right)^{\frac{\epsilon}{\epsilon-1}-1}\right] = 0$$

$$P_t(i) - \lambda\left[C_t(i)^{\frac{-1}{\epsilon}}\int_0^1 \left(C_t(i)^{\frac{\epsilon-1}{\epsilon}}di\right)^{\frac{-1}{\epsilon-1}}\right] = 0$$

$$P_t(i) = \lambda\left[C_t(i)^{\frac{-1}{\epsilon}}\int_0^1 \left(C_t(i)^{\frac{\epsilon-1}{\epsilon}}di\right)^{\frac{-1}{\epsilon-1}}\right]$$

$$C_t(i)^{\frac{-1}{\epsilon}} = \frac{P_t(i)}{\lambda\int_0^1 \left(C_t(i)^{\frac{\epsilon-1}{\epsilon}}di\right)^{\frac{-1}{\epsilon-1}}}$$

$$C_t(i) = \frac{P_t(i)^{-\epsilon}}{\lambda^{-\epsilon}\int_0^1 \left(C_t(i)^{\frac{\epsilon-1}{\epsilon}}di\right)^{\frac{-\epsilon}{\epsilon-1}}}$$

$$C_t(i) = \left(\frac{P_t(i)}{\lambda}\right)^{-\epsilon} C_t \quad (3.39)$$

Substituting (3.39) in the constraint

$C_t = \int_0^1 \left[\left(\frac{P_t(i)}{\lambda} \right)^{-\epsilon} C_t^{\frac{\epsilon-1}{\epsilon}} di \right]^{\frac{\epsilon}{\epsilon-1}}$
$C_t = \left[\frac{1}{\lambda^{1-\epsilon}} C_t^{\frac{\epsilon-1}{\epsilon}} \int_0^\infty P_t(i)^{1-\epsilon} di \right]^{\frac{\epsilon}{\epsilon-1}}$
$C_t = \left[\lambda^{\epsilon-1} C_t^{\frac{\epsilon-1}{\epsilon}} \int_0^\infty P_t(i)^{1-\epsilon} di \right]^{\frac{\epsilon}{\epsilon-1}}$
$C_t = \lambda^\epsilon C_t \left[\int_0^\infty P_t(i)^{1-\epsilon} di \right]^{\frac{\epsilon}{\epsilon-1}}$
$\lambda^\epsilon = \left[\int_0^\infty P_t(i)^{1-\epsilon} di \right]^{\frac{\epsilon}{1-\epsilon}}$
$\lambda = \left[\int_0^\infty P_t(i)^{1-\epsilon} di \right]^{\frac{1}{1-\epsilon}}$

$$\lambda = P_t \tag{3.40}$$

Substituting (3.39) in (3.40) gives the optimal allocation on consumption expenditure

$C_t(i) = \left(\frac{P_T(i)}{P_t} \right)^{-\epsilon} C_t$

The consumer's problem

The consumer maximizes

$$E_0 \sum_{t=0}^{\infty} \beta^t \left(\log C_t - \frac{\chi}{1+\phi} N_t^{1+\phi} \right)$$

Subject to

$$C_t + Q_t \frac{B_t}{P_t} \leq \frac{B_{t-1}}{P_t} + \frac{W_t}{P_t} N_t + \frac{\Pi_t}{P_t}$$

Setting up the Lagrangian

$L = E_0 \sum_{i=0}^{\infty} \beta^i \left(\log C_{t+i} - \frac{\chi}{1+\phi} N_{t+i}^{1+\phi} \right) + E_0 \sum_{i=0}^{\infty} \beta^i \lambda_{t+i} \left(\frac{B_{t+i-1}}{P_{t+i}} + \frac{W_{t+i}}{P_{t+i}} N_{t+i} + \frac{\Pi_{t+i}}{P_{t+i}} - C_{t-i} + Q_{t+i} \frac{B_{t+i}}{P_{t+i}} \right)$
First order conditions

$$\frac{\partial L}{\partial C_t} = \frac{1}{C_t} - \lambda_t = 0 \tag{3.41}$$

$$\frac{\partial L}{\partial N_t} = -\chi N_t^{\phi} + \lambda_t \frac{W_t}{P_t} = 0 \tag{3.42}$$

$$\frac{\partial L}{\partial B_t} = -\lambda_t \frac{Q_t}{P_t} + \beta E_t \left\{ \frac{\lambda_{t+1}}{P_{t+1}} \right\} = 0 \tag{3.43}$$

From (3.41)

$$\frac{1}{C_t} = \lambda_t \tag{3.44}$$

(3.44) into (3.42)

$$\chi N_t^{\phi} = \frac{W_t}{P_t C_t} \tag{3.45}$$

(3.44) into (3.43)

$$\frac{Q_t}{P_t C_t} = \beta E_t \left\{ \frac{1}{P_{t+1} C_{t+1}} \right\}$$

$$Q_t = \beta E_t \left\{ \frac{P_t}{P_{t+1}} \frac{Ct}{C_{t+1}} \right\} \tag{3.46}$$

The Social Planner Equilibrium

The benevolent social planner maximizes

$$E_0 \sum_{t=0}^{\infty} \beta^t \left(\log C_t - \tfrac{\chi}{1+\phi} N_t^{1+\phi} \right)$$

subject to

$$C_t = A_t \left(N_t - B x_t^{\alpha} H_t \right)$$

where

$H_t = N_t - (1-\delta)N_{t-1}, 0 \leq N_t \leq 1, x_t \equiv \frac{H_t}{U_t}, U_t = 1 - (1-\delta)N_{t-1}$

The constraint therefore changes to

$$C_t = A_t N_t - A_t B \tfrac{[N_t - (1-\delta)N_{t-1}]^{\alpha+1}}{[1-(1-\delta)N_{t-1}]^{\alpha}}$$

Therefore

$$L = E_0 \sum_{i=0}^{\infty} \beta^i \left(\log C_{t+i} - \tfrac{\chi}{1+\phi} N_{t+i}^{1+\phi} \right) - E_0 \sum_{i=0}^{\infty} \beta^i \lambda_{t+i} \left[C_t - A_t N_t - A_t B \tfrac{[N_t - (1-\delta)N_{t-1}]^{\alpha+1}}{[1-(1-\delta)N_{t-1}]^{\alpha}} \right]$$

First order conditions

$$\frac{\partial L}{\partial C_t} = \frac{1}{C_t} - \lambda_t = 0 \tag{3.47}$$

$$\tfrac{\partial L}{\partial N_t} = -\chi N_t^{\phi} - \lambda_t A_t + \left\{ \tfrac{(\alpha+1)[\lambda_t A_t B - (1-\delta)\beta\lambda_{t+1}A_{t+1}B][N_{t+i}-(1-\delta)N_{t+i-1}]^{\alpha}[1-(1-\delta)N_{t+i-1}]^{\alpha}}{[1-(1-\delta)N_{t+i-1}]^{2\alpha}} \right\} -$$
$$\left\{ \tfrac{\alpha[-(1-\delta)\beta\lambda_{t+1}A_{t+1}B][1-(1-\delta)N_{t+i-1}]^{\alpha-1}[N_{t+i}-(1-\delta)N_{t+i-1}]^{\alpha+1}}{[1-(1-\delta)N_{t+i-1}]^{2\alpha}} \right\} \geq 0$$

$$-\chi N_t^{\phi} - \lambda_t A_t + \tfrac{[N_{t+i}-(1-\delta)N_{t+i-1}]^{\alpha}}{[1-(1-\delta)N_{t+i-1}]^{\alpha}} \left\{ \begin{array}{c} (\alpha+1)\left[\lambda_t A_t B - (1-\delta)\beta\lambda_{t+1}A_{t+1}B\right] + \\ \alpha\left[(1-\delta)\beta\lambda_{t+1}A_{t+1}B\right] \tfrac{[N_{t+i}-(1-\delta)N_{t+i-1}]}{[1-(1-\delta)N_{t+i-1}]} \end{array} \right\} \geq 0$$

$$-\chi N_t^{\phi} - \lambda_t A_t + x_{t+i}^{\alpha} \left\{ (\alpha+1)\left[\lambda_t A_t B - (1-\delta)\beta\lambda_{t+1}A_{t+1}B\right] + \alpha\left[(1-\delta)\beta\lambda_{t+1}A_{t+1}B\right] x_{t+i} \right\} \geq 0$$

$$-\chi N_t^{\phi} - \lambda_t A_t + (\alpha+1)\lambda_t A_t B x_t^{\alpha} - \alpha(1-\delta)\beta\lambda_{t+1}A_{t+1}B x_{t+1}^{\alpha}$$
$$-(1-\delta)\beta\lambda_{t+1}A_{t+1}B x_{t+1}^{\alpha} + \alpha(1-\delta)\beta\lambda_{t+1}A_{t+1}B x_{t+1}^{\alpha+1} \geq 0$$

$$-\chi N_t^{\phi} - \lambda_t A_t + (\alpha+1)\lambda_t A_t B x_t^{\alpha} + (1-\delta)\beta E_t \left\{ \begin{array}{c} -\alpha\lambda_{t+1}A_{t+1}B x_{t+1}^{\alpha} \\ -\lambda_{t+1}A_{t+1}B x_{t+1}^{\alpha} + \alpha\beta\lambda_{t+1}A_{t+1}B x_{t+1}^{\alpha+1} \end{array} \right\} \geq 0$$

$$-\chi N_t^{\phi} - \lambda_t A_t + (\alpha+1)\lambda_t A_t B x_t^{\alpha} + (1-\delta)\beta E_t \left\{ \lambda_{t+1}A_{t+1}B x_{t+1}^{\alpha} \left(-\alpha - 1 + \alpha x_{t+1} \right) \right\} \geq 0$$

$$-\chi N_t^{\phi} - \lambda_t A_t + (\alpha+1)\lambda_t A_t B x_t^{\alpha} + (1-\delta)\beta E_t \left\{ \lambda_{t+1}A_{t+1}B x_{t+1}^{\alpha} \left(-(1 + \alpha(1 - x_{t+1})) \right) \right\} \geq 0$$

$$-\chi N_t^{\phi} - \lambda_t A_t + (\alpha+1)\lambda_t A_t B x_t^{\alpha} + (1-\delta)\beta E_t \left\{ \lambda_{t+1}A_{t+1}B x_{t+1}^{\alpha} \left(-(1 + \alpha(1 - x_{t+1})) \right) \right\} \geq 0$$

$$-\chi N_t^{\phi} - \lambda_t A_t + (\alpha+1)\lambda_t A_t B x_t^{\alpha} - (1-\delta)\beta E_t \left\{ \lambda_{t+1}A_{t+1}B x_{t+1}^{\alpha} \left(1 + \alpha(1 - x_{t+1}) \right) \right\} \geq 0$$

$$\chi N_t^{\phi} \leq \lambda_t A_t - (\alpha+1)\lambda_t A_t B x_t^{\alpha} + (1-\delta)\beta E_t \left\{\lambda_{t+1} A_{t+1} B x_{t+1}^{\alpha}\left[1+\alpha(1-x_{t+1})\right]\right\} \tag{3.48}$$

From (3.47):

$$\frac{1}{C_t} = \lambda_t \tag{3.49}$$

Substituting (3.49) into (3.48)

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

$$\chi C_t N_t^{\phi} \leq A_t - (1+\alpha) A_t B x_t^{\alpha} + (1-\delta)\beta E_t \left\{\frac{C_t}{C_{t+1}} A_{t+1} B x_{t+1}^{\alpha}\left[1+\alpha(1-x_{t+1})\right]\right\} \tag{3.50}$$

which is the optimality condition for the social planner

Nash bargained wage

$$\mathcal{V}_t^N = W_t - \chi C_t N_t^{\phi} + \beta E_t \left\{\frac{C_t}{C_{t+1}}\left[\left(1-\delta(1-x_{t+1})\right)\mathcal{V}_{t+1}^N + \delta(1-x_{t+1})\mathcal{V}_{t+1}^U\right]\right\} \tag{3.51}$$

and

$$\mathcal{V}_t^U = \beta E_t \left\{\frac{C_t}{C_{t+1}}\left[x_{t+1}\mathcal{V}_t^N + (1-x_{t+1})\mathcal{V}_{t+1}^U\right]\right\} \tag{3.52}$$

The surplus from an established employment relationship is given by:

$$\mathcal{S}_t^H = W_t - \chi C_t N_t^{\phi} + \beta E_t \left\{\tfrac{C_t}{C_{t+1}}\left[\begin{array}{c}\left(1-\delta(1-x_{t+1})\right)\mathcal{V}_{t+1}^N + \delta(1-x_{t+1})\mathcal{V}_{t+1}^U \\ -x_{t+1}\mathcal{V}_t^N - (1-x_{t+1})\mathcal{V}_{t+1}^U\end{array}\right]\right\}$$

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

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

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

$$\mathcal{S}_t^H = W_t - \chi C_t N_t^{\phi} + \beta(1-\delta)E_t\left\{\frac{C_t}{C_{t+1}}(1-x_{t+1})\mathcal{S}_{t+1}^H\right\} \tag{3.53}$$

Nash bargaining must satisfy

$$\mathcal{S}_t^H = \vartheta \mathcal{S}_t^F \tag{3.54}$$

Combining (3.53) and (3.54) and given that $\mathcal{S}_t^H = A_t B x_t^{\alpha}$

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

$$W_t = \chi C_t N_t^{\phi} + \vartheta\left(A_t B x_t^{\alpha} - \beta(1-\delta)E_t\left\{\frac{C_t}{C_{t+1}}(1-x_{t+1})A_{t+1}Bx_{t+1}^{\alpha}\right\}\right) \tag{3.55}$$

which gives the Nash bargained wage

The equilibrium consistent with the Nash bargained wage

Combining 3.55) and the condition for profit maximization by final goods producers given by

$$Bx_t^{\alpha} = \left(\frac{1}{\mathcal{M}} - \frac{W_t}{A_t}\right) + \beta(1-\delta)E_t\left(\frac{C_t}{C_{t+1}}\frac{A_{t+1}}{A_t}Bx_{t+1}^{\alpha}\right) \tag{3.56}$$

we therefore obtain

$$Bx_t^{\alpha} = \tfrac{1}{\mathcal{M}} - \tfrac{1}{A_t}\left[\chi C_t N_t^{\phi} + \vartheta\left(A_t B x_t^{\alpha} - \beta(1-\delta)E_t\left\{\tfrac{C_t}{C_{t+1}}(1-x_{t+1})A_{t+1}Bx_{t+1}^{\alpha}\right\}\right)\right]$$
$$+\beta(1-\delta)E_t\left(\tfrac{C_t}{C_{t+1}}\tfrac{A_{t+1}}{A_t}Bx_{t+1}^{\alpha}\right)$$
$$Bx_t^{\alpha} = \tfrac{1}{\mathcal{M}} - \tfrac{\chi C_t N_t^{\phi}}{A_t} - \vartheta Bx_t^{\alpha} + \vartheta\beta(1-\delta)E_t\left\{\tfrac{C_t}{C_{t+1}}\tfrac{A_{t+1}}{A_t}(1-x_{t+1})Bx_{t+1}^{\alpha}\right\} + \beta(1-\delta)E_t\left(\tfrac{C_t}{C_{t+1}}\tfrac{A_{t+1}}{A_t}Bx_{t+1}^{\alpha}\right)$$
$$Bx_t^{\alpha} = \tfrac{1}{\mathcal{M}} - \tfrac{\chi C_t N_t^{\phi}}{A_t} - \vartheta Bx_t^{\alpha} + \beta(1-\delta)E_t\left\{\tfrac{C_t}{C_{t+1}}\tfrac{A_{t+1}}{A_t}\left[\vartheta(1-x_{t+1})Bx_{t+1}^{\alpha} + Bx_{t+1}^{\alpha}\right]\right\}$$
$$Bx_t^{\alpha} = \tfrac{1}{\mathcal{M}} - \tfrac{\chi C_t N_t^{\phi}}{A_t} - \vartheta Bx_t^{\alpha} + \beta(1-\delta)E_t\left\{\tfrac{C_t}{C_{t+1}}\tfrac{A_{t+1}}{A_t}Bx_{t+1}^{\alpha}\left[\vartheta(1-x_{t+1})+1\right]\right\}$$
$$\tfrac{\chi C_t N_t^{\phi}}{A_t} = \tfrac{1}{\mathcal{M}} - Bx_t^{\alpha} - \vartheta Bx_t^{\alpha} + \beta(1-\delta)E_t\left\{\tfrac{C_t}{C_{t+1}}\tfrac{A_{t+1}}{A_t}Bx_{t+1}^{\alpha}\left[1+\vartheta(1-x_{t+1})\right]\right\}$$

$\frac{\chi C_t N_t^{\phi}}{A_t} = \frac{1}{\mathcal{M}} - (1+\vartheta)Bx_t^{\alpha} + \beta(1-\delta)E_t\left\{\frac{C_t}{C_{t+1}}\frac{A_{t+1}}{A_t}Bx_{t+1}^{\alpha}\left[1+\vartheta(1-x_{t+1})\right]\right\}$

$$\chi C_t N_t^{\phi} = \frac{A_t}{\mathcal{M}} - (1+\vartheta)A_t Bx_t^{\alpha} + \beta(1-\delta)E_t\left\{\frac{C_t}{C_{t+1}}A_{t+1}Bx_{t+1}^{\alpha}\left[1+\vartheta(1-x_{t+1})\right]\right\} \tag{3.57}$$

which is the equilibrium consistent with the Nash bargained wage

Real wage rigidities

Let

$$W_t = \Theta A_t^{1-\gamma} \tag{3.58}$$

where $\Theta \equiv \left(\left(\frac{1}{\mathcal{M}}\right) - (1-\beta(1-\delta))Bx^{\alpha}\right)A^{\gamma}$

Combining (3.56) and (3.58)

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

$$\Theta A_t^{1-\gamma} = \frac{1}{\mathcal{M}} - Bx_t^{\alpha} + \beta(1-\delta)E_t\left(\frac{C_t}{C_{t+1}}\frac{A_{t+1}}{A_t}Bx_{t+1}^{\alpha}\right) \tag{3.59}$$

Log linearization and Phillips Curve

Marginal Cost

Intermediate goods producers profit maximization condition

$$\left(\frac{P_t^I}{P_t}\right)A_t = W_t + G_t - \beta(1-\delta)E_t\left(\frac{C_t}{C_{t+1}}G_{t+1}\right) \tag{3.60}$$

where $G_{t+1} = A_{t+1}Bx_{t+1}^{\alpha}$

let $MC_t = \frac{P_t^I}{P_t}$ be the real marginal cost.

Combining (3.59) and (3.60) gives

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

$$MC_t = \Theta A_t^{-\gamma} + Bx_t^{\alpha} - \beta(1-\delta)E_t\left(\frac{C_t}{C_{t+1}}\frac{A_{t+1}}{A_t}Bx_{t+1}^{\alpha}\right) \tag{3.61}$$

From (3.61)

$MC_t = \left(\frac{1}{\mathcal{M}} - \left(1-\beta\left(1-\delta\right)\right)Bx^{\alpha}\right)A^{\gamma}A_t^{-\gamma} + Bx_t^{\alpha} - \beta(1-\delta)E_t\left(\frac{C_t}{C_{t+1}}\frac{A_{t+1}}{A_t}Bx_{t+1}^{\alpha}\right)$
$dMC_t = -\gamma\left(\frac{1}{\mathcal{M}} - \left(1-\beta\left(1-\delta\right)\right)Bx^{\alpha}\right)A^{\gamma}A_t^{-\gamma-1}dA_t + \alpha Bx_t^{\alpha-1}dx_t - \beta(1-\delta)$
$E_t\left\{\frac{dC_tC-CdC_{t+1}}{C^2}\frac{A}{A}Bx^{\alpha} + \frac{dA_{t+1}A-AdA_t}{A^2}\frac{C}{C}Bx^{\alpha} + \frac{C}{C}\frac{A}{A}Bx^{\alpha-1}dx_{t+1}\right\}$

Let $g = Bx^{\alpha}$

$dMC_t = -\gamma\left(\frac{1}{\mathcal{M}} - \left(1-\beta\left(1-\delta\right)\right)g\right)\frac{dA_t}{A} + \alpha g\frac{dx_t}{x} - \beta(1-\delta)$
$E_t\left\{\left(\frac{dC_t}{C} - \frac{dC_{t+1}}{C}\right)g + \left(\frac{dA_{t+1}}{A} - \frac{dA_t}{A}\right)g + \alpha g\frac{dx_{t+1}}{x}\right\}$

$$dMC_t = -\gamma\left(\frac{1}{\mathcal{M}} - \left(1-\beta\left(1-\delta\right)\right)g\right)\widehat{a}_t + \alpha g\widehat{x}_t - \beta(1-\delta)gE_t\left\{\left(\widehat{c}_t - \widehat{a}_t\right) - \left(\widehat{c}_{t+1} - \widehat{a}_{t+1}\right) + \alpha\widehat{x}_{t+1}\right\} \tag{3.62}$$

Let MC be the unconditional mean of MC_t, given by

$MC = \left(\frac{1}{\mathcal{M}} - \left(1-\beta\left(1-\delta\right)\right)g\right) + g - \beta(1-\delta)g$

$MC = \frac{1}{\mathcal{M}} - g - \beta\left(1-\delta\right)g + g - \beta(1-\delta)g$

$$MC = \frac{1}{\mathcal{M}} \tag{3.63}$$

(3.63) into (3.62)

$\frac{dMC_t}{MC} = -\gamma\left(\frac{1}{\mathcal{M}} - \left(1-\beta\left(1-\delta\right)\right)g\right)\mathcal{M}\widehat{a}_t + \alpha g\mathcal{M}\widehat{x}_t - \beta(1-\delta)g\mathcal{M}E_t\left\{\begin{array}{c}\left(\widehat{c}_t - \widehat{a}_t\right) - \\ \left(\widehat{c}_{t+1} - \widehat{a}_{t+1}\right) + \alpha\widehat{x}_{t+1}\end{array}\right\}$

$\frac{dMC_t}{MC} = -\gamma\left(1-\left(1-\beta\left(1-\delta\right)\right)g\mathcal{M}\right)\widehat{a}_t + \alpha g\mathcal{M}\widehat{x}_t - \beta(1-\delta)g\mathcal{M}E_t\left\{(\widehat{c}_t-\widehat{a}_t)-(\widehat{c}_{t+1}-\widehat{a}_{t+1})+\alpha\widehat{x}_{t+1}\right\}$

Assuming $\Phi = \left(1-\beta\left(1-\delta\right)\right)g\mathcal{M}$

$$\widehat{mc}_t = \alpha g\mathcal{M}\widehat{x}_t - \beta(1-\delta)g\mathcal{M}E_t\left\{(\widehat{c}_t-\widehat{a}_t)-(\widehat{c}_{t+1}-\widehat{a}_{t+1})+\alpha\widehat{x}_{t+1}\right\} - \gamma\Phi\widehat{a}_t \tag{3.64}$$

Log linearization of the labour market tightness index

$x_t = \frac{H_t}{U_t}$

$x_t = \frac{[N_t-(1-\delta)N_{t-1}]}{[1-(1-\delta)N_{t-1}]}$

$dx_t = \frac{[dN_t-(1-\delta)dN_{t-1}][1-(1-\delta)N]+(1-\delta)dN_{t-1}\delta N}{[1-(1-\delta)N]}$

where $x = \frac{\delta N}{[1-(1-\delta)N]}$ is the unconditional mean of x_t

$dx_t = \frac{\delta N}{[1-(1-\delta)N]}\left[\widehat{n}_t-(1-\delta)\widehat{n}_{t-1}+(1-\delta)x\widehat{n}_{t-1}\right]$

$\delta dx_t = \frac{\delta N}{[1-(1-\delta)N]}\left[\widehat{n}_t-(1-\delta-x+x\delta)\widehat{n}_{t-1}\right]$

$\delta dx_t = x\left[\widehat{n}_t-(1-\delta)(1-x)\widehat{n}_{t-1}\right]$

$\frac{\delta dx_t}{x} = \widehat{n}_t-(1-\delta)(1-x)\widehat{n}_{t-1}$

$$\delta\widehat{x}_t = \widehat{n}_t-(1-\delta)(1-x)\widehat{n}_{t-1} \tag{3.65}$$

Log linearization of the resource constraint

$C_t = A_t\left(N_t - Bx_t^{\alpha}H_t\right)$

$C_t = A_tN_t - A_tBx_t^{\alpha}(N_t-(1-\delta)N_{t-1})$

$C_t = A_tN_t - A_tBx_t^{\alpha}N_t - A_tBx_t^{\alpha}(1-\delta)N_{t-1}$

$dC_t = NdA_t + AdN_t - (Bx^{\alpha}NdA_t + AN\alpha Bx^{\alpha-1}dx_t + Bx^{\alpha}AdN_t) + (1-\delta)(Bx^{\alpha}NdA_t + AN\alpha Bx^{\alpha-1}dx_t + Bx^{\alpha}AdN_{t-1})$

$dC_t = AN\frac{dA_t}{A} + AN\frac{dN_t}{N} - \left(gAN\frac{dA_t}{A} + \alpha gAN\frac{dx_t}{x} + gAN\frac{dN_t}{N}\right) + (1-\delta)\begin{pmatrix} gAN\frac{dA_t}{A} + \\ \alpha gAN\frac{dx_t}{x} + gAN\frac{dN_{t-1}}{N}\end{pmatrix}$

$dC_t = AN\widehat{a}_t + AN\widehat{n}_t - ANg\widehat{a}_t - \alpha gAN\widehat{x}_t - gAN\widehat{n}_t + (1-\delta)gAN\widehat{a}_t + \alpha(1-\delta)gAN\widehat{x}_t + (1-\delta)gAN\widehat{n}_{t-1}$

$dC_t = (1 + g - g - \delta g)AN\widehat{a}_t + (1-g)AN\widehat{n}_t + (1-\delta)gAN\widehat{n}_{t-1} - (1-1+\delta)\alpha gAN\widehat{x}_t$

$$dC_t = (1-\delta g)AN\widehat{a}_t + (1-g)AN\widehat{n}_t + (1-\delta)gAN\widehat{n}_{t-1} - \delta\alpha gAN\widehat{x}_t \tag{3.66}$$

Let C be the unconditional mean of C_t, given by

$C = AN - ANg + ANg - \delta ANg$

$C = AN - \delta ANg$

$$C = (1-\delta g)AN \tag{3.67}$$

Dividing both sides of (3.66) by (3.67)

$\frac{dC_t}{C} = \frac{(1-\delta g)AN}{(1-\delta g)AN}\widehat{a}_t + \frac{(1-g)AN}{(1-\delta g)AN}\widehat{n}_t + \frac{(1-\delta)gAN}{(1-\delta g)AN}\widehat{n}_{t-1} - \frac{\delta\alpha gAN}{(1-\delta g)AN}\widehat{x}_t$

$$\widehat{c}_t = \widehat{a}_t + \frac{1-g}{1-\delta g}\widehat{n}_t + \frac{(1-\delta)g}{1-\delta g}\widehat{n}_{t-1} - \frac{\alpha g}{1-\delta g}\delta\widehat{x}_t \tag{3.68}$$

Log linearization of the Consumer's first order condition

From (3.46)

$Q_t = \beta E_t \left\{ \frac{P_t}{P_{t+1}} \frac{Ct}{C_{t+1}} \right\}$

Taking the log gives

$\log Q_t = \log\beta + \log P_t - \log P_{t+1} + \log C_t - \log C_{t+1}$

$$\log C_t = \log Q_t - \log\beta + \log P_{t+1} - \log P_t + \log C_{t+1} \tag{3.69}$$

Let $-\log \beta = \rho$. Also following Gali (2006), let $\log Q_t = -i$, the short term nominal interest rate. By following the notation consistent with Blanchard and Gali (2010), we may write (3.69) as

$\widehat{c}_t = -i + \rho + E_t\left\{\pi_{t+1}\right\} + E_t\left\{\widehat{c}_{t+1}\right\}$

$$\widehat{c}_t = E_t\left\{\widehat{c}_{t+1}\right\} - \left(i - E_t\left\{\pi_{t+1}\right\} - \rho\right) \tag{3.70}$$

Determination of the Phillips Curve

Let$\pi_t = \beta E_t\left\{\pi_{t+1}\right\} + \lambda \widehat{mc}_t$. λ here is defined as follows $\lambda \equiv (1-\beta\theta)(1-\theta)/\theta$

Combining (3.65) and (3.68)

$\widehat{c}_t = \widehat{a}_t + \frac{1-g}{1-\delta g}\widehat{n}_t + \frac{(1-\delta)g}{1-\delta g}\widehat{n}_{t-1} - \frac{\alpha g}{1-\delta g}\left[\widehat{n}_t - (1-\delta)(1-x)\widehat{n}_{t-1}\right]$
$\widehat{c}_t = \widehat{a}_t + \frac{1-g}{1-\delta g}\widehat{n}_t - \frac{\alpha g}{1-\delta g}\widehat{n}_t + \frac{(1-\delta)g}{1-\delta g}\widehat{n}_{t-1} + \frac{\alpha g}{1-\delta g}(1-\delta)(1-x)\widehat{n}_{t-1}$
$\widehat{c}_t = \widehat{a}_t + \frac{1-g-\alpha g}{1-\delta g}\widehat{n}_t + \frac{(1-\delta)g+\alpha g(1-\delta)(1-x)}{1-\delta g}\widehat{n}_{t-1}$
$\widehat{c}_t = \widehat{a}_t + \frac{1-(1+\alpha)g}{1-\delta g}\widehat{n}_t + \frac{(1-\delta)g(1+\alpha(1-x))}{1-\delta g}\widehat{n}_{t-1}$

Let $\xi_0 \equiv \left(1 - g(1+\alpha)\right)/(1-\delta g)$ and $\xi_1 \equiv \left(g(1-\delta)\right)\left(1 + \alpha(1-x)\right)/(1-\delta g)$

Hence

$$\widehat{c}_t = \widehat{a}_t + \xi_0\widehat{n}_t + \xi_1\widehat{n}_{t-1} \tag{3.71}$$

(3.68) and (3.71) into (3.64)

$\widehat{mc}_t = \frac{\alpha g\mathcal{M}}{\delta}\left[\widehat{n}_t - (1-\delta)(1-x)\widehat{n}_{t-1}\right] - \beta(1-\delta)g\mathcal{M}$
$E_t\left\{(\widehat{a}_t + \xi_0\widehat{n}_t + \xi_1\widehat{n}_{t-1} - \widehat{a}_t) - (\widehat{a}_{t+1} + \xi_0\widehat{n}_{t+1} + \xi_1\widehat{n}_t - \widehat{a}_{t+1}) + \frac{\alpha}{\delta}\left[\widehat{n}_{t+1} - (1-\delta)(1-x)\widehat{n}_t\right]\right\} - \gamma\Phi\widehat{a}_t$
$\widehat{mc}_t = \frac{\alpha g\mathcal{M}}{\delta}\widehat{n}_t - \frac{\alpha g\mathcal{M}(1-\delta)(1-x)}{\delta}\widehat{n}_{t-1} - \beta(1-\delta)g\mathcal{M}E_t\left\{\begin{array}{c}\xi_1\widehat{n}_{t-1}+\\ \left(\xi_0 - \xi_1 - \frac{\alpha(1-\delta)(1-x)}{\delta}\right)\widehat{n}_t + \left(\frac{\alpha}{\delta} - \xi_0\right)\widehat{n}_{t+1}\end{array}\right\} -$
$\gamma\Phi\widehat{a}_t$

$\widehat{mc}_t = \left[\frac{\alpha g\mathcal{M}}{\delta} + \beta(1-\delta)g\mathcal{M}\left(\xi_1 - \xi_0 + \frac{\alpha(1-\delta)(1-x)}{\delta}\right)\right]\widehat{n}_t - \left[\begin{array}{c}\frac{\alpha g\mathcal{M}}{\delta}(1-\delta)(1-x)+\\ \beta(1-\delta)g\mathcal{M}\xi_1\end{array}\right]\widehat{n}_{t-1} - \beta(1-\delta)g\mathcal{M}\left(\frac{\alpha}{\delta} - \xi_0\right)E_t\{$
$\gamma\Phi\widehat{a}_t$

$$\widehat{mc}_t = \left[\frac{\alpha g\mathcal{M}}{\delta}\left(1+\alpha\beta(1-\delta)^2(1-x)\right)+\beta(1-\delta)g\mathcal{M}(\xi_1-\xi_0)\right]\widehat{n}_t -$$
$$\left[\frac{\alpha g\mathcal{M}}{\delta}(1-\delta)(1-x)+\beta(1-\delta)g\mathcal{M}\xi_1\right]\widehat{n}_{t-1}-\beta(1-\delta)g\mathcal{M}\left(\frac{\alpha}{\delta}-\xi_0\right)E_t\left\{\widehat{n}_{t+1}\right\}-\gamma\Phi\widehat{a}_t$$

Let

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

Therefore

$$\widehat{mc}_t = h_0\widehat{n}_t + h_L\widehat{n}_{t-1} + h_F E_t\left\{\widehat{n}_{t+1}\right\} - \gamma\Phi\widehat{a}_t \tag{3.72}$$

Substituting (3.72) in the expression for inflation above

$$\pi_t = \beta E_t\left\{\pi_{t+1}\right\} + \lambda h_0\widehat{n}_t + \lambda h_L\widehat{n}_{t-1} + \lambda h_F E_t\left\{\widehat{n}_{t+1}\right\} - \lambda\Phi\gamma\widehat{a}_t$$

Given that $\widehat{u}_t = -(1-u)\widehat{n}_t$,

$$\pi_t = \beta E_t\left\{\pi_{t+1}\right\} - \frac{\lambda h_0}{1-u}\widehat{u}_t - \frac{\lambda h_L}{1-u}\widehat{u}_{t-1} - \frac{\lambda h_F}{1-u}E_t\left\{\widehat{u}_{t+1}\right\} - \lambda\Phi\gamma\widehat{a}_t$$

Let

$$\kappa_0 \equiv \frac{\lambda h_0}{1-u}\widehat{u}_t$$
$$\kappa_L \equiv -\frac{\lambda h_L}{1-u}$$
$$\kappa_F \equiv -\frac{\lambda h_F}{1-u}$$

The Phillips Curve implied by the proposed study is therefore given by:

$$\pi_t = \beta E_t\left\{\pi_{t+1}\right\} - \kappa_0\widehat{u}_t + \kappa_L\widehat{u}_{t-1} + \kappa_F E_t\left\{\widehat{u}_{t+1}\right\} - \lambda\Phi\gamma\widehat{a}_t \tag{3.73}$$

3.9 Appendix B

ADDITIONAL IMPULSE RESPONSES

Figure 1B: Productivity shock

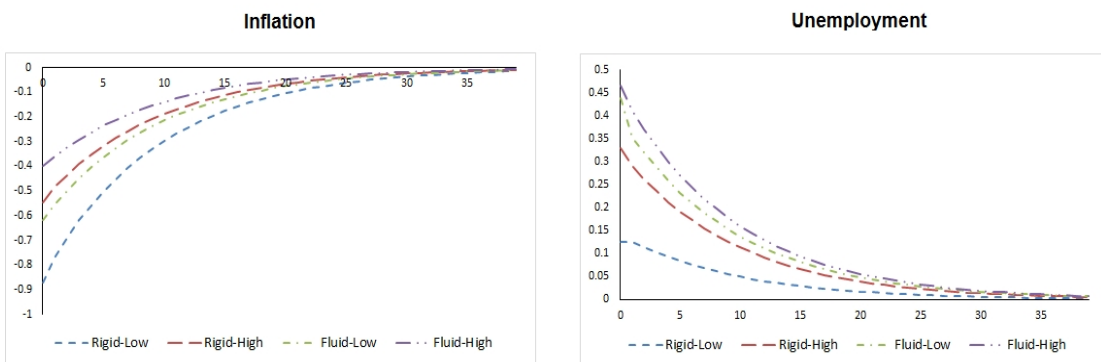


Figure 2B: Demand shock

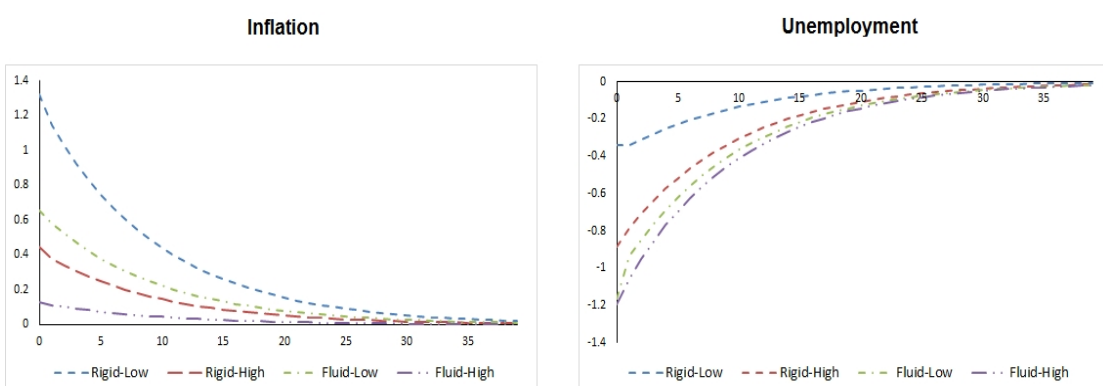


Table 1B: Welfare Loss

	Rigid-Low		Rigid-High		Fluid-Low		Fluid-High	
	STR	OTR	STR	OTR	STR	OTR	STR	OTR
Monetary shock	8.92	4.02	4.78	1.89	7.88	1.26	7.86	1.65
Productivity shock	3.79	1.32	2	0.99	2.73	0.98	1.87	0.84
Preference shock	8.92	4.02	4.78	1.89	7.88	1.24	7.08	1.66

Notes: STR: Simple Taylor Rule; OTR: Optimized Taylor Rule

Chapter 4

Labour Market Effects of Public Employment

Abstract

This chapter investigates the effects of private sector productivity and public sector wage shocks on a calibrated South Africa's labour market. We do so using a DSGE model with two sectors of a labour market composed of skilled and unskilled individuals as we study how the difference in bargaining power, and in productivity efficiency between public and private sectors impact the responsiveness of variables.

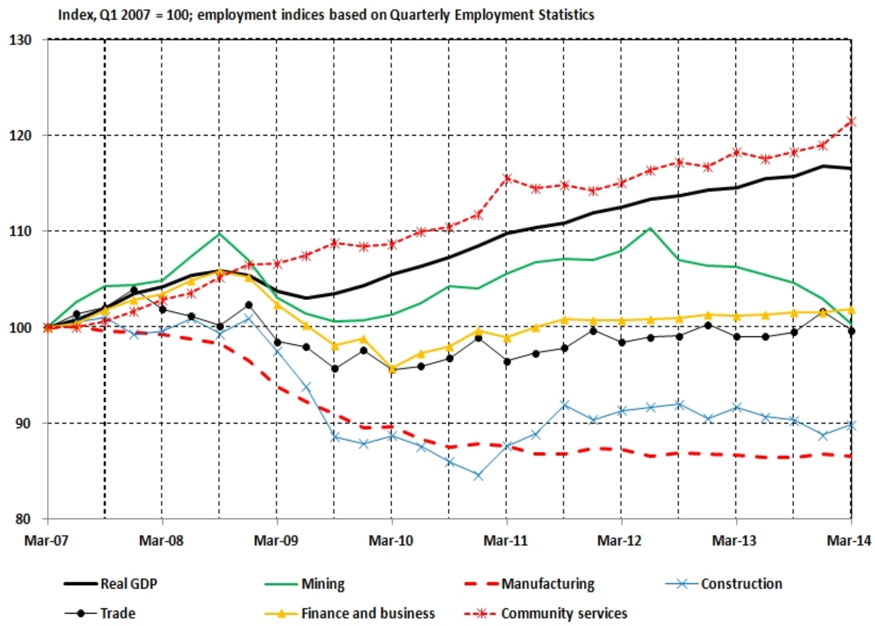
The findings show that an increase in private sector productivity produces more desirable results with an increase in employment for both skilled and unskilled workers which translates into a decrease in overall unemployment. Public sector wage shock on the other hand mainly crowds out private skilled labour which the firms react to by substituting it with unskilled workers. Ultimately, the increase in public wages raises overall unemployment as supplementary skilled unemployed individuals queue for public jobs. Altogether, the effects are more pronounced when the bargaining power of unskilled workers is raised. Also, when productivity efficiency is lower in the public sector compared to the private, a public wage shock leads to more skilled individuals queuing for public sector jobs. Finally, public wage premium generates an incentive for private sector workers to demand higher wages, which contributes to the presence of wage rigidities and labour shedding in the private sector during recessions.

4.1 Introduction

The end of the Apartheid era signaled the beginning of the implementation of the new government's policies with a primal focus on significantly reducing inequalities inherited from the previous regime. These drastic measures had two main impacts on labour market dynamics regarding public employment. First of all, the government embarked into reforms that had the principal objective of recruiting individuals from previously disadvantaged groups. As a result, the public sector expanded rapidly to became in 1994 the largest single entity to absorb formal employment in South Africa; with public employment accounting for 14.2 percent of total employment (Hassen and Altman, 2010). Secondly the public sector preponderantly hired skilled individuals which turned the sector rather predominantly skilled intensive. Given these premises, this chapter raises two questions. How do these two particular features of public employment affect overall labour market dynamics in South Africa? Moreover, could the fact that the public sector is for the most part skilled workers intensive, and the existence of the public wage premium contribute partly in explaining the rigidities in private sector wages as found in chapter 2?

Two decades after 1994, the public sector in South Africa continued its expansion and in 2014, 17.5 percent of all employees worked in the public sector. This number is in line with various OECD countries where the percentage of workers in the public sector ranges from 10 to 30 percent of total employment (Gomes, 2013). Evidence from after the 2008 financial crisis in the US shows that the number of individuals seeking jobs in the public sector increased in recent years mainly for two reasons. First, more individuals turned to public sector where the salaries were higher as private sector wages significantly dropped in the aftermath of the crisis. Second, as the rate of job destruction was increasing in the private sector, government institutions continued to hire. The graph below shows a comparative performance of selected industrial sectors regarding employment and the real GDP in South Africa between 2007 and 2014.

Figure 1: Industrial sectors employment performance and real GDP



Source: Stats SA - Youth employment, unemployment, skills and economic growth, 1994-2014

Note that the employment figures in this graph are from the formal economy only. The most striking feature of this picture is that in the aftermath of the 2008 financial crisis, the employment growth has been well below the real GDP growth in most sectors. Only the community, social and personal services sector, which as mentioned earlier is predominantly constituted of public sector firms, experienced higher growth in jobs relative to the real GDP. The manufacturing sector performance is dramatic and perhaps the worst compared with other sectors performances. Indeed, it is reported that the sector employed 13 percent less workers in 2014 compared with the figure in 1994. The quarterly labour force survey data in South Africa further emphasizes that since the fourth quarter of 2008, private sector employment has decreased by 4.5 percent whereas public sector employment has risen by 11.1 percent. Two reasons may explain this behaviour. First, wages in the private sector have fallen while public wages have been on a steady rise. Second, more jobs are now available in the public compared to the private sector as reported by Duncan (2013) - 314 000 jobs added in the public sector against 268 000 in the private sector. In particular, the public sector is more attractive with better working conditions, therefore resulting in a crowding out effect on private sector employment.

In this chapter, we use a DSGE model with search and matching frictions in two sectors composed of skilled and unskilled workers to primarily analyze the labour market effects of a positive public sector wage shock in a calibrated model to reflect South Africa's economy. We also assess the impact of an increase in productivity in the private sector for comparison purposes. The findings show that a private sector productivity shock produces more desirable results with a decrease in overall unemployment, a surge in employment for both skilled and unskilled workers and an overall increase in the private sector production. The public sector wage shock on the other hand mainly crowds out skilled private sector employment which is substituted by cheaper unskilled labour, as skilled workers move to the public sector. In all cases, the effects are more pronounced the higher the bargaining power of unskilled workers. Furthermore, when productivity is low in the public sector compared to the private, a public wage shock leads to more skilled individuals queuing for public sector jobs.

Public wage premium as a source of private employment crowding out for starters raises the issue of the gap between private and public sector wages. This issue has been addressed in the South African literature by a couple of studies including Woolard (2002), Bosch (2006), Kerr and Teal (2012) and more recently by Kwenda and Ntuli (2015). In particular, Kwenda and Ntuli (2015) argue that the public sector is able to attract workers with better endowments. Furthermore, in an attempt to pursue wage equality, South Africa's government faces a major setback in terms of the forgone opportunity to pursue competitive or profit based wage setting procedures as it is the case for private firms. Consequently, the public sector ends up paying more than the private in a consistent basis. Such a high public wage bill has a significant blow regarding labour market efficiency and overall economic performance.

At an international level, the following studies essentially conclude that the public sector has a non negligible negative impact on private sector employment: Holmlund & Linden (1993), Calmford and Lang (1995), Finn (1988), Algan *et al (*2002), and Gomes (2013). Gomes (2013) for instance finds that raising wages in the public sector turns the sector more appealing and workers have an incentive to move from private sector jobs. Further, he argues that the government faces some sort of dilemma. In essence, by offering high wages, the government induces too many unemployed to queue for public jobs, ultimately raising unemployment. On the other hand, if the wages are too low, the government faces recruitment problems. Gomes (2013) goes on to argue that there is an urgent need of designing an optimal policy as the government's wage policy plays a key role in attaining the efficient allocation. Basically, over the business cycle, it is optimal to have procyclical public sector wages. Thus, public sector wages should closely follow the evolution of wages in the private sector. Failure to do so may lead to an undesirable and highly volatile unemployment.

The South African case in general diverges from current available literature for two main reasons. First off, there is an important dynamic of unskilled individuals in the labour market that is crucial to take into account. Second, the considerable collective bargaining power of unions in wage settlement is the other important concept to consider in this analysis. The first point has been discussed by Canova and Ravn (1998) to a certain extent as they analyze the macroeconomic effects of German unification. However, the workers (skilled and low skilled) are not employed by the government in their model. The issue of a unionized labour market has also been tackled by Ehrenberg and Schwarz (1986), Borland (1999) and Ardagna (2007) amongst others. These papers however do not separate between skilled and unskilled agents.

The rest of the paper is organized as follows. The second section discusses the development in the South African public sector regarding its expansion in terms of employment. We also cover in this section the public wage premium and the theoretical effects of public employment. Section 3 lays down the model following Gomes (2013). We begin however by giving a brief overview of the assumptions that depart from the original framework and therefore allows us to apply it to the South African economy. We parameterize the model in section 4 to match the South African economy as much as possible. Section 5 discusses the impulse responses and we explore the optimal policy response and the contributing role of public wage premium in explaining wage rigidities in section 6. Section 7 concludes.

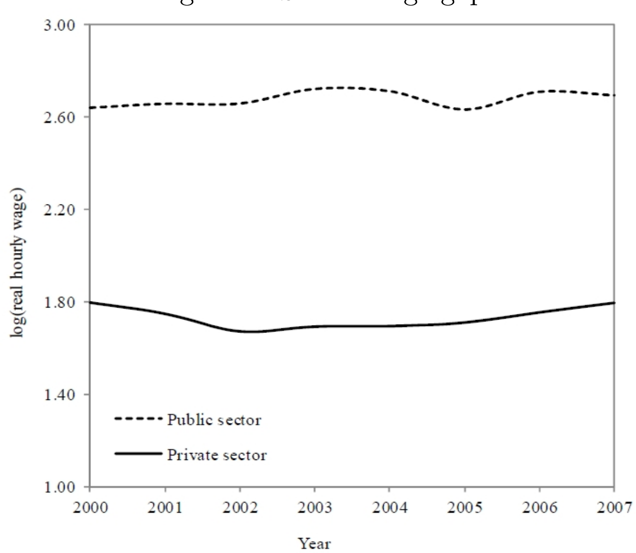
4.2 Public employment effects: theory and stylized facts

As mentioned in the introduction, an intensive recruitment by the new government targeting previously disadvantaged groups occurred in South Africa at the end of the Apartheid regime which resulted in a drastic expansion of the public sector. The fact that this recruitment preponderant focus was on skilled workers shaped the labour market. Therefore the demand for low skilled workers in the public sector decreased dramatically, hence contributing in part to the structural nature of unemployment in South Africa. Hassen and Altman (2010) give an overview of the public sector between 1994 and 2009.

They mainly argue that since 1994, the public sector has been the largest single entity to absorb formal employment the most. The authors report that public employment accounted for 14.2 percent of total employment before it significantly declined in 2006 to about 10 percent. However between 2007 and 2008, the share of general government to total employment rose to reach 13.5 percent. Recent statistics from the quarterly labour force survey reveal that in the aftermath of the 2008 financial crisis, the public sector acted as the principal creator of jobs when private sector firms performed below par. Thus, in 2014 public sector employment accounted for 17.5 percent of total jobs in South Africa, therefore surpassing its highest recorded level in 1994. Contrary to the events of 1994, most jobs created after the 2008 financial crisis were in favour of low and medium skilled workers, with a relatively smaller share for skilled individuals. Although this is the case, the public sector remains predominantly skilled workers intensive.

Bhorat *et al* (2015) outline that 45 percent of all public sector employees fall into the top three occupational categories that require a certain level of skills set. Skilled individuals in the private sector on the other hand account for a small 26 percent. These findings are similar to that of Hassen and Altman (2010) and Kwenda and Ntuli (2015). The latter argue that the difference of skills between the two sectors explain for the sectoral wage gap, with wages significantly higher in the public than in the private sector as they show in the figure below.

Figure 2: Sector wage gap



Source: Kwenda and Ntuli (2015)

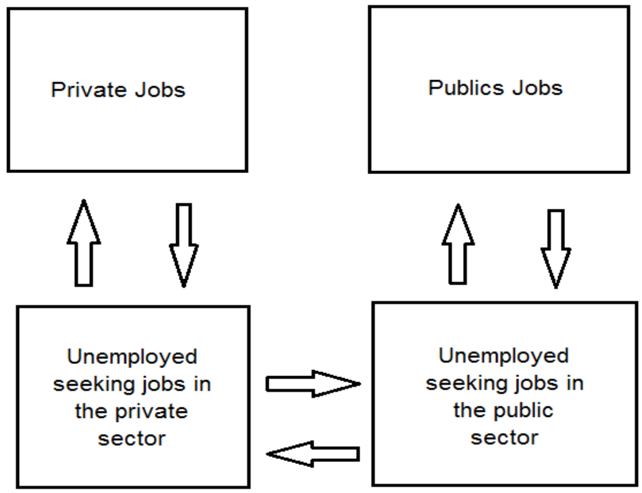
A direct comparison of wages between public and private sectors in selected Europe countries shows that government employees earn about 15 percent more than private sector workers. This wage gap is explained by the fact that public and private sectors are different in the kind of jobs they offer and the type of workers they hire. Furthermore, the two sectors differ in terms of job stability and income progression, two highly influential factors to take into account in individuals career choices (Postel-Vinay, 2015). Although South Africa may relate to European and US cases, the dynamics resulted from the large skill gap between workers may certainly influence the economy's performance.

The theory suggests that if private employment and labour force remain constant, an additional public job would result directly in a reduction of unemployment. However, public employment can also affect unemployment indirectly by essentially crowding out private employment through a couple of channels.

First of all, the goods produced by the two sectors can be substitutes. As it turns out, the crowding out effect of public jobs on private employment increases with the degree of substitutability between public and private production. Typically, one would expect that public employment is accountable for the fall in private jobs in countries where public sector jobs are more attractive. Furthermore, creating new jobs in the public sector increases the expected gains of the unemployed individuals. This in turn applies upward pressure on wages in the private sector which eventually decreases employment in the sector as pointed out by Holmlund and Linden (1993). Moreover, Algan *et al* (2002) argue that the cost of public jobs mainly implies an increase in public expenditure or public expenditure switching. This consequently may result in a reduction of the after tax profitability of firms for the former and that of public investment or infrastructure building for the latter. These reductions may eventually lead to a negative impact on productivity in the private sector, manifested by a fall in labour demand.

The figure below depicts labour market flows between public and private employment as reported by Algan *et al* (2002).

Figure 3: Labour market flows



In economies with a relatively small proportion of low skilled individuals, the unemployed can afford to choose which sector they intend to direct their search into. Their decision fundamentally depends on the favourability of economic conditions prevailing in the economy. For instance, if wages are higher in the public sector, the share of unemployed individuals seeking jobs in state owned firms may rise. On the other hand, an improvement in technology in the private sector may result in firms posting more vacancies, therefore making the sector more attractive.

4.3 Model

4.3.1 General assumptions

The model we adopt in this chapter is based on the simple and very comprehensive framework originally introduced by Gomes (2013). However, we make certain assumptions in this section to accommodate the framework to South African peculiar features. Consequently, we depart form the original framework on three points. First, we assume two sets of workers based on their skills level. Second, for simplicity, the public sector exclusively hires skilled workers. Finally, we take into account the role played by the level of workers' bargaining power. We discuss each points further in the next few paragraphs. To the best of our knowledge, no work of such a nature has been conducted in the South African literature at this stage.

Regarding the first point, we assume that the labour market consists of skilled and low skilled individuals. The importance of this differentiation arises from the fact that South Africa displays a shortage of crucial skilled individuals while the unskilled workers are abundant. Therefore, we cannot fully rely on the original model simply because doing so would not reflect one of the distinctive feature of the South African labour market. The table below reports skill groups as categorized by Statistics South Africa, which include the skilled, the semi-skilled, and the low-skilled.

Table 1: Composition of employment by skilled level

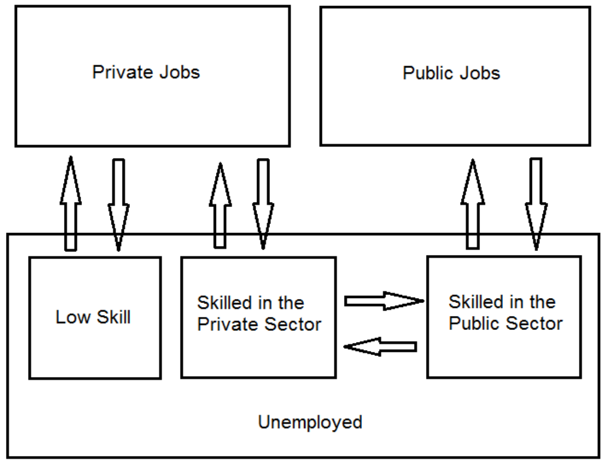
Skills level	Occupation	1994 (%of total)	2014 (% of total)	Change
Skilled	Manager, Professional	20.6%	25.2%	+4.6%
Semi-skilled	Clerk, Sales &Services	47%	46.6%	-0.8%
low-skilled	Elementary, Domestic worker	32.4%	28.5%	-3.9%

Source: The quarterly labour force survey

Although the proportion of skilled workers has improved in the past two decades, the growth rate remains noticeably sluggish. In addition, the amount of low skill individuals in the labour force slightly decreased but in 2014, it is still quantitatively massive relative to skilled individuals. This evidently has further implications in terms of labour market flows. The general consensus is that public sector jobs require a certain level of education and skill set. Private sector firms on the other hand may be forced to turn to cheap labour in their quest for profit maximization, depending on the suitability of economic conditions.

Based on these facts, we turn to the second important assumption of our model which is, for simplicity reasons, the public sector exclusively hires skilled workers whereby private firms have access to all type of workers. This assumption allows us to depict labour market flows as implied by our model. Accounting for skill gap dynamics alters the labour market flows described by Algan *et al* (2002) in the previous section.

Figure 4: Labour market with skill gap dynamics



Low skilled individuals cannot afford to direct their search in a sector other than the private unless improvement in their skills set. This assumption has various implications in terms of the functioning of the labour market and in particular, it may explain for the existential wage gap between low and skilled workers. Often referred to as the skilled wage premium, it is the basically the equivalent of the public wage premium since the public sector is mainly skilled workers intensive. Given the scarcity of skilled individuals, they are more likely to demand higher wages relative to low skilled workers. Since public sector firms provide better endowments, they are in a better position to attract skilled labour, especially during periods of recessions. Moreover, the increase in the demand for skilled workers which almost matched the decline in low skilled workers demand over the past few decades, further motivates our question to investigate the labour market effects of a public wage increase.

The final point on which we diverge from the original model of Gomes (2013) regards the level of bargaining power of workers. Indeed, we take a distinct interest in the role played by the bargaining power of workers in our setup. Wages in the private and public sectors are determined by collective bargaining of workers that are all represented by trade unions. It is reported that the unions power in South Africa when it comes to wage settlement with firms is relatively and significantly high, especially for low skilled workers (Schultz & Mwabu, 1998). As a result, wages are not really responsive to labour market conditions as unions are labelled too powerful for the country's level of income. Indeed, consistent evidence in the private sector reveals that during recession, adjustments are done through considerable job shedding rather than wage cuts that would allow the market to clear. This therefore incentivized us to take into account various level of bargaining power to assess its impact on the dynamics of the model.

4.3.2 General Setting

The model is a dynamic stochastic general equilibrium framework which accounts for public and private sectors as first illustrated by Gomes (2013). Rigidities enter the labour market in the form of search and matching frictions.

The labour force constitutes of many individuals $j \in [0,1]$ that are either skilled or unskilled ($n \in [s,u]$). They are either unemployed (u_t), skilled and employed by private sector firms ($l^p_{s,t}$), skilled and employed in the public sector ($l^g_{s,t}$), or unskilled and employed by private sector firms ($l^p_{u,t}$). Therefore the government only employs skilled workers:

$$1 = l^p_{s,t} + l^p_{u,t} + l^g_{s,t} + u_t \tag{4.1}$$

l_t is the total level of employment. Search and matching frictions present in the labour market prevent some of the unemployed individuals from finding jobs. Employment (skilled and unskilled) in both sectors evolves according to the number of new matches $m^i_{n,t}$ ($i \in [g,p]$) and the separation rates. Jobs are destroyed each period at a constant rate λ^i_n. Therefore:

$$l^i_{n,t+1} = (1 - \lambda^i_n) l^i_{n,t} + m^i_{n,t} \tag{4.2}$$

New matches are determined by the following Cobb-Douglas matching function:

$$m^i_{n,t} = \mu^i_n (u^i_{n,t})^{\eta^i_n} (v^i_{n,t})^{1-\eta^i_n} \tag{4.3}$$

The skilled individuals amongst the unemployed can afford to choose in which sector they wish to concentrate their search ($u^i_{s,t}$). The unemployed individuals with low skills are however restricted from doing so, given the assumption that public sector firms will only hire individuals with skills. $v^i_{n,t}$ denotes the vacancies in each sector for both sets of individuals, $\eta^i_{n,t}$ is the matching elasticity with respect to unemployment, while $\mu^i_{s,t}$ represents the matching efficiency. It is important at this stage to define a variable that captures the fraction of unemployed individuals with skills seeking public sector jobs which can be specified by:

$$s_t = \frac{u^g_{s,t}}{u_{s,t}}$$

Next the probabilities of vacancies being filled ($q^i_{n,t}$), the job finding rates conditional on searching in a particular sector which is only specific to skilled individuals ($p^i_{s,t}$), and the unconditional job finding rates ($f^i_{n,t}$), are defined such that they all depend on matching functions.

$$q^i_{n,t} = \frac{m^i_{n,t}}{v^i_{n,t}}, \quad p^i_{s,t} = \frac{m^i_{s,t}}{u^i_{s,t}}, \quad f^i_{n,t} = \frac{m^i_{n,t}}{u_t}$$

4.3.3 Households

We assume that the household live infinitely and consume both private consumption and public goods. Even though workers with low skills are not hired by government owned firms, they still consume public goods given that they are free. There is also a utility of unemployment with sensitivity parameter bigger in size for the low skilled individuals. This utility captures leisure and home production.

$$E_t \sum_{t=0}^{\infty} \beta^t \left[u(c_t, g_t) + v(u_t) \right] \tag{4.4}$$

where $\beta \in (0,1)$ is the discount factor. The budget constraint is given by:

$$c_t + B_{n,t} = (1 - r_{n,t-1}) B_{n,t-1} + w^p_{n,t} l^p_{n,t} + w^g_{s,t} l^g_{s,t} + \Pi_{n,t} \tag{4.5}$$

where $r_{n,t-1}$ is the real interest rate from period $t-1$, $B_{n,t}$ are the holdings of one period bonds. $w^i_{n,t} l^i_{n,t}$ is the total wage income from household members of skills set n working in sector i at time t. $\Pi_{n,t}$ denotes the lumps sum taxes that finance the government's wage bill as well as possible transfers from private sector firms. There are no unemployment benefits.

4.3.4 Workers

Skilled Workers

Each household's skilled member's value depends on their current state. Therefore the value of being employed in a particular sector is given by:

$$W^i_{s,t} = w^i_{s,t} + E_t\beta_{s,t,t+1}[(1-\lambda^i_s W^i_{s,t} + \lambda^i_s U^i_{s,t+1}] \tag{4.6}$$

where $\beta_{s,t,t+k} = \beta^k \frac{u_{n,c}(c_{t+k},g_{t+k})}{u_{n,c}(c_t,g_t)}$ is the stochastic discount factor. Essentially, the value of being employed for a skilled worker in a particular sector is a function of the current wage and the continuation value of the job, which in turns depends on the separation rate. Similarly, the value of being unemployed is given by:

$$U^i_{s,t} = \frac{\upsilon_{s,u}(u_t)}{u_{s,c}(c_t,g_t)} + E_t\beta_{s,t,t+1}[p^i_{s,t}W^i_{s,t+1} + (1-p^i_{s,t})U_{t+1}] \tag{4.7}$$

The above implies that the value of being unemployed for a skilled individual searching in a particular sector depends in essence on the probability of finding a job and the value of working in that sector. If the optimality assumption holds, then movements between the two sectors guarantee no additional gain for searching in one sector *vis-a-vis* the other.

$$U^p_{s,t} = U^g_{s,t} = U_{s,t} \tag{4.8}$$

This assumption allows to implicitly determine the share of the unemployed skilled individuals seeking jobs in each sector:

$$\frac{m^p_{s,t}E_t\beta_{s,t,t+1}[W^p_{s,t+1} - U_{s,t+1}]}{(1-s_t)} = \frac{m^g_{s,t}Et\beta_{s,t,t+1}[W^g_{s,t+1} - U_{st+1}]}{s_t} \tag{4.9}$$

An increase in the value of employment in the public sector which can be driven by either wage increases or a separation rate decrease, will raise s_t until there is no extra gain from searching in that sector. Also, wages in the public sector play an important role in the determination of the share of the unemployed seeking jobs in government institutions.

Low skilled workers

Similar to the skilled individuals, the unskilled also have a certain value depending on whether they are employed or unemployed.

$$W^p_{u,t} = w^p_{u,t} + E_t \beta_{u,t,t+1}[(1 - \lambda^p_u W^p_{u,t} + \lambda^p_u U^p_{u,t+1}] \tag{4.10}$$

where $\beta_{u,t,t+k} = \beta^k \frac{u_{u,c}(c_{t+k}, g_{t+k})}{u_{u,c}(c_t, g_t)}$.

$$U^p_{u,t} = \frac{\upsilon_{u,u}(u_t)}{u_{u,c}(c_t, g_t)} + E_t \beta_{u,t,t+1}[f^p_{u,t} W^p_{u,t+1} + (1 - f^p_{u,t}) U_{t+1}] \tag{4.11}$$

4.3.5 Private sector firms

The representative firm hires both skilled and unskilled labour to produce private consumption goods. Following Gomes (2013), private firms use a linear production function without capital and with part of the resources produced that have to be used for posting vacancies:

$$y_t = a^p_t \left(l^p_{s,t}\right)^{\alpha} \left(l^p_{u,t}\right)^{(1-\alpha)} - \left(\varsigma^p_s v^p_{s,t} + \varsigma^p_u v^p_{u,t}\right) \tag{4.12}$$

ς^i_n denotes the cost of posting vacancies. At time t, the level of employment is predetermined with the firm only able to control the number of vacancies it can post. The value of opening a vacancy is thus given by:

$$V^p_{n,t} = E_t \beta_{n,t,t+1} \left[q^p_{n,t} J^p_{n,t+1} + (1 - q^p_{n,t}) V^p_{n,t}\right] - \varsigma^p_n \tag{4.13}$$

where $J^p_{n,t}$ is the value of a job for the firm defined as:

$$J^p_{n,t} = a^p_t - w^p_{n,t} + E_t \beta_{n,t,t+1} \left[(1 - \lambda^p_n) J^p_{n,t+1}\right] \tag{4.14}$$

Assuming free entry guarantees that the value of posting a vacancy is 0 ($V^p_{n,t} = 0$). Combining the two equations above therefore gives:

$$\frac{\varsigma^p_n}{q^p_{n,t}} = E_t \beta_{n,t,t+1} \left[a^p_{t+1} - w^p_{n,t+1} + (1 - \lambda^p_n \frac{\varsigma^p_n}{q^p_{n,t+1}}) \right] \tag{4.15}$$

This condition simply emphasizes that the expected cost of hiring a worker must equal its expected return. The benefit of hiring an extra worker is the discounted value of the expected difference between the worker's marginal productivity and his/her wage, plus the continuation value, knowing that with a probability λ^p_n the match is destroyed.

The private sector wages are subject to the outcome of a Nash bargaining between workers and firms with the following as sharing rule:

$$(1 - b_n)(W^p_{n,t} - U_t) = b_n J^p_{n,t} \tag{4.16}$$

with b_n being the workers' bargaining power.

4.3.6 Government

The government produces public goods using a linear technology on skilled labour exclusively. Contrary to private consumption goods, government goods are non-rival and are supplied to the representative household for free. The production function is given by:

$$g_t = a^g_t l^g_{s,t} - \varsigma^g v^g_{s,t} \tag{4.17}$$

Finally, the government collects lump sum taxes to finance its wage bill:

$$\tau_t = w^g_{s,t} l^g_{s,t} \tag{4.18}$$

4.4 Calibration

Following Gomes (2013), we assume CES utility functions for skilled and unskilled. The two functions for unemployment are linear, with higher sensitivity for unskilled individuals.

$$u_n(c_t, g_t) = \frac{1}{\gamma} \ln \left[c_{n,t}^{\gamma} + \xi g_{n,t}^{\gamma} \right] ; \nu_n(u_t) = \chi_n u_t \tag{4.19}$$

The model is calibrated to match the South African economy as much as possible. However, some of the parameters deemed unnecessary to change are taken from Gomes (2013).

The disutility of working is higher for unskilled workers ($\chi_u = 0.6$) than that of the skilled ($\chi_s = 0.46$). The discount factor takes the usual $\beta = 0.9$ value and the productivity levels in the private sector and public sector are fixed respectively to $A^g = 1$ and $A^p = 1$. Private firms sensitivity with respect to skilled labour is set to the high value of $\alpha = 0.7$. Kerr *et al* (2013) did an analysis of the dynamics of jobs creation and destruction in South Africa's labour market. The findings show that smaller businesses tend to have higher job creation and destruction rates compared to bigger ones. In essence, enterprises of about 20 workers have jobs creation and destruction rates respectively of about 10.1 percent and 14.3 percent. Meanwhile bigger firms of above 5000 employees have respective job creation and destruction rates of about 6.7 percent and 4.0 percent. This provides ground to make the following assumptions. First off, big firms tend to hire more skilled labour, therefore the separation rate for skilled workers in private firms is set at $\lambda_s^p = 4$ percent. Further, it is commonly observed that the separation rates in the public sector are slightly lower than in the private sector. Evidence from the 2008 financial crisis shows for instance that when the manufacturing sector in South Africa suffered a significant loss in employment, the public sector was not as much affected. Hence, the separation rate for public firms is set to a lower value of $\lambda_s^g = 3$ percent. The separation rate for unskilled individuals is set as high as $\lambda_u^p = 14$ percent.

Gomes (2013) finds by observing data in the United Kingdom that the cost of posting vacancies in the public sector is slightly lower than the one in the private sector. There is no incentive to diverge from that. Therefore, the cost of posting vacancies for skilled labour in the private sector are fixed at $\varsigma_s^p = 2$ and $\varsigma_s^g = 1.1$ in the public sector while unskilled labour is cheaper which leads to $\varsigma_u^p = 0.9$.

The lack of data availability for South Africa does not permit an estimation of matching elasticities with respect to unemployment and vacancies. Findings from Gomes (2013) suggest however that vacancies are more important determinants of matches in the private sector. Therefore, for the skilled individuals in the private sector $\eta_s^p = 0.5$ and for unskilled individuals, $\eta_u^p = 0.3$, whereas in the public sector $\eta_s^g = 0.2$. Also, the matching efficiency is higher for the skilled than it is for the unskilled individuals. Thus: $a_s^p = 1.9$, $a_u^p = 1$, $a_s^g = 1.7$.

Calibrating the wage bargaining power plays a pivotal role in this analysis. First, the baseline values for both skilled and unskilled workers are set at the same level of $b_s = b_u = 0.5$. Later it is assumed that skilled workers have a higher bargaining power ($b_s = 0.7$) while it remains the same for the unskilled ($b_u = 0.5$). The final scenario involves a high bargaining power for unskilled workers ($b_u = 0.7$) as the value for the skilled ones holds to the original $b_s = 0.5$.

The empirical evidence concerning the elasticity of substitution between private and public consumption is inconclusive. Therefore the elasticity of substitution is assumed to equal 1, which implies a calibrated value for $\gamma = 0$.

The steady state unemployment rate is set at $u = 23$ percent segmented such that $u_s = 3$ percent are skilled (having completed at least the tertiary level) and $u_u = 20$ percent are unskilled. Breaking it down further, $u_s^g = 1$ percent direct their search in the public sector while the remaining $u_s^p = 2$ percent are seeking jobs in the private sector. This allows us to calculate the share of skilled individuals looking for jobs in the public sector. $s = \frac{u_s^g}{u_s} = 0.33$. As discussed much earlier the quarterly labour force survey in 2014 reports 25.2 percent of total employment are skilled, the semi-skilled accounts for 46.2 percent, and the low-skilled share is 28.5 percent. In light of this evidence, the skilled labour force (unemployed included) is set slightly higher at $l_s^p + l_s^g + u_s = 30$ percent of the total labour force. Grouping semi-skilled and low-skilled together shows that the unskilled account for $l_u^p + u_u = 70$ percent of the total labour force.

The complete table of the model parameterization is available in the appendix.

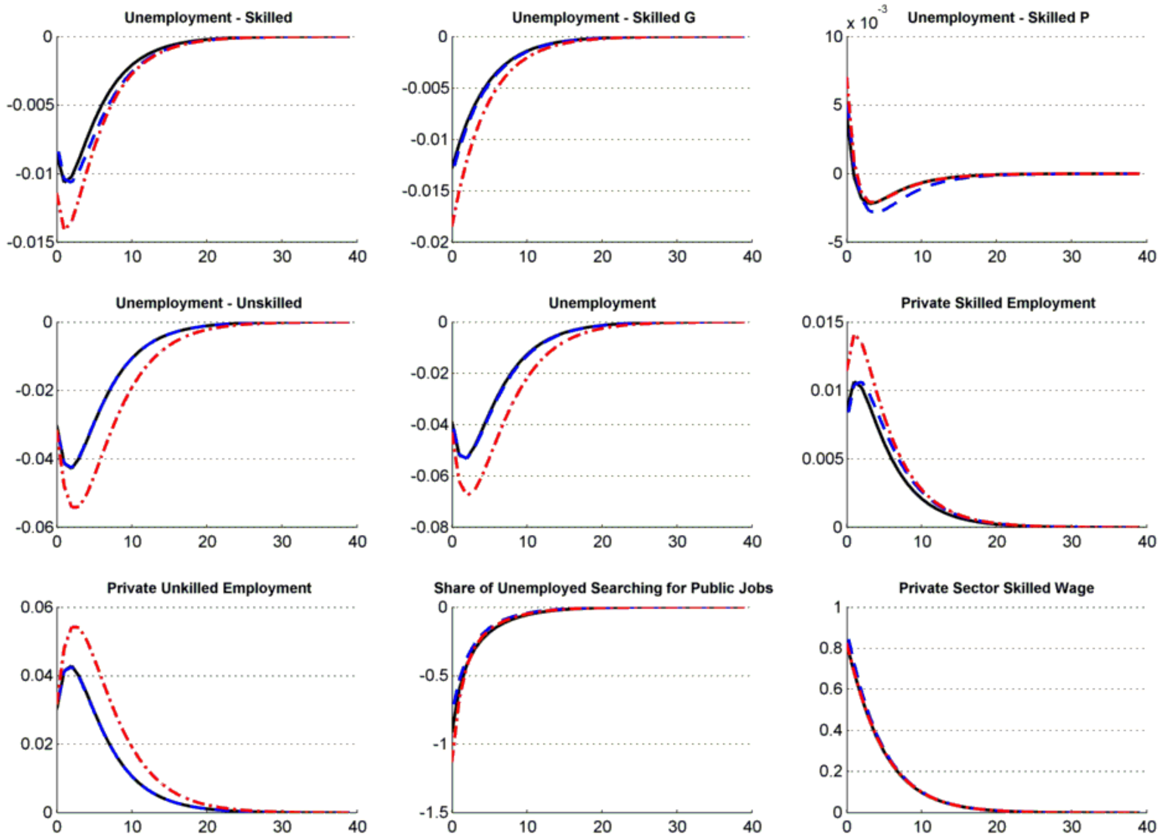
4.5 Impulse response functions

This section investigates the effects of private sector productivity and public sector wage shocks. Two cases are discussed below. First of all, different levels of bargaining power between skilled and unskilled workers are assumed to assess the impact of such a differentiation in the responses. Second, the productivity in the private sector is set higher than in the public sector. Each shock is an AR(1) process with an autocorrelation coefficient of 0.8. The figures below depict the responses of selected variables to a magnitude of 1 percent shock. The time line is set to be in quarters.

4.5.1 Effects of different levels of bargaining power

We begin with the effects of a positive private sector productivity shock. For the most part, the findings are in line with prior expectations. Overall, the responses are about the same for the baseline calibration and the scenario with high bargaining power for skilled workers. However, the effects are quantitatively higher when the bargaining power of unskilled workers is greater. An increase in private sector productivity leads to a rise in employment in that sector for both the skilled and the unskilled individuals. This results in a fall in unemployment of 4 percent, with persistence increasing with the level of bargaining power for the unskilled. Dissecting the effects of unemployment between skilled and unskilled individuals shows that in both cases unemployment decreases and it appears that for the skilled unemployed, individuals direct their search more toward private sector jobs as the number of unemployed seeking public employment decreases. While wages in the private sector for both skilled (figure 3) and unskilled (figure 4) workers increase, the effects on public wages are quantitatively and significantly small to be reported.

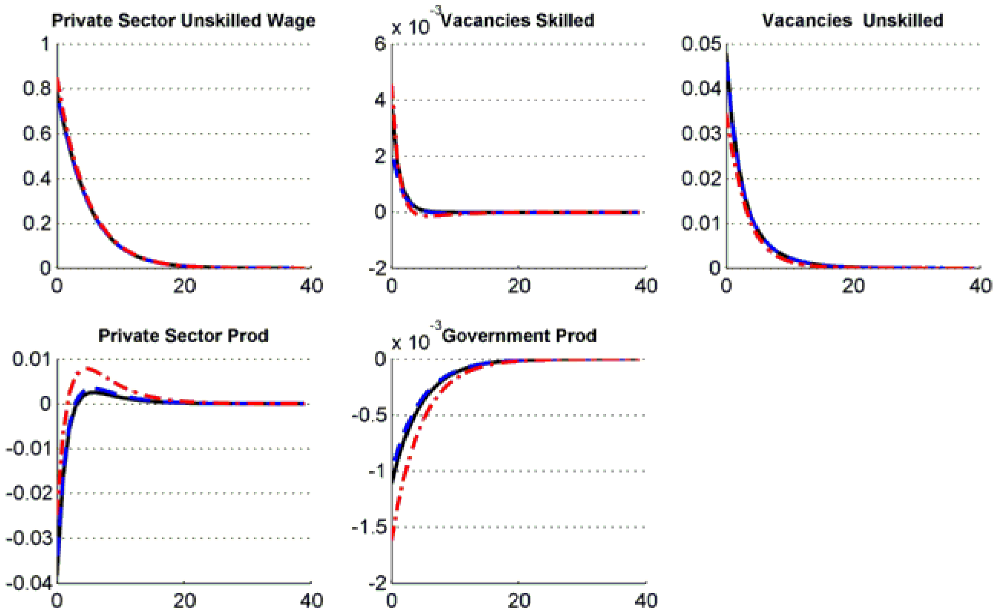
Figure 5: Private Sector Productivity Shock Part 1



Note: solid line ($b_s = b_u = 0.5$); dashed line ($b_s = 0.7; b_u = 0.5$); chain line ($b_s = 0.5; b_u = 0.7$)

As vacancies increase for skilled and unskilled (the former smaller in scale than the latter), private sector production decreases. The level of bargaining power is the defining factor in the response of private sector production. First of all, when the bargaining power of unskilled workers is high, the decrease is the smallest - about 2 percent on impact. Second, private sector production then rapidly increases in the next few quarters to reach a peak of 1 percent. The following is a tentative explanation to why this is the case. Note that the responses of vacancies for the skilled are roughly the same regardless of the level of bargaining power. For the unskilled on the other hand, firms post less vacancies the higher their bargaining power. As initially mentioned, posting vacancies comes at a cost of production to firms which implies that the cost of hiring an unskilled worker decreased while that of skilled workers stayed constant. This therefore leads to a lesser decrease in production when the bargaining power of unskilled workers is inflated, keeping in mind that private sector employment for both skilled and unskilled workers are on the rise as well.

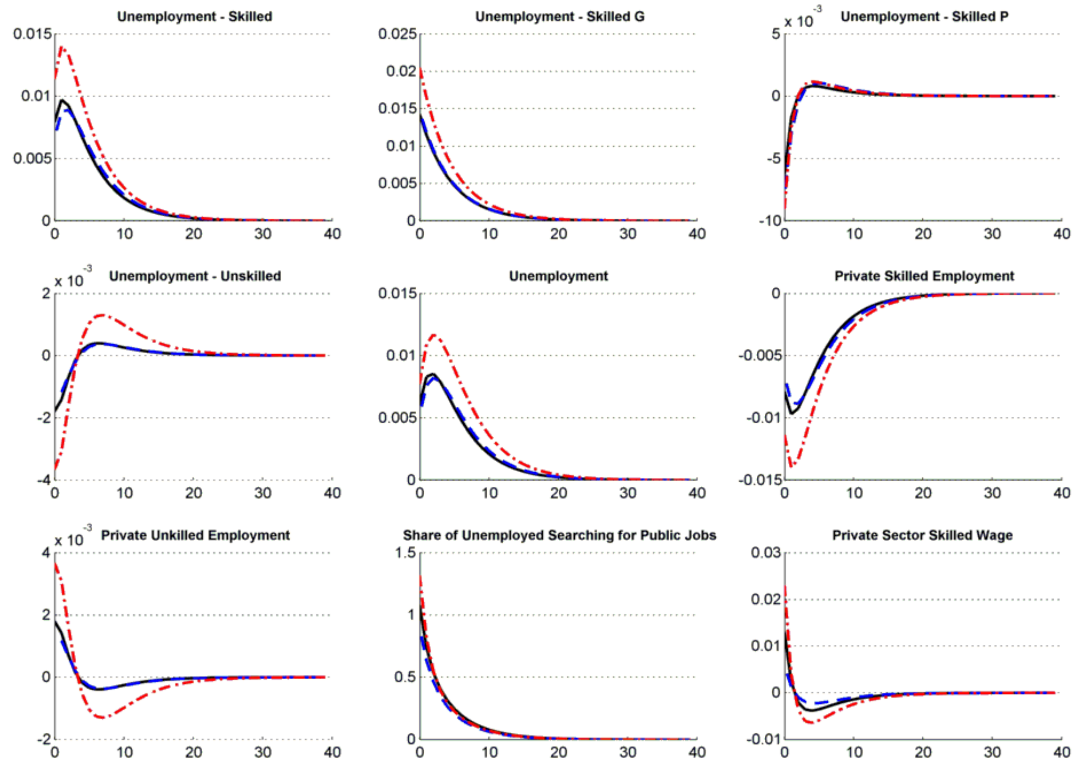
Figure 6 : Private Sector Productivity Shock Part 2



Note: solid line ($b_s = b_u = 0.5$); dashed line ($b_s = 0.7; b_u = 0.5$); chain line ($b_s = 0.5; b_u = 0.7$)

Similar to the private sector productivity shock effects, responses for a positive public wage shock are more pronounced the higher the bargaining power of unskilled workers altogether, while they are relatively the same for the baseline calibration and for higher skilled workers bargaining power. An increase in the public sector wage crowds out private sector skilled employment by about 0.6 percent for the baseline calibration and the high skilled workers bargaining power as shown in the figure below. This decrease in private sector skilled employment is significantly pronounced when we assume higher unskilled workers bargaining power. All in all, this crowding out effect leads to more skilled unemployed individuals to seek public jobs as they become more attractive. Consequently, fewer vacancies for skilled workers are posted in the private sector, ultimately resulting in a rise in unemployment amongst the skilled individuals.

Figure 7 : Public Wage Shock Part 1



Note: solid line ($b_s = b_u = 0.5$); dashed line ($b_s = 0.7; b_u = 0.5$); chain line ($b_s = 0.5; b_u = 0.7$)

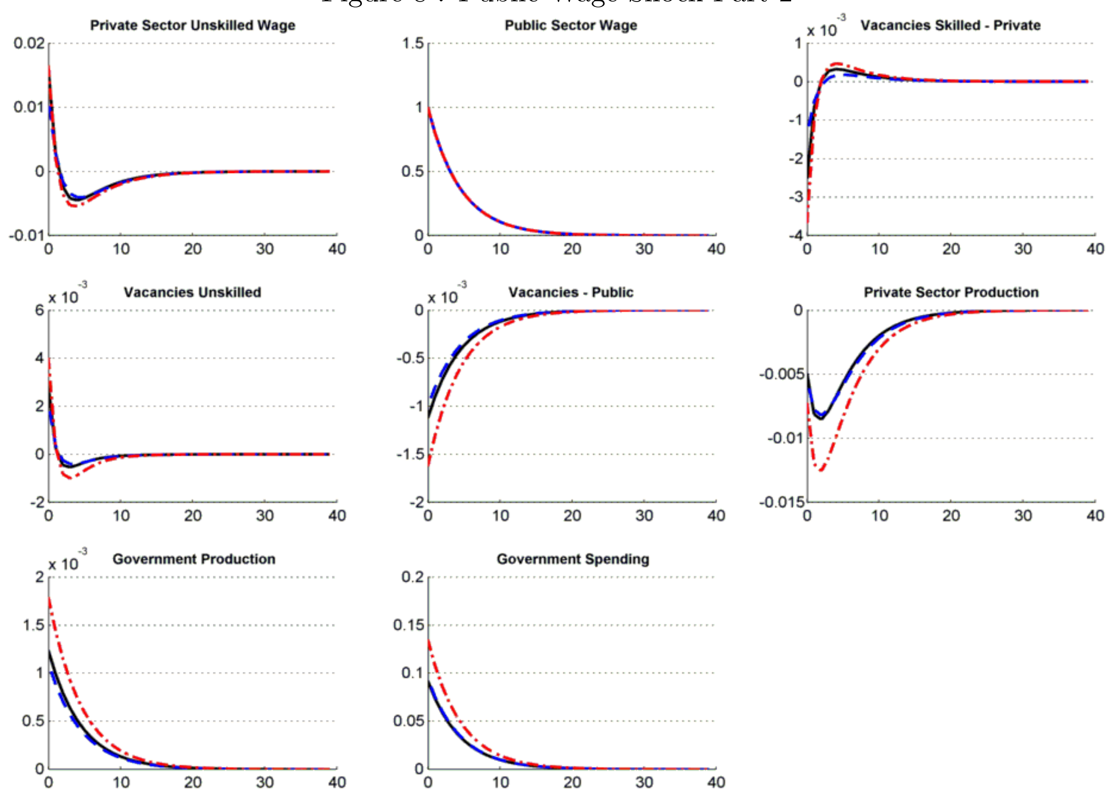
The probability of matching vacancies in the private sector falls since both the number of vacancies posted and that of new matches decrease at the same time. This in turn reduces the overall job finding rate for skilled individuals. In the public sector, the surge in wages has a negative effect on the number of vacancies posted (figure 6) but because the number of new matches stays constant, the probability of matching vacancies already available increases.

The public sector wage increase has a ripple effect on skilled workers wage in the private sector, with amplitude higher when unskilled workers bargaining power is increased. However, this rise is shortly lived and is followed by a decrease a few quarters later on until return to the steady state value about 20 quarters later.

The shock causes private sector employment amongst the unskilled to increase. The reason behind this increase is perhaps that private firms substitute skilled labour with more affordable unskilled one, given that skilled workers are more likely to move to the public sector where better wages are offered. However, the probability of matching the vacancies available amongst the unskilled falls. This is due to the fact that the shock incentivizes private sector firms to increase the number of vacancies for unskilled labour in a greater proportion relative to the rise in the number of new matches. Nevertheless, the probability of finding a job for the unskilled rises.

Wage for the unskilled rises, albeit slightly and for a short period of time. The unemployment response amongst the unskilled is relatively worse the more power in wage bargaining they have as it fluctuates more. Taking the whole picture into consideration, this increase in unskilled unemployment coupled with more individuals queuing for public jobs are reflected in the overall unemployment as it rises reaching a peak slightly above 1 percent. Private consumption goods production decreases given the crowding out effect of skilled workers that evidently contribute for a bigger proportion of the production. Consequently, government goods production rises as well as government expenditure.

Figure 8 : Public Wage Shock Part 2



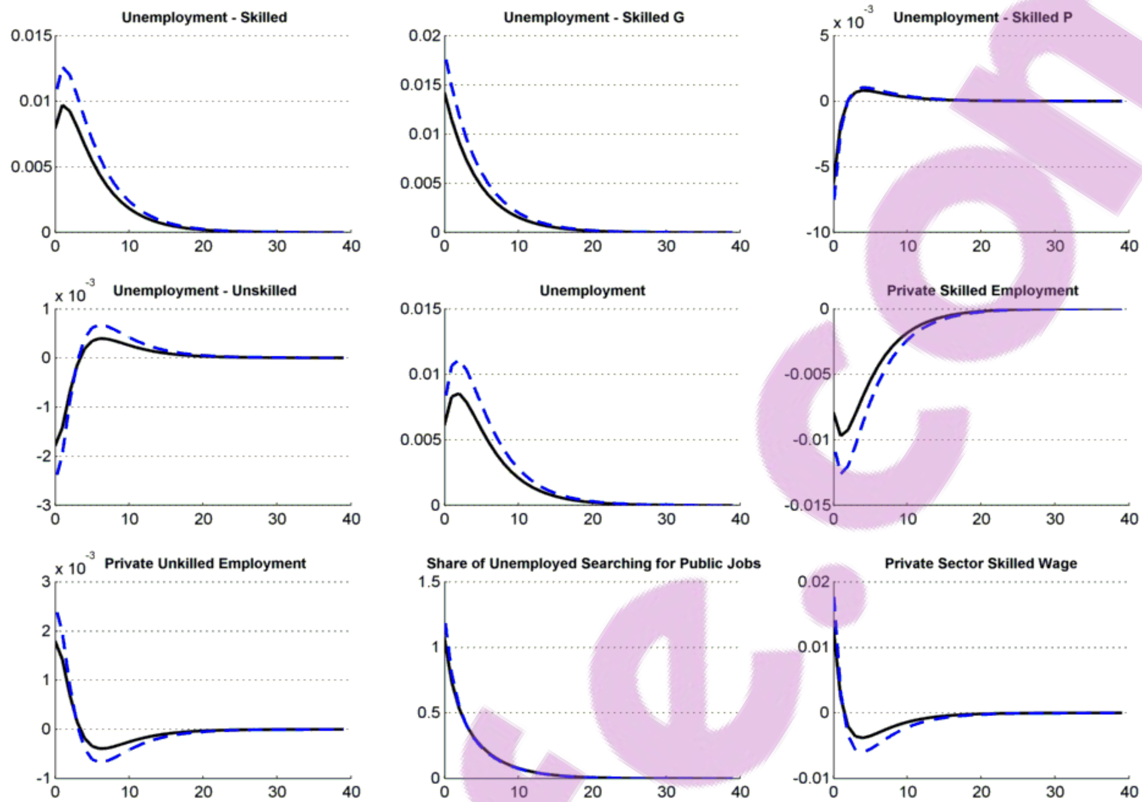
Note: solid line ($b_s = b_u = 0.5$); dashed line ($b_s = 0.7; b_u = 0.5$); chain line ($b_s = 0.5; b_u = 0.7$)

4.5.2 Difference of productivity between private and public sectors

This section focuses the effects of a public sector wage increase when the private sector is assumed to have more productive efficiency than the public. Productivity tend to be an important factor to private firms in their profit maximization problem. while the public sector pursues a different agenda. Therefore, we compare the following scenarios. First, the, and We first assume a baseline scenario where $A^p = A^g = 1$, which we compare to the setup with the productivity in the private sector is fixed at $A^p = 1$ and the one in the public sector is cut by half $A^g = 0.5$.

Overall the results show that skilled individuals tend to look for jobs in a sector with better endowments and less productive efficiency. The same crowding out effects as before can be observed here too but the effects are now more pronounced in the private sector as the productivity in the public sector is decreased. Further, the unemployed individuals that are skilled direct their searches more towards the public sector while the response for those looking for private sector jobs remains relatively the same under both scenarios. But because private employment decreases even further when public sector productivity is lower, unemployment amongst the skilled rises. This in turn is reflected by the increase in the overall unemployment rate.

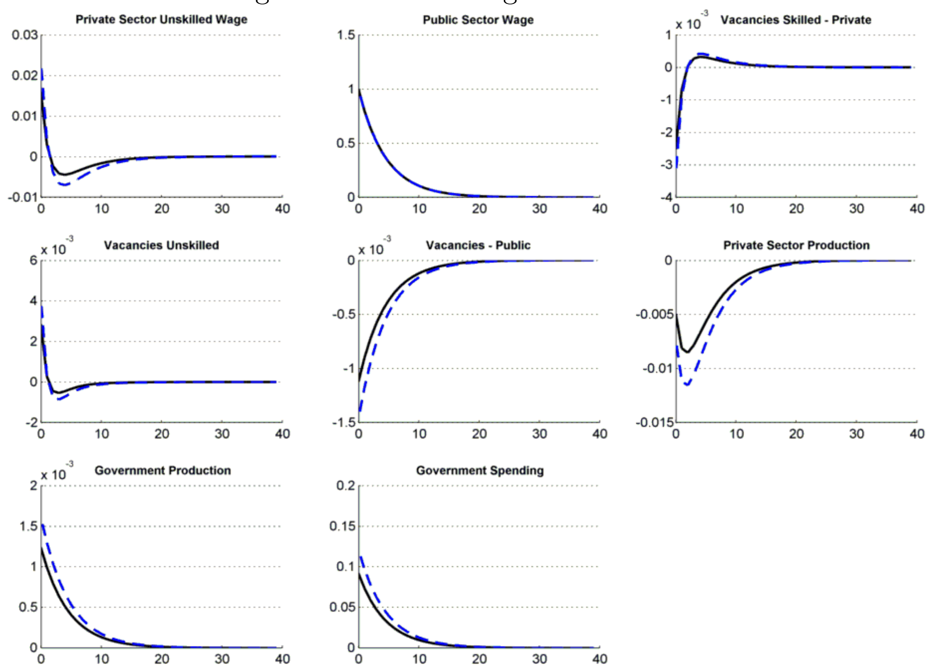
Figure 9: Public Wage Shock Part 1



Note: solid line ($A^p = A^g = 1$); dashed line ($A^p = 1; A^g = 0.5$)

Vacancies posted in the public sector are in decline as observed in the figure below. Essentially, since the number of people seeking public jobs is on the rise, the available vacancies posted in that sector get matched fairly rapidly, therefore implying a high probability of matching available vacancies for public firms and higher probability of finding jobs for skilled individuals in the public sector.

Figure 10: Public Wage Shock Part 2



Note: solid line ($A^p = A^g = 1$); dashed line ($A^p = 1$; $A^g = 0.5$)

4.6 Analysis of the results and optimal policy response

Whether we account for different levels of workers bargaining power or for a difference of productivity efficiency between public and private sectors, one result remains unchanged, *i.e.* an increase in public wages crowds out private skilled employment, and it appears a substitution for unskilled workers is taking place. In turns, this typically generates undesirable fluctuations in overall unemployment. The skilled workers wage premium, which in this case is the equivalent of the public wage premium, therefore has for the most part negative effects on labour market dynamics overall. One point that has not been discussed thus far is the contribution of the public wage premium to wage rigidities in the private sector.

We found in chapter 2 that wages in the private sector had a weak response to labour market conditions. In particular, increases in private sector wages are often correlated with significant job shedding by private firms. The public wage premium plays a contributing role in the following way. An increase in public wages as we found in the previous section may spill over to private sector wages. This can occur through various channels. For instance, through the trade unions channel, higher wages for public servants intuitively incentivize private sector workers to demand an increase in salaries, regardless of the economy's position in the business cycle. Since private firms main objective is profit maximization, compliance to such demands during recession periods inevitably leads to job shedding. This is most likely to happen in economies with high level of trade unions bargaining power. An optimal policy response is thus required. In chapter 3, we argue that the perverse effects of wages rigidities could be offset through optimal monetary policy if trade unions are concerned about the penalizing cost of employment which will result from wage increases. In this section, we discuss the optimal fiscal policy response.

It is important to mention that the first response to overcome the negative effects of the increase in public wage in the South African context would be to improve workers skills. This point has been covered extensively in the South African literature. However, this policy response alone will not overcome the crowding out effects of private employment. Indeed, if workers search is random, the sector with better endowment will be the most attractive. In the case the most attractive sector is the public sector, a public wage premium will induce too many unemployed individuals to queue for public jobs, which will eventually end up raising overall unemployment. Consequently, it is important to design a sound policy response.

Gomes (2013) suggests a procyclical public wage policy over the business cycle. Therefore governments should closely follow the evolution of wages in the private sector. In particular, public wages should be reduced in periods of recession and increased in periods of expansion; since individuals tend to excessively queue for public jobs during recessions whereas they apply significantly less for them during booms. However, government policy should adopt a countercyclical vacancies stance. During recessions, private firms display lower productivity. It is therefore optimal for the government to hire more in order to absorb the unused labour force. It is on the other hand not optimal for the government to post more vacancies when the jobs offered are not productive.

This is particularly important in the South African context given the shortage of skilled workers in the economy. A procyclical wage policy could prevent the exodus of skilled workers to the public sector or worse, for jobs abroad as it has been the case in the past few years. However, it is worth noting that, although optimal, the implementation of such a policy may turn out difficult to achieve. For instance, cutting wages in the public sector during periods of recession may prove difficult to accomplish, especially under severe political pressures. On the other hand, this policy in an economy dealing with the setbacks of falling commodity prices will most likely generate the desired results.

4.7 Conclusion

In the second chapter of this thesis, we find empirical evidence at the sectoral level that wages have a weak response to market conditions except for the community, social and personal services; where we find a remarkably strong correlation between wages, employment and labour productivity. We argue that the sector is predominantly consisting of government owned firms. Furthermore, since the abolishment of the Apartheid regime, the public sector has expanded enough to become the single entity to absorb employment the most. This labour force for the most part consists of skilled workers. This has led us to investigate how these features of public employment affect overall labour market dynamics. In addition, we explore the potential contribution of public wage premium in explaining wage rigidities in the private sector as we found in chapter 2. Therefore in this chapter, we use a DSGE model with two sectors composed of skilled and unskilled workers to primarily investigate the effects a positive public sector wage shock on a calibrated South African labour market. This is done by assuming different levels of collective bargaining power and difference of productivity efficiency between private and public sectors.

The findings suggest that an increase in private sector productivity produces more desirable results as opposed to a rise in public sector wages. Indeed, the productivity shock essentially raises employment for skilled and unskilled workers, reduces overall unemployment and augments wages in the private sector. On the other hand, a public sector wage shock mainly crowds out employment in the private sector as skilled workers move to the public sector where the wages have increased. The decrease in skilled employment in the private sector is matched by an increase in unskilled labour, therefore suggesting that a substitution effect is taking place. Furthermore, an increase in public sector wages results in more unemployed individuals queueing for public jobs given the attractive benefits, which ultimately increases overall unemployment. All in all, the effects are more pronounced when the level of collective bargaining power for unskilled workers is high.

It is however important to interpret these results cautiously. Although an increase in public sector investment, which may or may not be reflected by an increase in public sector wages, seems to worsen the overall labour market performance, by doing so the public sector may as well offer access to good health, better education and transport, etc. It is therefore important to take into account a number of parameters in an attempt to design an optimal public wage policy. Gomes (2013) suggests that such a policy should allow for public wages to be procyclical. In other words, public wages should follow closely the evolution of wages in the private sector in an attempt to avoid a highly volatile unemployment.

There are a couple of limitations about this study which suggest that the work could be improved upon. For starters, it would have been ideal to estimate the model using South African data which could not be achieved given the crucial lack of it (a recurring theme throughout this thesis). Finally, one could expand the model by incorporating unskilled labour in the public sector as well, in an attempt to make the model more 'realistic'.

4.8 Appendix A

PARAMETER VALUES

Table 1A: Skilled workers

Parameter	Description	Value
χ_s	Disutility of working	0.46
η_s^p	Private sector matching elasticity w.r.t. unemployment	0.5
η_s^g	Public sector matching elasticity w.r.t. unemployment	0.2
λ_s^p	Separation rate - Private sector	0.04
λ_s^g	Separation rate - Public sector	0.03
a_s^p	Matching efficiency - Private sector	1.96
a_s^g	Matching efficiency - Public sector	1.7
c_s^p	Private sector cost of posting vacancies	2
c^g	Public sector cost of posting a vacancy	1.1
b_s	Bargaining power	0.5

Table 2A: Low skilled workers

Parameter	Description	Value
χ_u	Disutility of working	0.6
η_u^p	Matching elasticity w.r.t. unemployment	0.3
λ_u^p	Separation rate	0.14
a_u^p	Matching efficiency - Private sector	1
c_u^p	Private sector cost of posting vacancies	0.9
b_u	Bargaining power	0.5

Table 3A: Common parameters

Parameter	Description	Value
β	Discount factor	0.99
ι	Fritch elasticity of labour	0
α	Private firm production elasticity w.r.t. skilled labour	0.7
A^p	Private sector productivity	1
A^g	Public sector productivity	1
γ	Elasticity of substitution	0
ξ	Weight of public consumption	0.18
b	Bargaining power	0.5
ρ	Shock persistence	0.8

Table 4A: Steady state

Parameter	Description	Value
u	unemployment	0.23
u_s	Fraction of skilled unemployed	0.03
u_u	Fraction of unskilled unemployed	0.2
l_s^g	Public sector employment	0.1
s_s	Share of skilled seeking public jobs	0.33

4.9 Appendix B

ADDITIONAL IMPULSE RESPONSES

Difference of productivity between private and public sectors

Figure 1B: Productivity shock Part 1

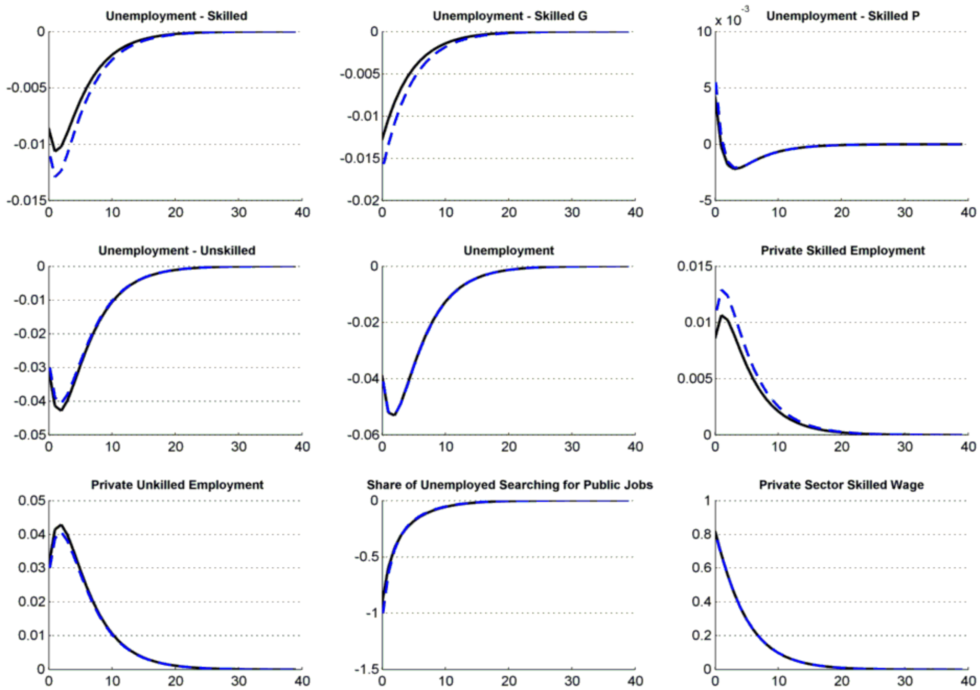
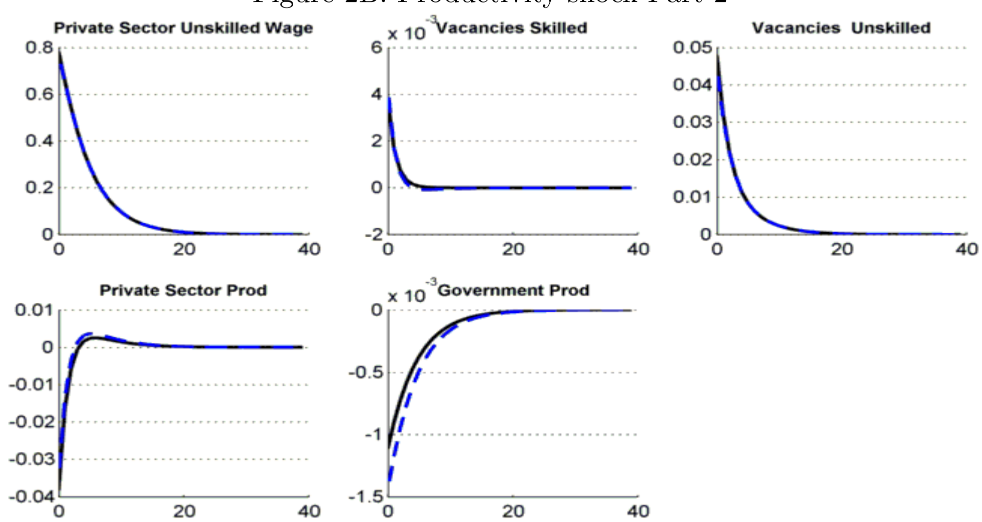


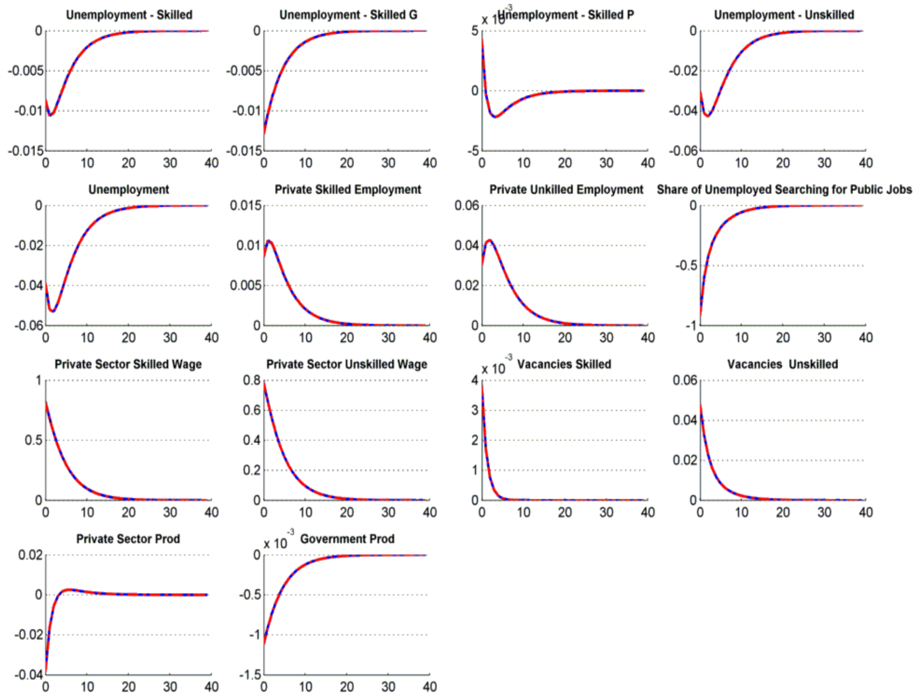
Figure 2B: Productivity shock Part 2



Note: solid line ($A^p = A^g = 1$); dashed line ($A^p = 1$; $A^g = 0.5$)

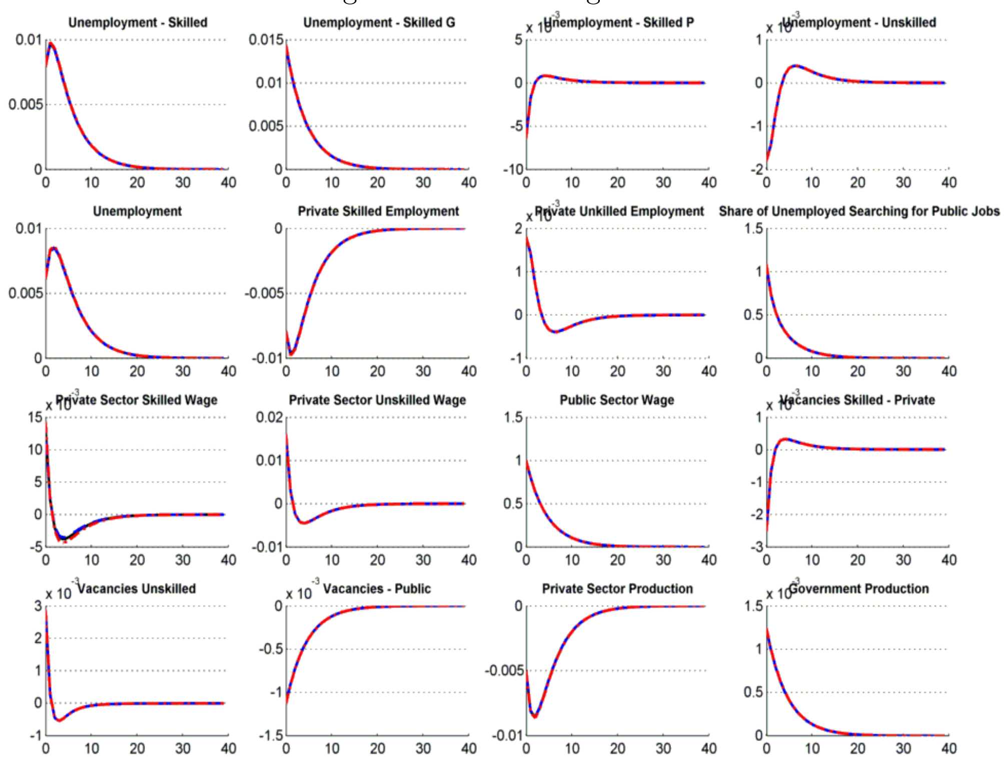
Relation between public and private sectors productions

Figure 3B: Productivity shock



Note: solid line (baseline); dashed line (substitutes); chain line (complements)

Figure 4B: Public wage shock



Note: solid line (baseline); dashed line (substitutes); chain line (complements)

Chapter 5

Summary and Concluding Remarks

5.1 Summary

The present thesis for starters focus on the relationship between labour market structure in South Africa and the ability of monetary authority to keep control of macroeconomic dynamics. The answer to this main question is threefold which constitutes the three main chapters of the proposed study. We begin with an empirical investigation of wage rigidities which leads us to assess the impact of the presence of such rigidities on the conduct of monetary policy. Finally we introduce the public sector in an economy experiencing a shortage of skilled workers to analyze the impact of public employment on labour market dynamics, given the public wage premium.

Therefore, chapter 2 evaluates the responsiveness of wages to market conditions at the aggregate level for the first part, using a wage Phillips curve framework in the context of a microfounded New Keynesian framework, following the original work of Gali (2010) which itself, is based on a framework originally developed by Erceg, *et al* (2000). For the second part of the chapter, we investigate wage rigidities at a sectoral level using a pool of nine industrial sectors in South Africa. In this part, we also take into account the dynamics generated by labour productivity and the reservation wage, following the framework of Blanchard and Katz (1999). The results typically show at the aggregate level a weak relationship between wage inflation and employment, which is mainly robust for different measures of wage inflation. This relationship is even weaker when the sample is narrowed to the inflation targeting regime period, which is basically the period where we find it reliable to use unemployment data. Wage rigidities is confirmed in this case as well as we find a weak relationship between wage inflation and unemployment. This relationship is only significant when we account for price inflation. Finally, the inflation targeting era allows us to account for the dynamics generated by the observed expected inflation of trade unions as recorded in South Africa by the BER. The results essentially highlights the importance of inflation expectations in the determination of wage inflation in the inflation targeting regime.

The result of a weak sensitivity of wages to market conditions is confirmed at the sectoral level. In addition, wages also have a weak relationship with labour productivity, given the reservation wage. Furthermore, the results indicate the presence of an error correction term in the wage equation for South Africa, which has previously been found to be absent in the US one and also present in various European cases. It is however important to highlight that the error correction term in the South African wage equation is quantitatively smaller relative to the average coefficient for European markets. This therefore implies features of the South African labour market including a considerable baragining power of trade unions, stringent firing and hiring regulations and a sizeable informal sector, all play an important role in wage dynamics. Finally, another striking results we find is the remarkably strong response of wages in the community, social and personal services sector which is dominated by public sector firms.

The findings of this chapter defined how the thesis is structured. First of all, in the following chapter we explore the implications that wage rigidities may have on the conduct of monetary policy in South Africa. Second, we introduce the public sector to assess the labour market effects of public employment given the shortage of skills the country has been experiencing.

Regarding the monetary policy response in an environment with wage rigidities, we follow the work of Blanchard and Gali (2010) who mainly argue that when frictions are present in the labour market, the *divine coincidence* no longer holds. In particular, stabilizing inflation does not automatically result in a stable unemployment (output gap). Therefore, optimal monetary response must be tailored depending on the type of labour market the central banker is facing. Thus, in this chapter we use a DSGE model with unemployment to design four typologies of labour markets that differs in the level of fluidity in terms of flows and also in the level of steady state unemployment. The results show that for a fluid labour market with high steady state unemployment, pursuing the objective of a stable inflation typically results into persistent and undesirable fluctuations in unemployment. Furthermore, this scenario also displays the worst possible sacrifice ratio. An estimation of the model using bayesian methods for starters confirms the finding in the previous chapter of pervasive wage rigidities. Moreover, the estimation also depicts a picture of a labour market with large flows in terms of job creation and job destruction rates, with the latter dominating the dynamics.

One particular observation in chapter 2 as already mentioned was the strong response of wages to labour productivity, prices and employment in the community, social and personal services sector. A possible explanation to why this is the case is perhaps that the sector is mainly skilled intensive. This sector consists predominantly of public firms. Furthermore, the public sector has been expanding since the 2008 financial crisis while private sector firms have been experiencing tough times. Given these features, we investigate in chapter 4 of this thesis the labour market effects of public employment and the contribution of public wage premium in explaining the weak response of wages in the private sector as found in chapter 2. We follow the framework originally introduced by Gomes (2013) to design a DSGE model with two sectors and two different types of workers namely the skilled and the low skilled. We then assess the responses of the main variables to a positive wage shock. For comparison purposes, the effects of a positive private sector productivity shock are also reported. Typically, we find that the productivity shock displays more desirable outcomes, with an increase in employment for skilled and unskilled workers, which in turns translate into a decrease in overall unemployment. The wage shock on the other hand essentially crowds out private sector skilled employment as more skilled individuals queue for public sector jobs. This results into an undesirable persistence in unemployment. Furthermore, it appears a substitution effect between skilled and low skilled workers is taking place. Given the premises, it is therefore important to design an optimal policy response. In particular, the government should closely follow the evolution of wages in the private sector and adopt a procyclical stance. Essentially, wages should be cut down during recessions and increased during periods of expansions.

5.2 Limitations and lines for further research

Although this thesis tackles issues in a way that have barely been approached in the South African literature when it comes labour market dynamics and its implications in terms of monetary policy response, a recurring theme throughout is the crucial lack of usable data when conducting macroeconomic research in the South African scene. Indeed the data for the most part is notoriously unreliable for various reasons including and not limited to changes in the methods adopted during the collection stages. For that reason, we are forced in chapters 2 and 3 to mainly use employment data when it would have been ideal to rely on unemployment data. We rely in chapter 3 on the index for manufacturing employment to proxy for overall employment in South Africa, which one may argue may not be ideal as well. Although we are well aware this may not be the preferred proxy, the results, regardless, give us an overall good depiction of the South African labour market.

Chapter 2 in the second section focuses on comparing the labour market in South Africa to that of the US and Europe by essentially investigating the presence of an error correction term in the wage equation when accounting for the reservation wage. However in the South African case, the reservation wage is not well understood at this stage. In particular, significant research in understanding its determinants is highly required. What we find in the literature is studies that attempt to link the reservation wage to explain youth unemployment. To the best of our knowledge, no studies assess the impact of the reservation wage in contributing to wage rigidities in South Africa the way we have approached the issue.

After assessing in chapter 3 the impact of wage rigidities in the way monetary policy should be implemented, the thesis could have taken a completely different turn. Indeed, further research could focus on introducing dynamics originated from the outside world by expanding the model into a small open economy. This is particularly interesting given that the job shedding that was witnessed in the manufacturing sector in the aftermath of the 2008 financial crisis was mainly the result of an external shock. Furthermore, the exchange rate in South Africa has been fluctuating quite a bit in recent years. With most central banks around the world normalizing monetary policies after long periods of unconventional policies, coupled with the US embarking in a fiscal policy expansion - which essentially means a stronger dollar - this may have non negligible repercussions on the South African economy, which is mainly a commodity exporter.

In chapter 4, although our finding of a substitution effect in the private sector between skilled and unskilled workers makes intuitive sense, it is important to highlight that we were at this point unable to confirm this result with actual data and other studies in the South Africa literature. This is mainly due to the fact that data to back up this finding is virtually difficult to obtain. Further, very few studies in the literature have researched the impact public employment on labour market dynamics in South African. Studies in the international literature similar to Gomes (2013) essentially does not account for low skilled workers dynamics, which is one of the main features of the South African labour market. A possible fix to the issue would be introducing capital in the model. We suspect by doing so that private sector firms would instead possibly substitute skilled workers with capital as a response to the crowding out of skilled workers.

Chapter 4 makes the unorthodox assumption that public sector firms exclusively hire skilled workers. This primarily is done for simplicity reasons but also, we observe in South Africa as explained earlier that the public sector share of skilled workers to total hire is twice as much relative to the private sector. However, it is important to note that in recent years, the South African government has embark into reforms that has created more jobs mainly for semi and low skilled workers. Therefore, it would be interesting for further research to include low skilled workers in the public sector to assess how this inclusion may alter our current results.

Chapter 6

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