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Labor Market Institutions and Wage and Inflation Dynamics

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Abstract: This paper develops a New Keynesian (NK) model that incorporates standard search and matching structure with firing costs. I analyze how labor market institutions affect the macroeconomic dynamics, in particular, wage and inflation dynamics. I particularly look at two important labor market institutions namely unemployment benefits and firing costs. I find that in countries where unemployment benefits are higher and there are more strict employment protection legislations, inflation and wages become less volatile and more persistent. I also find that the level of these labor market institutions affect how wages and inflation respond to exogenous shocks, in particular, to productivity and monetary policy shocks. I first present some empirical evidence that shows a cross-country link between labor market institutions and wages and inflation. Then I build a dynamic stochastic general equilibrium model which provides theoretical support for this empirical evidence.

I. INTRODUCTION

The recent development of models that combine the traditional New Keynesian models and standard search and matching models have been quite successful in replicating the main business cycle dynamics that standard models fail to achieve. For instance, these models are able to obtain large and persistent responses of output to exogenous shocks and relatively smooth behavior of wages over the cycle. Gertler, Sala, and Trigari (2008) find that these models accompanied by staggered wage contracting fit the data roughly well. In a related paper Macit (2010) shows that incorporating on-the-job search does the job of staggered wage contracting and achieves the same results with fully flexible wages. Trigari (2006), Krause and Lubik (2006), and Christoffel, Kuester, and Linzert (2006) are some recent examples of this modelling literature and they have been quite successful in matching important business cycle facts. Besides matching the business cycle dynamics there have also been papers that attempt to look at optimal monetary policy in these models. Faia (2006), Thomas (2008), and Arseneau and Chugh (2007) are some

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recent examples that look at optimal monetary policy with search and matching frictions in the labor market in an otherwise standard NK model.

The aim of this paper is different from the ones listed above as it does not aim to match business cycle dynamics or look at optimal monetary policy. I investigate whether labor market institutions affect business cycle dynamics, in particular, wage and inflation dynamics. I particularly focus on two important labor market institutions namely, the benefit replacement rate and firing costs. I choose these two institutions as they substantially influence the worker's incentive to keep a job and the firm's incentive to preserve an existing match with a worker, respectively. *Figure 1* shows the relationship between the volatility of inflation and employment protection legislation index for the OECD economies. *Figure 2* shows the same relationship for the volatility of real wages and *Figure 3* for the volatility of marginal cost.[1] The volatilities of inflation, real wages, and marginal cost are calculated for the HP filtered data. The data for employment protection legislation index is taken from Nickell (2006) and the data for inflation, real wages, and marginal cost is obtained from OECD database. The marginal cost is measured as the unit labor cost. As one can consider the employment protection legislation as a proxy for the firing costs the graphs show that there is a negative relationship between volatilities of these variables and the level of firing costs. These results are only suggestive and in order to be able to understand the effect of firing costs on inflation and wage dynamics I build a theoretical model to isolate the effect of firing costs. For this purpose I develop a dynamic stochastoc general equilibrium model in which the firm pays a fixed firing cost when an existing employment relationship breaks up. I find that higher levels of firing costs generate less volatile and more persistent movements in inflation and wages in response to monetary policy and productivity shocks. The results also show that when firing costs are lower inflation and wages show a larger response on impact but they adjust more quickly.

Firing costs have especially been an important area of study for the standard search and matching models. The main focus of these studies has been to explain the differences in unemployment rates between European Union countries and the U.S. There have also been papers that try to establish a link between the level of firing costs and business cycle dynamics. Veraciarto (2004) builds a real business cycle model with establishment level dynamics and finds that when firing costs are higher employment becomes less variable and more persistent. Thomas (2006) finds that firing costs reduce the volatility of business cycle fluctuations. He also shows that introducing firing costs into the standard search and matching models can be a remedy for the failure of the standard model in generating a negative correlation between the cyclical components of unemployment and vacancies. This paper differs from these papers in that it incorporates firing costs into a sticky price dynamic stochastic general equilibrium model and to the best of my knowledge it is the first paper that investigates how firing costs affect inflation dynamics. As firing costs affect the surplus for an employment relationship one may expect the level of firing cost to influence wage dynamics. The interest for inflation comes from the fact that wages affect the level of real marginal cost and the deviation of real marginal costs from their natural levels enters into a NK Phillips curve. So the effect of firing costs on inflation is expected to occur through its influence on marginal costs. I find that

1 I present the results for the marginal cost as the level of marginal cost is an important determinant of inflation in New Keynesian Phillips Curve.

higher firing costs make inflation less volatile and more persistent. The level of firing cost also affects the pattern that inflation shows in response to exogenous shocks, in particular, to productivity and monetary policy shocks.

Besides the effect of firing costs on wages and inflation dynamics I also investigate how these variables are affected by the level of unemployment benefits. In this regard an important previous study has been done by Campolmi and Faia (2010). They build a dynamic stochastic general equilibrium open economy model for a monetary union. They then ask the question whether the inflation differentials between European Union countries can be explained by the differences in labor market institutions. They particularly look at the level of unemployment benefits in European Union countries measured by benefit replacement rate and find that higher levels of unemployment benefits are associated with lower volatilies of inflation, wages, and real marginal cost. In the current model I look at the effect of unemployment benefits on wages and inflation from the perspective of a closed economy as opposed to the open economy model of Campolmi and Faia (2007) and I also investigate how these variables respond to productivity and monetary policy shocks.

The rest of the paper is organized as follows. In the next section, I build a closed dynamic stochastic general equilibrium model in order to be able to isolate the effect of firing cost on inflation and wage dynamics. Section III deals with the calibration of the model and Section IV presents the results. Section V concludes.

II. MODEL

The model that I adopt is very close to that developed by Trigari (2006). The difference between this model and the one proposed by Trigari (2006) is that firms incur firing costs when an existing employment relationship breaks up. There are four agents in the economy: workers, intermediate good firms, retail firms, and a monetary authority. I first characterize the problem of the representative household and then the labor and product markets.

2.1 Households

Each household consists of a continuum of members with names on the unit interval. Each member has the following utility function:

$$u(c_t, c_{t-1}) - g(h_t) = \log(c_t - \xi c_{t-1}) - \Psi_h \frac{h_t^{1+\phi}}{1+\phi} \tag{1}$$

where c_t is the consumption of the final good, h_t is the hours worked and I allow for habit persistence.[2] The representative household maximizes lifetime utility by choosing consumption, c_t, and bond holdings, B_t, subject to the budget constraint. The lifetime utility of the household is given by:

$$E_t \sum_{s=0}^{\infty} \beta^s [u(c_{t+s}, c_{t+s-1}) - G_{t+s}] \tag{2}$$

where $\beta \varepsilon (0,1)$is the intertemporal discount factor and the variable G_t is the family's disutility from supplying hours of work.[3] I do not write this function explicitly as hours worked is not a choice variable for the household. In each period households are subject to the following budget constraint:

$$c_t + \frac{B_t}{p_t r_t} = d_t + \frac{B_{t-1}}{p_t} \tag{3}$$

where p_t is the aggregate price level and r_t is the gross nominal interest rate on the bond. Following Merz (1995) and Andolfatto (1996), I assume that there is perfect consumption risk sharing between employed and unemployed family members. The variable d_t includes wage income earned by employed members, unemployment benefits earned by unemployed members, the share of profits from retailers, net of a government lump-sum tax used to finance unemployment benefits.

The representative household maximizes (2) subject to the period budget constraint by choosing consumption and bond holdings. The first order conditions for an interior solution are as follows:

$$\lambda_t = \frac{1}{c_t - \xi c_{t-1}} - E_t \beta \xi \frac{1}{c_{t+1} - \xi c_t} \tag{4}$$

$$\lambda_t = E_t[\beta r_t \frac{\lambda_{t+1}}{\pi_{t+1}}] \tag{5}$$

where λ_t is the Lagrange multiplier associated with the budget constraint and π_{t+1} is the gross inflation rate.

2.2 Firms and the Labor Market

There are two types of firms in the model: intermediate goods firms and retail firms. Intermediate goods firms carry out the actual production using labor as the only factor of production. These firms are subject to search and matching frictions in the labor market and sell their output in a perfectly competitive market. Retail firms face monopolistic competition and are subject to nominal rigidities in the price setting decision.

2.2.1 The Labor Market

The matching process between the workers and the firms is characterized by a matching function which gives the number of matches in a given period between job seekers and vacancies. The total number of per period new matches is given by the following function:

$$m_t = M u_t^{\mu} v_t^{1-\mu} \tag{6}$$

where v_t is the measure of vacancies posted by firms and u_t is the measure of unemployed workers searching for a job. I assume a constant return to scale matching function which is characterized by $m_t = M u_t^{\mu} v_t^{1-\mu}$. The constant M reflects the efficiency of the matching process.

[3] Assuming that there is perfect consumption risk sharing between employed and unemployed family members allows one to aggregate the utility function for the family.

I can derive the probabilities of making a match for firms and searching workers using the matching function. I define $\theta_t = v_t/u_t$ as the measure of labor market tightness in the matching market. A firm fills a vacancy with probability $q_t \equiv m_t/v_t$ and a worker searching for a job makes a match with probability $st \equiv m_t/u_t$. These probabilities are given by:

$$q_t = M\theta_t^{-\mu} \tag{7}$$

$$s_t = M\theta_t^{1-\mu} \tag{8}$$

I assume that matches break up exogenously with probability ρ. Given this the evolution of employment is as follows:

$$n_{t+1} = (1-\rho)(n_t + m_t) \tag{9}$$

where n_t is the number of people employed in period t. This equation implies that new matched cannot enter into the production function if the relationship is broken up right after being negotiated. As the measure of labor is equal to one, the number of unemployed people, u_t, is given by:

$$u_t = 1 - n_t \tag{10}$$

2.2.2 Value Functions

The problem of the workers and the firms is characterized by Bellman equations. I first start with the value functions for the firms. The value of a continuing employment relationship for a firm is denoted as J_t and the the value of a new emploment relationship denoted as J_t^n and are given by:

$$J_t = x_t a_t f(h_t) - w_t h_t + E_t \beta_{t,t+1}[(1-\rho)J_{t+1} + \rho(V_t - F)] \tag{11}$$

$$J_t^n = x_t a_t f(h_t) - w_t^n h_t + E_t \beta_{t,t+1}[(1-\rho)J_{t+1} + \rho(V_t - F)] \tag{12}$$

where w_t is the wage paid for an existing employment relationship and w_t^n is the one for a new employment relationship, x_t is the price of the intermediate good and a_t is the productivity shock. The value of a continuing match is equal to the current profits which is given by $x_t a_t f(h_t) - w_t h_t$ plus the continuation value.[4] With probability $1-\rho$ the match continues and the firm enjoys the expected value of the job. With probability ρ the match breaks up next period. In this case the firm enjoys the value of a vacancy but at the same time incurs the fixed firing cost given by F.[5] The future value of the job is discounted by the discount factor β_{t+1} which is given by $\beta\lambda_t + 1 / \lambda_t$.

The value of a vacancy, V_t, is as follows:

$$V_t = -\kappa + E_t \beta_{t,t+1}[q_t(1-\rho)J_{t+1} + (1-q_t)V_{t+1}] \tag{13}$$

4 The production function f(h) is assumed to be a decreasing returns to scale production function.
5 Firing costs are not modelled in the form of severance payment.

where κ is the flow cost of posting a vacancy. With probability $q_t(1-\rho)$ a vacancy will be filled next period and will actually be producing. Assuming free entry of vacancies will drive the value of a vacancy to zero in order to eliminate any arbitrage opportunity. This will give the following equilibrium condition:

$$\frac{\kappa}{q_t} = E_t \beta_{t,t+1}[(1-\rho)J_{t+1}] \tag{14}$$

The meaning of this equilibrium condition is that the expected cost of a vacancy is equal to the expected benefit received from filling that vacancy.

Now let W_t and U_t be the value of employment and unemployment respectively from the perspective of a worker. Value of employment for a worker is given by:

$$W_t = w_t h_t - \frac{g(h_t)}{\lambda_t} + E_t \beta_{t,t+1}[(1-\rho)W_{t+1} + \rho U_{t+1}] \tag{15}$$

The term $\frac{g(h_t)}{\lambda_t}$ is the disutility from supplying hours of work and it is expressed in terms of current consumption in order to preserve consistency between the terms. The value of unemployment is given by the following value function:

$$U_t = b + E_t \beta_{t,t+1}[s_t(1-\rho)W_{t+1} + (1 - s_t(1-\rho))U_{t+1}] \tag{16}$$

where b is the value of unemployment benefits received by the worker which is financed by a lump-sum government tax.

2.2.3 Wage Bargaining

I assume that wages are determined by surplus splitting assumption. However, the presence of firing costs creates difference between the surplus for a new employment relationship and the surplus for an existing employment relationship from the perspective of a firm. When a worker and a firm meet for the first time for a wage bargain the firm does not need to pay a firing cost if the match is not successful. On the other hand, for an existing employment relationship if the match breaks up the firm incurs a fixed firing cost. So when calculating the surplus for a firm that has an existing match one needs to take into account the firing costs that are avoided if the match continues. For a new match the outcome of the surplus splitting assumption maximizes the product:

$$(W_t - U_t)^{\eta}(J_t^n - V_t)^{1-\eta} \tag{17}$$

where the first term is the surplus for the worker and the second term is the surplus for the firm. The parameter η reflects the bargaining power of the worker. Firms and workers maximize the joint surplus of the match. The wage that maximizes the joint surplus gives the following first order condition:

$$\eta J_t^n = (1-\eta)(W_t - U_t) \tag{18}$$

As I mentioned above the surplus for a firm from an existing employment relationship will differ from the one for a new match due to the firing cost that the firm incurs when the match breaks up. For an existing employment relationship the outcome of the surplus splitting assumption maximizes the following product:

$$(W_t - U_t)^{\eta}(J_t - (V_t - F))^{1-\eta} \tag{19}$$

The second term reflects the fact that when the match ends up the firm ends up with the value of vacancy and pays the fixed firing costs F. The wage that maximizes the joint surplus gives the following optimality condition:

$$\eta(J_t + F) = (1-\eta)(W_t - U_t) \tag{20}$$

Using these bargaining equations and the job creation condition gives us the wage for a new match and the wage for an existing employment relationship:

$$w_t = \eta \frac{x_t a_t f(h_t)}{h_t} + \frac{\kappa\theta_t}{h_t} + \frac{(1-\beta\rho)F}{h_t}] + (1-\eta)[\frac{g(h_t)}{h_t\lambda_t} + \frac{b}{h_t}] \tag{21}$$

$$w_t^n = \eta \frac{x_t a_t f(h_t)}{h_t} + \frac{\kappa\theta_t}{h_t} - \frac{\beta\rho F}{h_t}] + (1-\eta)[\frac{g(h_t)}{h_t\lambda_t} + \frac{b}{h_t}] \tag{22}$$

where w_t^n refers to the wage for a worker that has made a new match with the firm. The wage equations show that workers that already have a job benefit from a higher firing cost whereas workers that do not have a job are harmed. This is also consistent with the empirical evidence reported by OECD mentioning that workers that already have a job are favored by higher firing costs whereas the higher firing costs make it more difficult for outsiders to find a job and reduces their wages.

For the determination of hours worked I assume that workers and firms jointly determine hours. Trigari (2006) defines this bargaining procedure as efficient bargaining. The optimality condition for the determination of hours worked is given by:

$$x_t a_t f_h(h_t) = \frac{g^{'}(h_t)}{\lambda_t} \tag{23}$$

where $a_t f_h(h_t)$ refers to marginal product of hours worked and $\frac{g^{'}(h_t)}{\lambda}$ denotes marginal rate of substitution.

2.3 Retail Firms

There is a continuum of retails firms on the unit interval indexed by j operating in a monopolistically competitive market. Retail firms transform the intermediate goods with a technology and resell them to the households as a final consumption good. Defining y_{jt} as the output produced by retail firm j, final goods, denoted by y_t, are given by the following combination of individual retail goods:

$$y_t = \left[\int_0^1 y_{jt}^{\frac{\varepsilon-1}{\varepsilon}} dj \right]^{\frac{\varepsilon}{\varepsilon-1}} \tag{24}$$

where ε is the elasticity of substitution across the differentiated retail goods. Using this condition each retail firm has the following demand function given by:

$$y_{jt} = \left(\frac{p_{jt}}{p_t}\right)^{-\varepsilon} y_t \tag{25}$$

where p_{jt} is the price charged by retail firm j and p_t is the aggregate price index given by:

$$p_t = \left[\int_0^1 p_{jt}^{1-\varepsilon} dj \right]^{\frac{1}{1-\varepsilon}} \tag{26}$$

Retail firms are subject to Calvo (1983) type nominal price rigidity. Each period a retail firm is allowed to adjust its price with probability 1 – φ and this probability is independent of history of price adjustments. The retail firms that have the chance to set their price will choose their price in order to maximize their expected future discounted profits subject to the demand for their good and to the condition that the price that they set at date t prevails at date $t + k$ with probability φ^{t+k}. The first order condition for the retail firm's profit maximization problem is given by:

$$p_{jt} = \varsigma E_t \sum_{k=0}^{\infty} \psi_{t,t+k} mc_{t+k}^{n} \tag{27}$$

where $\varsigma = \frac{\varepsilon}{\varepsilon - 1}$ is the flexible price markup and the term $mc_t^n = p_t mc_t$ is the nominal marginal cost at date t. The relevant weights $\Psi_{t,t+k}$ are written as:

$$\psi_{t,t+k} = \frac{\varphi^k \beta_{t,t+k} R_{jt,t+k}}{E_t \sum_{k=0}^{\infty} \varphi^k \beta_{t,t+k} R_{jt,t+k}} \tag{28}$$

where $R_{jt,\,t+k}$ is the revenue at time $t + k$ given that the last price adjustment is done in period t

2.4 Monetary Authority

I assume that the short-term interest rate is the policy instrument of the monetary policy and the money supply is adjusted accordingly. I set a Taylor type rule for the nominal interest rate r given by:

$$r_t = \beta^{-(1-\tau)} (r_{t-1})^{\tau} E_t(\pi_{t+1})^{\alpha_\pi (1-\tau)} (y_t - y)^{\alpha_y (1-\tau)} e^{\varepsilon_t^r} \tag{29}$$

where the parameter τ measures the degree of interest rate smoothing. The nominal interest rate responds to inflation and the deviation of output from its steady state value. The response coefficients are α_π and α_y respectively. The last term in the policy function, ε_t^r, is the i.i.d monetary policy shock.

I close the model by writing an aggregate resource constraint. That is given by:

$$y_t = c_t + \kappa v_t + \rho F n_{t-1} \tag{30}$$

This shows that output goes to consumption or vacancy posting cost or firing cost.

III. CALIBRATION

In order to investigate the business cycle properties of the theoretical model I assign numerical values to the structural parameters. I set the discount factor, β, to 0.99 which implies a 4% annual interest rate. The value of the habit persistence parameter is set as 0.6. I set the labor supply elasticity as 1/3 which is consistent with the microeconomic studies that estimate the labor supply elasticity close to 0 and not higher than 0.5.

Following the literature I choose a Cobb-Douglas form for the matching function. The matching function is given by $m = Mv^{1-\mu}u^{\mu}$. Following Krause and Lubik (2006) I set the level parameter, M, as 0.6. In accordance with Trigari (2006) I set the elasticity parameter, μ, equal to 0.5.[6] The parameter for the separation rate is set as 0.1. There are some empirical estimates in the literature for the U.S. separation rate. Hall (1995) reports this rate to be between 8 to 10 percent. Davis, Haltiwanger, and Schuh (1996) estimates the U.S. separation rate as 8%. The value that I set is consistent with the empirical estimates. For the vacancy posting cost, following Krause and Lubik (2006) I calibrate it as 0.16. That implies that at the steady state about 4% of the output goes to vacancy posting cost. Following Krause and Lubik (2006) the value from unemployment given by z is set as 0.4 and the relative bargaining power of the worker is set as 0.5. This value is the same as the elasticity parameter of the matching function and so satisfies the Hosios (1990) condition.

I now calibrate the structural parameters for the retail sector. I set the probability that a firm is not allowed to change its price in a given period equal to 0.67 which implies prices on average are fixed by three quarters. I set the flexible price mark up as 10% which implies □

Lastly, I calibrate the parameters for the exogenous shocks and the monetary policy rule. I assume that the logarithm of the aggregate productivity shock follows an AR(1) process with a coefficient 0.923 which is used by Canzoneri, Cumby, and Diba (2007). Again following Canzoneri, Cumby, and Diba (2007) the interest rate smoothing parameter is set as 0.824 and the coefficients on inflation and output are set equal to 2.02 and 0.184 respectively.

IV. RESULTS

In this section I present the model results in terms of investigating how the level of the benefit replacement rate and firing costs affect the wage and inflation dynamics.

6 For the estimation of the matching function, Petrongolo and Pissarides (2001) report this parameter to be between 0.5 and 0.7 in their survey of the literature.

4.1 Volatility and Persistence

I first present the model results for the volatility of inflation and wages for different levels of firing cost. *Table 1* shows the standard deviations of these variables for three different firing cost levels. The first column is for the case where there are no firing costs. In the second column the *F* parameter is set to generate a firing cost that is equal to one wage at the steady state and in the third column it is set to generate a firing cost equal to two wages at the steady state. The standard deviations are measured relative to that of output. As the table shows as firing costs go up the volatility of inflation and wages go down. This is consistent with the empirical results that are presented above. It would also be nice to compare the orders of magnitude on *Figures 1* and *2* to *Table 1* by giving a sense of two countries in the data. In this regard I choose Germany and Netherlands. In terms of the employment protection legislation index the value for Netherlands is higher than that of Germany. In the data one can see that the volatility of inflation for Netherlands is about 30% lower than that of Germany. In terms of the volatility of wages the number for Netherlands is again lower than the volatility of wages in Germany. An important point to note here is that the volatility of wages is higher than what might be observed in actual data. The reason for this is that the model abstracts from many real rigidities including staggered wage contracting or on-the-job search mechanism.

Next, I will look at coefficients of autocorrelation for inflation and real wages for different levels of firing costs and the benefit replacement rate in order to assess how these labor market institutions affect the persistence in these variables. *Table 2* shows the results for different levels of firing costs. I look at coefficients of autocorrelation up to five lags for two different firing cost levels. The results show that when firing costs go up both inflation and real wages become more persistent. In terms of economic interpretation this result is not surprising. If firing costs are higher than in response to exogenous shocks firms have very little room to move in terms of adjusting their prices and in turn their wages. This makes both variables more persistent and less volatile. At this point it will be illustrative to give an example from a couple of countries in the data that may support the model results in terms of autocorrelation. To be consistent with the model the autocorrelations are calculated for the H-P filtered data. I present the results up to five lags and for four different countries namely Netherlands, Germany, France, and Denmark. *Table 3* shows the results for real wages and *Table 4* shows the results for inflation. It is seen from the results that countries that are subject to more rigid employment protection legislation tend to have more persistent inflation and wages. An important thing to note here is that the observed autocorrelations are much higher than the ones obtained from the model. The reason for this is that, as I mentioned before, the model abstracts from many real rigidities that may help in obtaining the observed pattern in wages. Incorporating staggered wage contracting or on-the-job search mechanism may be a remedy in this regard.

Besides the firing costs I also investigate the persistence in inflation and wages for different levels of the benefit replacement rate. I look for two diffferent levels of the benefit replacement rate. In the first one I set the *b* parameter which gives me at the steady state the value of unemployment benefits to the wage is 0.56. In the second one the parameter is set a lower value that at the steady state this ratio is 0.19. Both of these are within the range of benefit replacement rate observed in OECD countries reported by Nickell (2006). *Table 5* shows the results for inflation and wages. It is seen that especially for inflation the persistence becomes more obvious when the benefit replacement rate goes up. When the benefit replacement rate is higher workers are not willing to take large wage cuts in response to exogenous shocks. This makes both wages and inflation more persistent in response to these shocks.

4.2 Impulse Responses

Another important issue about the labor market institutions is whether differences in these affect how macro variables respond to exogenous shocks. In this section I investigate how the level of firing costs and the benefit replacement rate affect the pattern that inflation and wages show in response to exogenous shocks in particular to productivity and monetary policy shock. *Figure 4* shows the response of inflation to a positive productivity shock for two different firing cost levels. One can see that when firing costs are lower, on impact inflation shows a larger response. In this case on impact inflation goes down by 0.55% whereas in the case where firing costs are higher inflation goes down by about 0.45%. However, it is seen that when firing costs are lower inflation adjusts more quickly in response to the productivity shock. This is actually consistent with the previous results that are presented. That is when firing costs are higher, in response to the exogenous shocks inflation becomes more persistent. *Figure 5* shows the same results for a monetary policy shock that raises the interest rates. One can see the same pattern in the response of inflation that is seen in productivity shock. Once the economy is hit by a monetary policy shock on impact inflation goes down by about 0.4% when the firing costs are lower and it goes down by 0.25% when firing costs are higher. However, again, inflation does not show a persistent response when firing costs are lower and it adjusts more quickly compared to the case where firing costs are higher.

The pattern that is seen in inflation can also be seen in the response of wages. *Figure 6* shows the response of wages in response to a positive productivity shock. One can see that on impact lower firing costs create a larger response. However, this pattern does not persist and adjust very quickly. Lower firing costs generate more flexibility for the firms in adjusting their wages and creates larger and quicker adjustments in wages in response to the productivity shock.

Besides the level of firing cost the level of benefit replacement rate is also effective for the response of inflation and wages to productivity and monetary policy shocks. *Figure 7* shows the response of inflation to a positive productivity shock for two different benefit replacement rates that have been used in previous section. The same pattern is observed that has been seen for firing costs. When there are less generous unemployment benefits on impact, inflation shows a larger response to the positive productivity shock but it adjusts faster than is the case when there are more generous unemployment benefits. *Figure 8* shows the same results now for a monetary policy shock and exactly the same pattern is observed. Lower benefit replacement rates make inflation less persistent and this can be observed in the response of inflation to a productivity and monetary policy shock. *Figure 9* shows the response of wages to a monetary policy shock again for two different benefit replacement rate levels. When the benefit replacement rate is lower, wages show a slightly larger response at the beginning but then adjust very quickly. It is important to note that the level of firing costs seems to be relatively more influential on impulse responses compared to the effect of the benefit replacement rate.

V. CONCLUSION

In this paper I develop a dynamic stochastic general equilibrium model in an otherwise standard NK model. This paper differs from the previous literature that uses the same modelling strategy with the respect to the incorporation of firing costs. That is when an existing employment relationship breaks up the firm incurs a fixed firing cost. In this context I investigate how the level of firing cost and unemployment benefit affect the business cycle dynamics, particularly, wage and inflation dynamics.

I build a dynamic stochastic general equilibrium model for a closed economy and investigate how inflation and wages react for different levels of firing costs and benefit replacement rate. I find that higher levels of firing cost generate less volatile and more persistent pattern in wages and inflation in response to productivity and monetary policy shocks. The same pattern holds as well for benefit replacement rates. I also find that when firing costs are lower, in response to the productivity and monetary policy shocks, inflation and wages show larger responses on impact but they adjust quickly.

An important extension of this work may be to investigate the role of other important labor market institutions for business cycle dynamics. Among these duration of benefits, union density and coverage, and bargaining coordination and centralization can be listed. The role of these and other labor market institutions can be empirically investigated in terms of their effect on business cycle dynamics. Developing theoretical models that may provide support for the empirical evidence may also be an important future work in this direction.

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TABLES

Table 1: Standard Deviation of Variables for Different Firing Cost Levels

	F=0	F=*w*	F=2*w*
Inflation	1.11	0.55	0.45
Real Wage	2.30	1.58	1.21

Table 2: Coefficients of Autocorrelation for Inflation and Real Wages

	1	2	3	4	5
Inflation with F= *w*	0.4817	0.2193	0.0626	-0.0370	-0.0997
Inflation with F= 2*w*	0.5868	0.3241	0.1418	0.0125	-0.0777
Real Wage with F=*w*	0.3979	0.1564	0.0292	-0.0482	-0.0963
Real Wage with F=2*w*	0.5135	0.2794	0.1298	0.0215	-0.0581

Table 3: Coefficients of Autocorrelation for Real Wages

	1	2	3	4	5	EPL
Netherlands	0.7714	0.6170	0.4918	0.4297	0.2142	3.07
Germany	0.5973	0.3748	0.1530	-0.0068	-0.2758	2.66
France	0.7257	0.5771	0.4418	0.3208	0.1143	2.37
Denmark	0.4756	0.2082	0.0876	0.1188	-0.2053	1.49

Table 4: Coefficients of Autocorrelation for Inflation

	1	2	3	4	5	EPL
Netherlands	0.7943	0.5020	0.1955	-0.0977	-0.2634	3.07
Germany	0.7621	0.4930	0.2660	0.0308	-0.0667	2.66
France	0.6482	0.4460	0.3452	-0.0276	-0.1141	2.37
Denmark	0.6305	0.2939	-0.0294	-0.2077	-0.3028	1.49

Table 5: Coefficients of Autocorrelation for Inflation and Real Wages

	1	2	3	4	5
Inflation with $\frac{b}{w} = 0.56$	0.3788	0.1169	-0.0169	-0.0878	-0.1225
Inflation with $\frac{b}{w} = 0.19$	0.3226	0.0617	-0.0727	-0.1237	-0.1350
Real Wage with $\frac{b}{w} = 0.56$	0.3589	0.1158	-0.0085	-0.0785	-0.1158
Real Wage with $\frac{b}{w} = 0.19$	0.3658	0.1045	-0.0480	-0.1165	-0.1404

FIGURES

Figure 1: The Relationship Between the Volatility of Inflation and Employment Protection

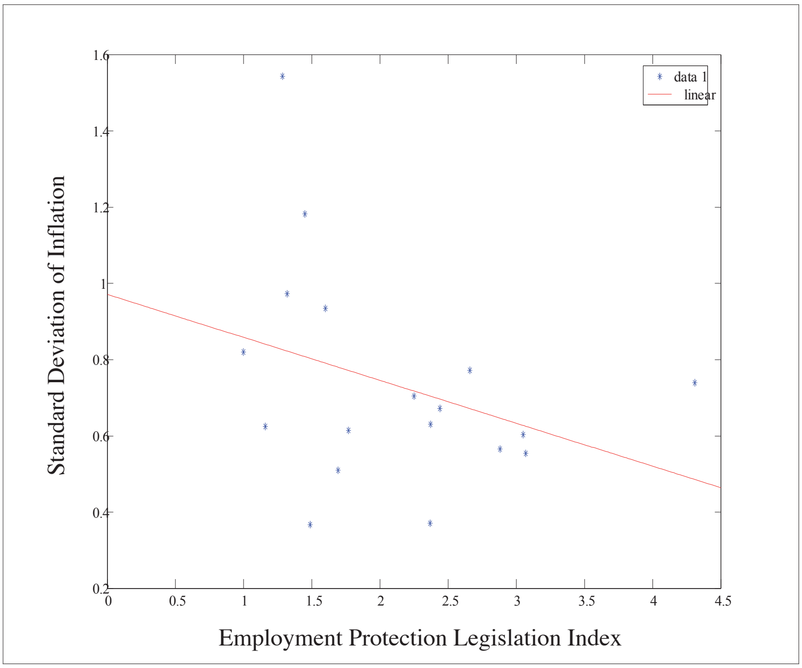

Figure 2: The Relationship Between the Volatility Real Wages and Employment Protection

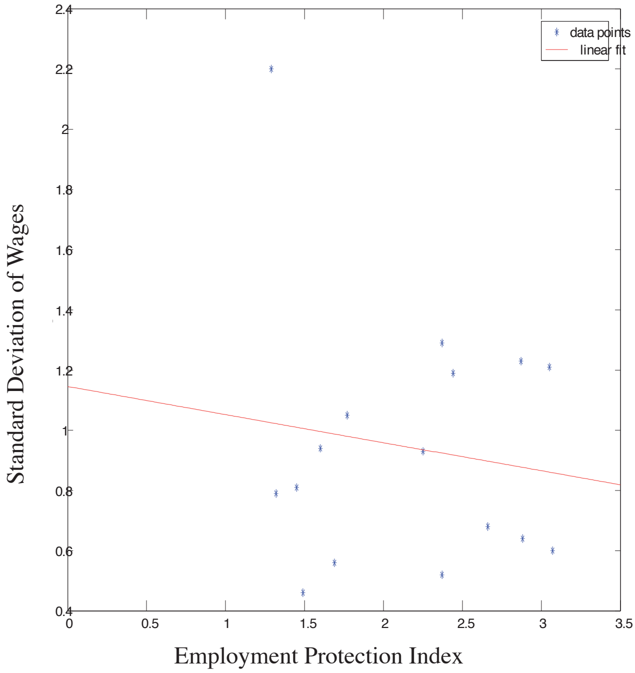

Figure 3: The Relationship Between the Volatility Marginal Cost and Employment Protection

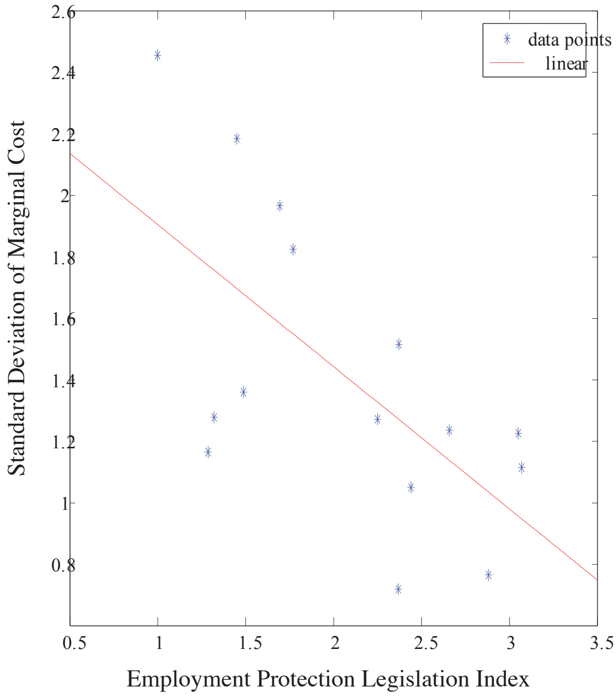

Figure 4: Impulse Response of Inflation for a Positive Productivity Shock

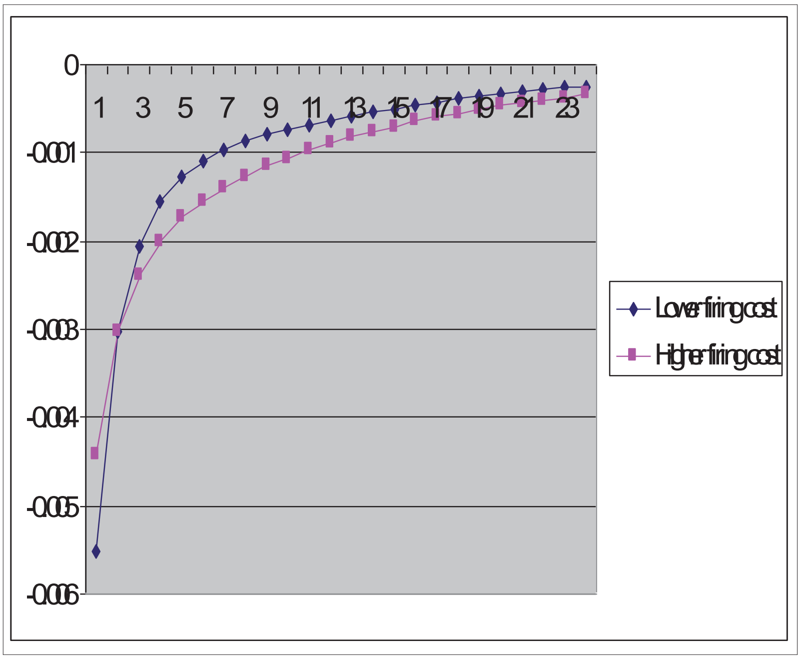

Figure 5: Impulse Response of Inflation for a Monetary Policy Shock

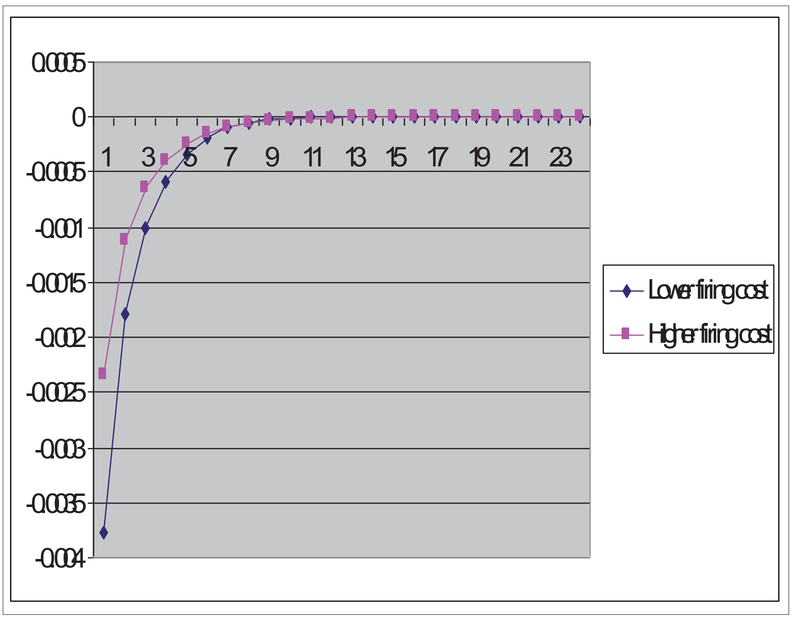

Figure 6: Impulse Response of Wages for a Positive Productivity Shock

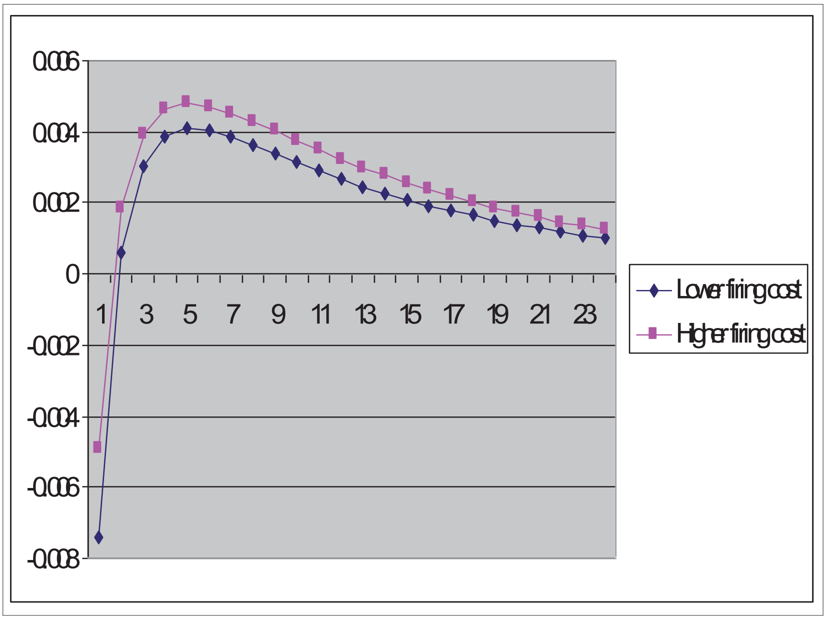

Figure 7: Impulse Response of Inflation to a Positive Productivity Shock

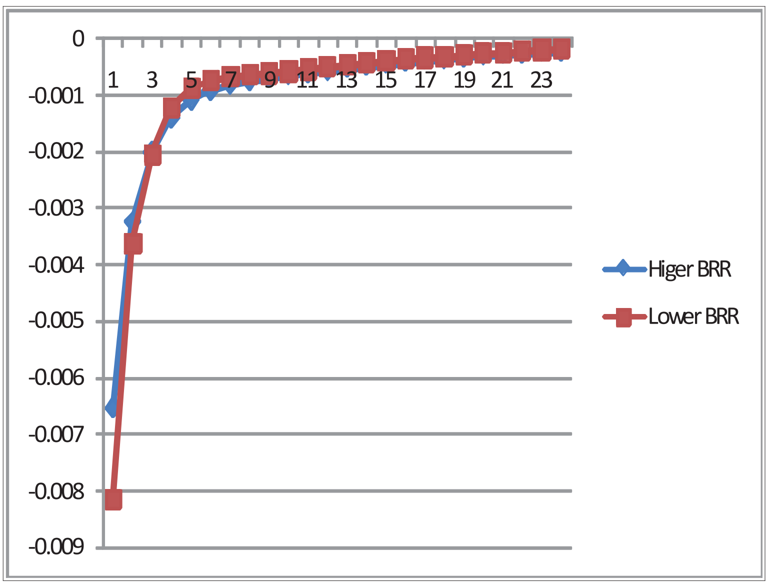

Figure 8: Impulse Response of Inflation to a Monetary Policy Shock

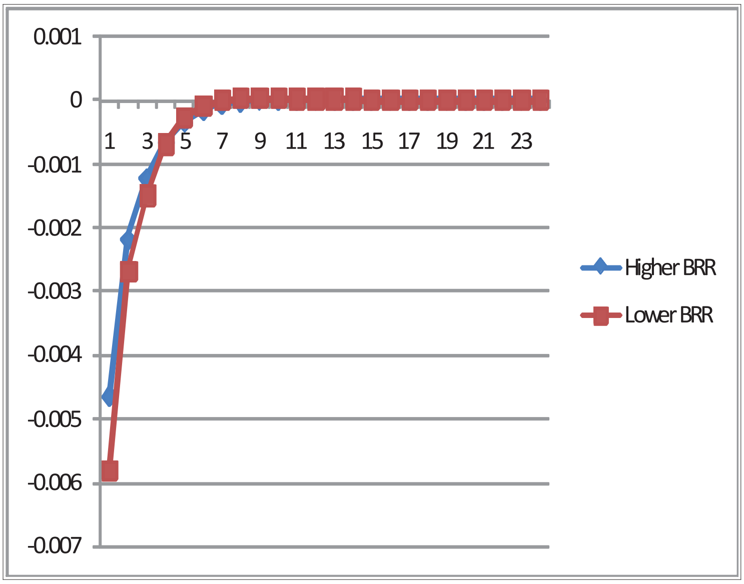

Figure 9: Impulse Response of Wages to a Monetary Policy Shock