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by Steffen Ahrens and Dennis Wesselbaum

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JEL classification: E24, E32, J64.

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†: We wish to thank Christian Haefke, Christian Merkl and Céline Poilly for highly valuable comments.

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Abstract

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1 Introduction

One of the standard explanations for international differences in the performance of labor market dynamics is given by the variability in firing costs, or more general, in employment protection. A complete branch of the literature deals with the importance of firing costs for cross-country differences, as for instance Hopenhayn and Rogerson (1993), Ljungqvist (2001), and L'Haridon and Malherbet (2006). The introduction of firing costs in dynamic equilibrium matching models is essential, since otherwise the firm's decision problem is distorted towards the exit margin. Intuitively, if the entry side of a firm faces hiring costs with yet costless adjustments along the exit site, a firm prefers to adjust along the destruction rather than the creation margin. Furthermore, firing costs are usually referred to as a wasteful tax on layoffs. This view exclusively considers the non-Coasean component of the total firing costs. As shown by Garibaldi and Violante (2005), total firing costs are determined by two components (i) severance payments and (ii) taxes. With this perception, the bonding critique states that firing costs are paid outside the firm-worker pair and hence, are not included in the wage bargaining process. However, whether to include or not include firing costs into the bargaining process is not without ramifications.

In this paper we scrutinize the recent literature about firing costs and analyse empirical studies. In addition, we begin withour analysis of the effects of firing costs in a partial equilibrium matching model. In what follows, we develop a NK model with purely endogenous separations and two types of firing costs. We explicitly differentiate between fix and productivity dependent firing costs. In particular, the latter can explain variations in employment protection of workers within a country. Moreover, we distinguish between respecting the bonding critique - firing cost have no influence in the bargaining process - and non-respecting the bonding critique. Wesselbaum (2009) shows that - by respecting the bonding critique - productivity dependent firing costs only slightly increase the performance of the matching model with respect to the labor market dimension. The exclusive use of endogenous separations is based on empirical evidence by Fujita et al. (2007), Fujita and Ramey (2007, 2008) and Ramey (2008), showing that the separation rate varies over the cycle and hence, is not exogenous. In addition, Balleer (2009) shows that the separation rate increases after a positive technology shock, again rejecting an exogenous separation rate. The paper proceeds as follows. In the next section we have a closer look on the literature about firing costs. Section 3 introduces firing costs in the baseline Mortensen and Pissarides (1994) search and matching model and to motivate the transmission channels of firing costs. Section 4 extends the model to a NKM with search frictions and firing costs. Sections 5 and 6 solve the model, while section 7 discusses the results. Finally, section 8 concludes.

2 Firing Costs: Empirical Evidence and Relation to the Literature

Following Nickell (1997) the mission of employment protection legislation is to protect currently employed economic agents from arbitrary, unfair or discriminatory actions by firms.[1] EPL contains dismissal protection, regulations for fixed-term and temporary work agency contracts, the regulation of hours worked and the definition of labor standards.[2] In the following, if we mention EPL, we will exclusively consider firing costs, i.e. dismissal protection, and disregard other facets. For the sake of simplicity we assume separations to take place on the individual basis and not as collective terminations as i.a. in Abowd and Kramarz (2003). Furthermore, we face the bonding critique, which pays tribute to the fact that the impact of firing costs crucially depends on the extent to which the additional costs can be transferred to the worker due to wage adjustments. As described in Lazear (1988, 1990) and Nickell (1997) the firm reduces the wage for new hires by the present value of future firing costs and hence the wage bill of the worker remains unchanged. To avoid this problem we follow the "standard view of firing costs" in the sense of Bertola and Rogerson (1997), i.e. we consider firing costs as a tax on job destruction.[3] This tax reflects real costs on separations and since it is paid outside the firm-worker pair, the firm is not able to include these costs into the wage bargaining process.[4] Burguet and Caminal (2008) provide a different approach by including private employment protection within the contract between firm and worker, i.e. they allow for various restrictions within the contract. They show that even if severance payments are included, the separation rate is inefficiently high and consistently there is cause for public intervention. In addition, Garibaldi and Violante (2005) distinguish between two immanent elements of firing costs, namely (i) transfers from firm to worker and (ii) a tax that is paid outside the firm-worker pair. In order to analyze the effects of firing costs we follow the mainstream literature, e.g. Koeniger and Prat (2007) or Stähler (2008),

[1] See also Boeri et al. (2003).
[2] For instance, maternity leave, health and safety, equality of treatment or mandatory sick pay. For further details see Addison and Teixeira (2003).
[3] See Fella (1999) for a critique of this approach.
[4] The tax includes e.g. administrative and procedural costs. See e.g. Delacroix (2003).

and intentionally neglect the relevance of the first intrinsic element - corresponding to a severance payment - and maintain our view of firing costs as being a tax on separation since at least one component is non-Coasean.

From our considerations it is quite intuitive that the presence of EPL creates employment adjustment costs, i.e. resource costs. If we consider job destruction as an intertemporal investment decision as in Booth et al. (1999) the introduction of firing costs afflicts separations with costs and presumably the separation process will be time-consuming as described in Garibaldi (1998). Following Addison and Teixeira (2003) EPL furthermore increases the amortized costs of a hire and hence reduces the incentives for job creation. It is beyond controversy that firing costs on the one hand lead to a decrease of hiring and firing rates, i.e. depress job flows, shown amongst others by Cahuc and Postel-Vinay (2001) or Ljungqvist (2001) and on the other hand increase with job tenure as shown by Garibaldi and Pacelli (2008). For instance, Messina and Vallanti (2006) in their empirical paper show that the volatility of job destruction is dampened and the effect on job creation is rather small. They conclude that EPL is in fact causative for the cross-country patterns in cyclicality. Samaniego (2008) and Veracierto (2008) consistently show that firing costs have a significant influence on business cycle fluctuations, e.g. the employment volatility is 30 % lower in Europe compared with the United States.

It is furthermore undisputed that firing costs reduce short-term and increase long-term unemployment, since the firing rate on impact decreases while the hiring rate remains virtually the same. The opposite holds for the long-term unemployment, since the inflow in employment is depressed and hence the more sclerotic labor market leads to higher long-term unemployment.[5] As a consequence, we infer higher unemployment in downturns and more persistent unemployment in upturns. However, the effect on aggregate unemployment is ambiguous. Bentolila and Bertola (1990) and Bertola (1990) show that within in a partial equilibrium model unemployment increases. In a general equilibrium context we find discordant outcomes, Burda (1992), Hopenhayn and Rogerson (1993), Millard (1994), Millard and Mortensen (1994) and Saint Paul (1995) show that unemployment decreases while Alvarez and Veracierto (1997) show the opposite. Following Chen et al. (2001) and De Michelis (2004) the effect of firing costs crucially depends on the properties of the shock. If for instance a negative, high frequency shock is more likely to occur, firing costs have a negative effect on aggregate employment. Moreover, firing costs may stimulate aggregate employment if productivity growths sufficiently fast

[5]Nickell (1997) regressed the effect of EPL on short-term and long-term unemployment and found -0.046, 0.051 respectively. See also Canziani and Petrongolo (2001).

and the likelihood of a recession is low enough.
More recently, Joseph et al. (2003) show that the effect of firing costs depends crucially on the level of wage rigidity. They show that the effect on employment is negative for low wage rigidities, while it tends to be positive for high wage rigidities. The reason is that firing costs have ceteris paribus a negative effect on profits, which would lead to a decrease of the wage. But since firms are constrained by wage rigidity, downward adjustments become too small to compensate this negative effect such that the firms adjust along the extensive margin, i.e. decrease employment.
Empirical evidence shows that the overall strictness of EPL varies significantly between countries, as shown in Figure 1. While e.g. Anglo-Saxon countries are characterized by low values of EPL, countries like Portugal or Mexico reveal values approximately three times as large as the value for the United Kingdom.

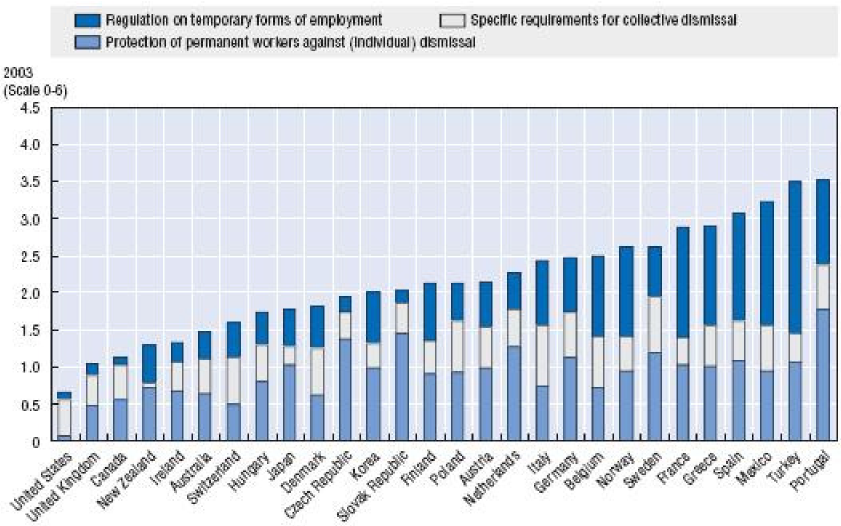

Figure 1: Strictness of EPL.
Source: OECD (2004).

From our precedent considerations it is straightforward that differences in labor market performances between Europe and the U.S. over the last decades might be caused by differences in EPL. From this perspective the more strict EPL causes higher and more persistent unemployment in Europe. This syndrome is widely known as "Eurosclerosis"[6], i.e. the U.S. labor market is less regulated and hence more flexible compared to the rigid, sclerotic European labor market.[7]

Alongside the considerable differences in EPL across countries there is little notice to the fact that EPL also varies within countries. According to Dolado et al. (2005) reasons for differences within a country amongst others are educational level, firm size, skill and tenure. They introduce a Mortensen and Pissarides (1994) model with heterogeneous workers and firing costs and show that reductions in firing costs, targeted on demographic groups, reveal very different results and depend critically on the initial state of the labor market.

However, up to the moment we almost entirely considered the model within the ivory tower. As a next step we need to compare the model's predictions with empirical data. In their Employment Outlook 2004, the OECD provides a cross-country analysis of their member countries (see Figure 2). Panel A and B give proof to the statement that EPL depresses job flows, since the relation between flows into and out of, respectively unemployment and EPL gives a significantly negative correlation. While European countries and the U.S. show a very distinct and striking performance difference this negative relation also holds when leaving out the North American countries. Panel C confirms our view that a more strict EPL increases long-term unemployment. Up to this point, we could verify the predictions of the model. However, Blanchard (2000) and the OECD (2004) confirm that the implication of EPL on aggregate unemployment is ambiguous (consider Figure 3).

Whereas the left panel in Figure 3 points to a negative correlation between EPL and employment that is significant at the 5 % level, the right panel gives no clear association between EPL and unemployment.

Furthermore, we want to consider the regression of EPL on labor market dynamics. The effect of EPL on flows into unemployment is -0.165, on flows out of unemployment -5.030 and on long-term unemployment 3.271 according to the OECD (2004) and statistically significant at the 1 % level. Blanchard (2000) found a value of -0.003 for the effect of EPL on the unemployment rate. We can conclude that higher EPL has an ambiguous effect on aggregate unemployment but significantly changes the volatility of job flows. Even though empirical evidence is in general inconclusive for the relevance of

[6]See e.g. Giersch (1985), Bentolila and Bertola (1990) and Chen et al. (2002).

[7]Chen and Funke (2006) state that the standard severance payment in Germany is set at 66.7 weekly wages while in the U.S. this value is 0.0.

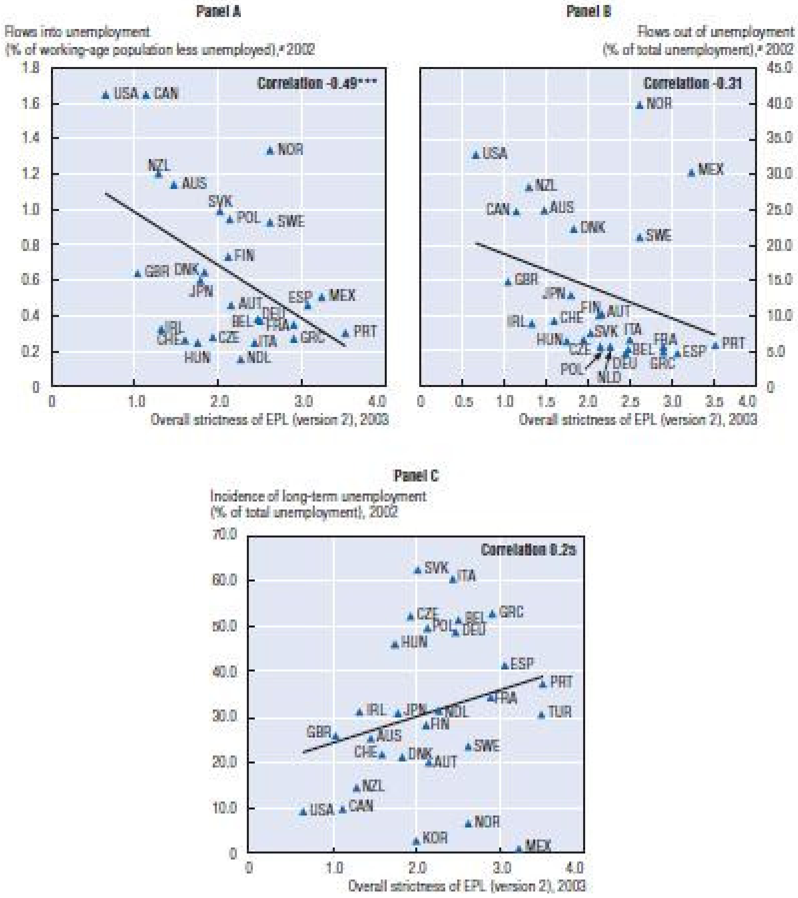

Figure 2: Correlations between EPL and Labor Market Dynamics.
Source: OECD (2004).

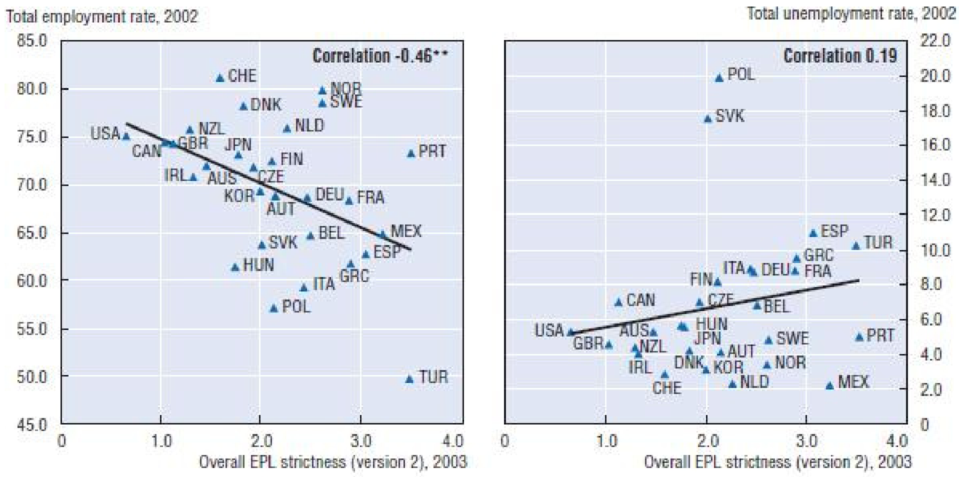

Figure 3: The Effect of EPL on Aggregate Employment and Unemployment.
Source: OECD (2004).

EPL for labor market adjustments.[8]

The predominantly used approach to introduce firing costs is to implement a fixed firing cost, see e.g. L'Haridon and Malherbet (2006), Keoniger and Prat (2007) or Veracierto (2008). In this thesis we use a different approach by assuming productivity dependent firing costs, hence the decisive object, i.e. the choice variable, is the amount of productivity that is redundant from the firm's profit maximizing viewpoint.

A disparate approach can be found in Saltari and Tilli (2008) introducing a firing cost function that is directly implemented into the matching probabilities. With this assumption they are able to show the direct impact of EPL on labor market tightness and job flows.

However, introducing productivity dependent firing costs allows us to pay tribute to several stylized facts related to cross-country differences in EPL as well as differences in EPL within a country, while fix firing costs can explain common costs being constant and correspond to all fired workers. It has to be emphasized that firing costs depend on a broad range of factors and hence could be introduced along several dimensions.[9] Since all conceivable factors have an impact on productivity, it is justified to aggregate and introduce productivity dependent firing costs.

Furthermore, we regard the total firing costs in the firm's maximization problem which is rather neglected in the literature. A mentionable exception is Thomas and Zanetti (2008) introducing a fixed firing cost into the maximization problem. From our viewpoint the introduction of the firing cost function into the firm's maximization problem is essentially important, since otherwise the firm's decision problem would be distorted. In the next section we will analyse the transmission channel of firing costs in a baseline partial equilibrium context.

3 The Transmission Channels of Firing Costs

Insights drawn from empirical research suggest the introduction of firing costs to the standard Mortensen and Pissarides (1994) (MP, for short) search and matching model. In their 1999 survey paper "New Developments in Models of Search in the Labour Market," Mortensen and Pissarides themselves dedicate a complete chapter to the introduction of firing costs. Within the standard partial equilibrium MP search and matching model, suppose that the firm has to pay fixed firing costs T at the time of job destruction.

[8]See e.g. Layard and Nickell (1998), Machin and Manning (1998), Blanchard and Wolfers (2000) and Messina and Vallanti (2006).

[9]For instance, age, education, skill or tenure. See Dolado et al. (2007).

Then, the value of a matched job for the firm is given by

$$rJ = p - w + \delta \left[\int_R^1 J(x)dF(x) - F(R)T - J \right], \tag{1}$$

where r is the discount rate, p is the output of the match, w is an arbitrary wage, δ is the separation probability, R is a critical threshold under which separation takes place, and $F(x)$ is the c.d.f. of the idiosyncratic productivity. The value of a job for the worker is given by

$$rW = w + \delta \left[\int_R^1 W(s)dF(s) + F(R)U - W \right]. \tag{2}$$

If the worker is unemployed he receives the value

$$rU = b + \lambda(\theta)(W - U). \tag{3}$$

Consequently, the standard job creation condition is given by

$$rV = -c + \eta(\theta)(J - V - C) = 0, \tag{4}$$

where c is the cost of posting a vacancy and C is a match creation cost, if the match takes place. rV is driven to zero due to the free entry property. We determine the threshold R, where

$$J(R) < -T. \tag{5}$$

The value of the worker for the firm has to be smaller than the associated firing costs. It is straightforward that the threshold in the case with firing costs is smaller than in the baseline model. Consequently, less productive workers - compared to the standard scenario without firing costs - are retained by the firm. Separating from these workers is costly and as long as the relative lack of productivity is less than the firing costs involved, firing them is unprofitable. Therefore, firing costs patronize some of the less productive workers. Of course, this effect influences the firm's exit side.

The match shares an economic rent which is split according to a Nash bargaining, which solves

$$\Lambda = \underset{w_t}{\operatorname{argmax}} \left\{ (W - U)^{\beta} (J - C - V)^{1-\beta} \right\}. \tag{6}$$

The solution satisfies the optimality condition

$$(1-\beta)(W-U)=\beta(J-C-V). \tag{7}$$

Because $V=0$, we obtain the wage

$$w=\beta(p-(r+\delta)C-\delta T)+(1-\beta)rU. \tag{8}$$

From (8) we infer that the wage is decreasing in the degree of firing costs. The higher the firing costs, the lower the wage that is paid to the worker. This result is a quite intuitive, since a part of the firing costs is borne by the worker. If we respect the bonding critique, there is no change in the wage and only the effect on the threshold arises.
Leaving the partial equilibrium and turning to the general equilibrium context yields the need to implement the firing costs into the firms maximization problem.
Consider a standard Rotemberg (1982) profit maximization problem, given by

$$\Pi_{i0}=E_0\sum_{t=0}^{\infty}\beta^t\frac{\lambda_t}{\lambda_0}\left[\frac{P_{it}}{P_t}y_{it}-\mathcal{W}_{it}-cv_{it}-G(a_{it})-\rho_{it}n_{it}\Gamma-\frac{\psi}{2}\left(\frac{P_{it}}{P_{it-1}}-\pi\right)^2 Y_t\right]. \tag{9}$$

In contrast to the standard problem, we obtain two extra terms given by $G(a_{it})$, which gives the total firing costs from the productivity dependent component, and $\rho_{it}n_{it}\Gamma$, being the total firing costs from the fixed component. Straightforwardly, the first-order condition with respect to the threshold and to the firm's work force, - defining the job destruction and job creation condition respectively, are affected. This can be interpreted as the entry side effect of firing costs, which is absent in the baseline NK specification.
The job creation condition is given by

$$\frac{c}{q(\theta_t)}=E_t\beta_{t+1}(1-\rho_{t+1})\left[\varphi_{t+1}A_{t+1}H(\tilde{a}_{t+1})-\frac{\partial\mathcal{W}_{t+1}}{\partial n_{t+1}}+\frac{c}{q(\theta_{t+1})}-\rho_{t+1}\Gamma\right]. \tag{10}$$

In contrast to the standard maximization problem, the latter term yields a more reluctant vacancy posting, since the present value of the match is smaller.
Exit and entry side effects change the behavior of the firm and therefore, result in altered dynamics compared with the standard search and matching model. In the next section, we explicitly derive the NK model with firing cost.

4 A New Keynesian Model with Firing Costs

In the following, we present a NK model with labor market frictions in the spirit of Mortensen and Pissarides (1994), den Haan et al. (2000), and Krause and Lubik (2007). Households maximize utility by choosing the optimal consumption path of a CES aggregate of differentiated products. Firms, acting on a monopolistically competitive market, maximize profits by setting prices and choosing optimal employment subject to price adjustment costs and labor turnover costs. Job creation is afflicted with hiring costs and job destruction is afflicted with fix and productivity dependent firing costs. Separations are driven by job-specific productivity shocks, generating a flow of workers into unemployment. The transition process from unemployment to employment is subject to search frictions, characterized by a matching function. Monetary policy targets the short term interest rate by a standard Taylor rule.

4.1 Household Maximization

We assume a discrete-time economy with an infinitely living representative household who seeks to maximize its utility given by

$$U = E_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{C_t^{1-\sigma} - 1}{1-\sigma} \right], \tag{11}$$

where σ is the degree of risk aversion and the consumption bundle $C_t = \int_0^1 \left[C_{it}^{\frac{\epsilon-1}{\epsilon}} di \right]^{\frac{\epsilon}{\epsilon-1}}$ is the Dixit-Stiglitz (1976) aggregator of the different types of goods. It is assumed that a household consists of a continuum of family members, inelastically suppling one unit of labor and being represented by the unit interval. For the sake of simplicity, we assume consumption pooling.[10] The household maximizes consumption subject to the intertemporal period budget constraint

$$C_t + \frac{B_t}{P_t} = \mathcal{W}_t + R_{t-1} \frac{B_{t-1}}{P_t} + bu_t + \Pi_t + T_t, \tag{12}$$

where b is the value of home production, $\mathcal{W}_t$ is labor income, and B_t is Bond holding, which pays a gross interest rate R_t. Further, Π_t are aggregate profits and T_t are real lump sum transfers from the government. Expenditure minimization yields the household's demand function for an individual good i given by $C_{it} = \left(\frac{P_{it}}{P_t} \right)^{-\epsilon} C_t$. Finally,

[10] See Merz (1995) and Andolfatto (1996).

intertemporally maximizing household's utility, we obtain the standard Euler equation for intertemporal consumption flows

$$C_t^{-\sigma} = \beta R_t E_t \left[\frac{P_t}{P_{t+1}} C_{t+1}^{-\sigma} \right]. \tag{13}$$

4.2 The Labor Market and Firm Maximization

The labor market is subject to search and matching frictions. Firms post vacancies to signal working opportunities and workers actively search for suitable jobs. Thus, matching a firm-worker pair is time consuming. We assume that matches are governed by a Cobb-Douglas type matching function with constant returns to scale.[11] Explicitly, the matching function is $\Psi(u_t, v_t) = m u_t^{\mu} v_t^{1-\mu}$, where u_t and v_t are the number of unemployed workers and open vacancies, respectively. The latter are assumed to lie on the unit interval $v_t = \int_0^1 v_{it}\, di$. The parameter $\mu \in (0,1)$ denotes the matching elasticity of unemployment and the positive scaling factor m is the match efficiency. The matching function is homogeneous of degree one, strictly increasing in each of its arguments, strictly concave, and twice continuously differentiable. Due to homogeneity of degree one the probability of filling a vacancy in the next period is given by $q(\theta_t) = m\theta_t^{-\mu}$. The relation of vacancies to unemployment gives the labor market tightness $\theta_t = v_t/u_t$.

We assume a continuum of firms, where each firm itself consists of a continuum of different jobs. While aggregate productivity A_t is common to all firms, specific productivity a_{it} is idiosyncratic. Every period, in advance of the production process, a_{it} is drawn from a time-invariant distribution with c.d.f. $F(a)$. The firm specific production function is the product of aggregate productivity, the number of jobs, and the aggregate over individual jobs productivity. Thus, it can be written as

$$y_{it} = A_t n_{it} \int_{\tilde{a}_{it}}^{\infty} a \frac{f(a)}{1 - F(\tilde{a}_{it})} da \equiv A_t n_{it} H(\tilde{a}_{it}). \tag{14}$$

The variable $\tilde{a}_{it}$ is an endogenously determined critical threshold and $H(\tilde{a}_{it})$ is the conditional expectation $E\left[a | a \geq \tilde{a}_{it}\right]$. If the specific productivity of a job is below this threshold, the job is not profitable and separation takes place. This consideration leads to an endogenous job destruction rate $\rho_{it} = F(\tilde{a}_{it})$.

Whenever separation takes place, firing costs arise. In this paper, we allow for two dif-

[11] In their empirical analysis Petrongolo and Pissarides (2001) find that the Cobb-Douglas function with constant returns to scale is the most appropriate specification. Furthermore, Stevens (2007) derives a microfounded matching function which is approximately Cobb-Douglas.

ferent types of firing costs; a fixed value Γ for every worker laid off and a flexible amount $g(a_{it})$, which relates to the idiosyncratic productivity of the fired worker. We assume that $\phi(a_{it})$ is a linear real-valued function $\phi(a_{it}) = ka_{it}$[12], which is twice continuously differentiable, strictly convex and strictly increasing in a. Thus, aggregate firing costs are

$$\Phi(a_{it}) = \rho_{it} n_{it} \Gamma + k \int_0^{\tilde{a}_{it}} a \frac{f(a)}{1 - F(\tilde{a}_{it})} da. \tag{15}$$

The first term of equation (15) says that the firm only pays the fixed severance payments for the fraction of separated workers, while the second term aggregates all workers, whose productivity is below the critical threshold and weights them with their individual productivity. Multiplying the aggregate productivity with a parameter $k > 0$, defines the firing tax.

Firms intend to maximize profits

$$\Pi_{i0} = E_0 \sum_{t=0}^{\infty} \beta^t \frac{\lambda_t}{\lambda_0} \left[\frac{P_{it}}{P_t} y_{it} - \mathcal{W}_{it} - cv_{it} - \Phi(a_{it}) - \frac{\psi}{2} \left(\frac{P_{it}}{P_{it-1}} - \pi \right)^2 Y_t \right], \tag{16}$$

which are real revenues depleted by total costs. Due to the assumptions about nominal and real frictions as well as pricey labor turnover, total costs are not solely determined by the wage bill $\mathcal{W}_{it}$. However, they additionally comprise vacancy posting-, aggregate firing-, and price adjustment costs. The parameters $c > 0$ and $\psi \geq 0$ denote the real costs per vacancy and the price adjustment costs, respectively. The wage bill aggregates the individual wages of the heterogeneous workers

$$\mathcal{W}_{it} = n_{it} \int_{\tilde{a}_{it}}^{\infty} w_t(a) \frac{f(a)}{1 - F(\tilde{a}_{it})} da. \tag{17}$$

From the first order conditions with respect to labor and vacancies, we directly derive the job creation condition

$$\frac{c}{q(\theta_t)} = E_t \beta_{t+1} (1 - \rho_{t+1}) \left[\varphi_{t+1} A_{t+1} H(\tilde{a}_{t+1}) - \frac{\partial \mathcal{W}_{t+1}}{\partial n_{t+1}} + \frac{c}{q(\theta_{t+1})} - \rho_{t+1} \Gamma \right], \tag{18}$$

where ξ_t denotes the current period's average value of workers across job-specific productivities and φ_t are real marginal costs. Equation (18) governs the hiring decisions, which reveal to be a trade-off between the costs of posting a vacancy and its discounted

[12] Abowd and Kramarz (2003) and Kramarz and Michaud (2004) empirically find a roughly linear relationship between severance payments and productivity.

expected return. The expression $1/q(\theta_t)$ measures the duration of the firm-worker relationship. Note that the existence of firing costs decreases the expected discounted return and hence, mitigates the incentive to post vacancies.
Analogously, combining the first order conditions with respect to labor and idiosyncratic productivity results in the job destruction condition

$$\varphi_t A_t \tilde{a}_t + \frac{c}{q(\theta_t)} - w_t(\tilde{a}_t) + \Gamma(1 - 2\rho_t) = 0. \tag{19}$$

Again, firing costs decrease firms' incentives to become active. Consequently, firing costs dampen hiring as well as the firing margin. Hence, we determine the evolution of employment at firm i given by

$$n_{it+1} = (1 - \rho_{it+1})(n_{it} + v_{it} q(\theta_t)), \tag{20}$$

which crucially depends on the firms decisions to post vacancies and to set the critical threshold. Finally, the assumption of staggered pricing leads to the characteristic New Keynesian Phillips Curve given by

$$\hat{\pi}_t = \beta E_t \hat{\pi}_{t+1} + \kappa \hat{\varphi}_t, \tag{21}$$

where $\kappa = (\epsilon - 1)/\psi$ governs the reaction of inflation to changes in the real marginal costs. The latter can be derived from the firm's first order condition with respect to employment.

$$\varphi_t = \frac{\partial \mathcal{W}_t / \partial n_t}{A_t H(\tilde{a}_t)} + \frac{\xi_t - c/q(\theta_t)}{A_t H(\tilde{a}_t)} + \frac{\rho_{t+1}\Gamma}{A_t H(\tilde{a}_t)}. \tag{22}$$

Intuitively, the presence of firing costs increase the real marginal costs.

4.3 Wage Setting

4.3.1 Respecting the Bonding Critique

In this section we strictly respect the bonding critique, i.e. we do not introduce the firing costs into the bargaining problem and the asset value functions. Following Trigari (2004) a matched firm-worker pair has an unambiguously higher expected return than an unmatched pair. This is a consequence from the time-consuming and expensive search and matching process. If a firm and a worker match, the job shares an economic rent which is split according to individual Nash bargaining. We maximize the Nash product

$$\Lambda = \underset{w_t}{\operatorname{argmax}} \Big\{ (W_t - U_t)^{\eta} (J_t - V_t)^{1-\eta} \Big\}, \tag{23}$$

where the first term is the worker's surplus and the latter term is the firm's surplus. Furthermore, $0 \leq \eta \leq 1$ denotes the constant relative bargaining power of the worker and U_t and V_t are the worker's and the firm's fall back options, respectively.[13] Furthermore, J_t is the firm's asset value of a filled job and W_t is the worker's asset value of being employed. Accordingly, U_t is the worker's asset value of being unemployed. The individual real wage satisfies the optimality condition

$$W_t(a_t) - U_t = \frac{\eta}{1-\eta} J_t(a_t). \tag{24}$$

To obtain an explicit expression for the individual real wage we have to determine the asset values and substitute them into the Nash bargaining solution (24).

The firm's asset value of the filled job depends on the real revenue, the real wage, and in case the workers is retained, the discounted future asset value. In case the job is destroyed it has zero value. We can write this relation in form of a Bellman equation given by

$$J_t(a_t) = \varphi_t A_t a_t - w_t(a_t) + E_t \beta_{t+1} \left((1 - \rho_{t+1}) \int_{\tilde{a}_{t+1}}^{\infty} J_{t+1}(a) \frac{f(a)}{1 - F(\tilde{a}_{t+1})} da \right). \tag{25}$$

The worker's asset value of being employed consists of the real wage, the discounted continuation value, and in case of separation the value of being unemployed

$$W_t(a_t) = w_t(a_t) + E_t \beta_{t+1} (1 - \rho_{t+1}) \int_{\tilde{a}_{t+1}}^{\infty} W_{t+1}(a) \frac{f(a)}{1 - F(\tilde{a}_{t+1})} da + E_t \beta_{t+1} \rho_{t+1} U_{t+1}. \tag{26}$$

Analogously, the asset value of a job seeker is given by

$$\begin{aligned} U_t = b + E_t \beta_{t+1} \theta_t q(\theta_t)(1 - \rho_{t+1}) \int_{\tilde{a}_{t+1}}^{\infty} W_{t+1} \frac{f(a)}{1 - F(\tilde{a}_{t+1})} da \\ + E_t \beta_{t+1} (1 - \theta_t q(\theta_t)(1 - \rho_{t+1})) U_{t+1}. \end{aligned} \tag{27}$$

Unemployed workers receive the value of home production b, the discounted continuation value of being unemployed, and in case she matches the value of future employment.

[13] Due to a free entry condition the equilibrium value of V_t is zero.

Having the assset function explicitly defined, the Nash bargaining solution yields the individual real wage

$$w_t(a_t) = \eta(\varphi_t A_t a_t + c\theta_t) + (1-\eta)b. \tag{28}$$

Now, the firm will endogenously separate from a worker if and only if

$$J_t(a_t) < -(\Gamma + k a_t), \tag{29}$$

i.e. if the worker's asset value is lower than the associated firing costs.[14] Consequently, the resulting threshold is

$$\tilde{a}_t = \frac{1}{(1-\eta)\varphi_t A_t + k}\left[(1-\eta)b + \eta c\theta_t - \frac{c}{q(\theta_t)} - \Gamma\right]. \tag{30}$$

4.3.2 Non-Respecting the Bonding Critique

In contrast to the precedent section, we now introduce the firing costs into the bargaining problem and the asset value functions. This yields an alternative Nash bargaining problem

$$\Lambda = \underset{w_t}{\text{argmax}}\left\{(W_t - U_t)^{\eta}(J_t - V_t + \Gamma + k a_t)^{1-\eta}\right\}. \tag{31}$$

The associated optimality condition is given by

$$W_t(a_t) - U_t = \frac{\eta}{1-\eta}\left(J_t(a_t) + \Gamma + k a_t\right), \tag{32}$$

and the corresponding asset value functions are

$$J_t(a_t) = \varphi_t A_t a_t - w_t(a_t) + E_t\beta_{t+1}\left((1-\rho_{t+1})\int_{\tilde{a}_{t+1}}^{\infty} J_{t+1}(a)\frac{f(a)}{1-F(\tilde{a}_{t+1})}da - \rho_{t+1}(\Gamma + k a_t)\right) \tag{33}$$

$$W_t(a_t) = w_t(a_t) + E_t\beta_{t+1}(1-\rho_{t+1})\int_{\tilde{a}_{t+1}}^{\infty} W_{t+1}(a)\frac{f(a)}{1-F(\tilde{a}_{t+1})}da + E_t\beta_{t+1}\rho_{t+1}U_{t+1}, \tag{34}$$

$$\begin{aligned} U_t &= b + E_t\beta_{t+1}\theta_t q(\theta_t)(1-\rho_{t+1})\int_{\tilde{a}_{t+1}}^{\infty} W_{t+1}\frac{f(a)}{1-F(\tilde{a}_{t+1})}da \\ &+ E_t\beta_{t+1}(1-\theta_t q(\theta_t)(1-\rho_{t+1}))U_{t+1}. \end{aligned} \tag{35}$$

[14]See Kugler and Saint-Paul (2000, 2004) and Lechthaler et al. (2008).

After some algebra this results in the altered expression for the individual real wage[15]

$$w_t(a_t) = \eta\big(\varphi_t A_t a_t + c\theta_t + (1-\beta_{t+1}\rho_{t+1})(\Gamma + k a_t)\big) + (1-\eta)b. \tag{36}$$

The introduction of firing costs increases the individual real wage. Intuitively, the change in the fall back position of the firm strengthens the bargaining position of the worker. Note that condition (29) still governs endogenous separations, independently, if we respect or disrespect the bonding critique. Applying the altered asset value functions to (29), we derive the new critical threshold

$$\begin{aligned}\tilde{a}_t = \frac{1}{(1-\eta)\varphi_t A_t + (1-\eta+(\eta-1)\beta_{t+1}\rho_{t+1})k}\Bigg[&(1-\eta)b + \eta c\theta_t - \frac{c}{q(\theta_t)} \\ &+((1-\eta)\beta_{t+1}\rho_{t+1} - 1 + \eta)\Gamma\Bigg],\end{aligned} \tag{37}$$

where $(1-\eta+(\eta-1)\beta_{t+1}\rho_{t+1})k > 0$ and $((1-\eta)\beta_{t+1}\rho_{t+1} - 1 + \eta) < 0$. Note that firing cost decrease the threshold, i.e. protect less productive worker.

5 Closing the Model

To close the private sector, note that aggregate household income matches aggregate production

$$Y_t = \mathcal{W}_t + \Pi_t = A_t n_t \int_{\tilde{a}_{it}}^{\infty} a \frac{f(a)}{1-F(\tilde{a}_{it})} da. \tag{38}$$

and that goods markets clear $C_t = Y_t$.
The public sector in this model conducts monetary policy. We assume central banks to follow a standard Taylor rule

$$i_t = \phi_\pi \pi_t + \phi_y Y_t + \varrho_t, \tag{39}$$

where ϕ_π and ϕ_y are the reaction parameters for variations in inflation and output, respectively. The interest rate shock ϱ_t follows an AR(1)

$$\varrho_t = \rho_i \varrho_{t-1} + \epsilon, \tag{40}$$

[15] Note, that in this case - and in contrast to ch. 1 - firing costs increase the wage due to the consideration of idiosyncratic productivity and the associated changes of the bargaining process.

with ρ_i being the persistence of the shock.
Analogously, the aggregate productivity shock also follows an AR(1)

$$A_t = \rho_A A_{t-1} + \alpha_{A,t}, \tag{41}$$

with ρ_A being the persistence of the productivity shock, respectively. The i.i.d. error term is $\alpha_{A,t} \sim N(0, \sigma_A)$ with $\text{cov}(A_{t-1}, \alpha_{A.t}) = 0 \; \forall \; t$.
In the remainder of the paper, we calibrate and solve the model.

6 Calibration

We calibrate the model on a quarterly basis for the U.S. The household sector is calibrated according to the standard literature. Thus, we set the relative risk aversion $\sigma = 2$, which is also in line with recent evidence from Smets and Wouters (2007). According to Küster (2007), we choose the discount factor β to be 0.99, corresponding a real interest of four percent for quarterly data. The elasticity of substitution is calibrated to $\epsilon = 11$, translating into a steady state markup of 10% (Trigari (2004)). Worker's idiosyncratic productivity is assumed be i.i.d. and to follow a normalized lognormal distribution with mean $\mu_{LN} = 0$ and $\sigma_{LN} = 0.12$. The variance parameter is set to match Cooley and Quadrini's (1999) finding that job destruction is about seven times as volatile as employment. Furthermore, this value is well between the values of 0.10 from den Haan et al. (2000) and 0.13 from Walsh (2005). For simplicity, we follow Christoffel and Linzert (2005) and choose symmetric bargaining, i.e. $\eta = 0.5$. The search elasticity of matches μ is also calibrated to be 0.5, satisfying the Hosios (1990) rule and thus, leading to a socially efficient outcome. Moreover, this calibration is close to 0.55, a value estimated by Trigari (2004).
On the firm side, we choose $\psi = 105$, which is analogous to a Calvo (1983) parameter for an average fixed price duration of one year. This is close to evidence of Taylor (2000), however, opposes the findings by Bils and Klenow (2004). Steady state inflation is set to unity. Additionally, firms face two kinds of firing costs; productivity dependend and productivity independent ones. Since there are no direct estimates on firing costs in the U.S., we follow the procedure from Brown et al. (2009). Therefore, we take the magnitude value of firing costs for the U.K. from Bentolila and Bertola (1990) and convert it to an U.S. estimate by multiplying this value with the ratio of the U.S. and the U.K. unemployment protection legislation indices. The latter we obtain from Belot et al.

(2007). This leads to a calibration of firing costs of approximately 10% of productivity. Furthermore, Brown et al. (2009) point out that estimates for industrialized European countries are somewhat higher. Due to missing empirical evidence, we perform an extensive robustness analysis of firing costs in the discussion.

The critical threshold is computed according to the inverse c.d.f. of the lognormal distribution, i.e. $\tilde{a} = F^{-1}(\rho)$. Separations ρ are purely endogenous and set to be 0.12 in steady state. We calibrate steady state unemployment u to be 0.2. A rather high value of unemployment also accounts for potential participants in the labor market as, for instance, discouraged workers or loosely attached to the labor force (Faia (Forthcoming)). However, this value is well between 0.12 as in Krause and Lubik (2007) and den Haan et al. (2000) and remarkebly higher values like 0.43 in Cooley and Quadrini (2004) and 0.58 in Andolfatto (1996). Furthermore, a rather high value of steady state unemployment is in accordance with Brown et al. (2009), who also apply a purely endogenous separations model with idiosyncratic productivity. Following den Haan et al. (2000), we impose a firm matching rate $\bar{q}$ of 0.7, which, additionally, is close to $\bar{q} = 0.8541$, the magnitude chosen by Fujita and Ramey (2005).

The missing parameters m, b, c, and κ are computed from several steady state representations.

Finally, we specify the shock processes. The calibration follows Cooley and Quadrini (1999). Thus, the interest rate shock shows a persistence parameter $\rho_i = 0.49$ and has standard deviation $\sigma_i = 0.0623$. Analogously, we assign $\rho_A = 0.95$ and $\sigma_A = 0.0049$ to the productivity shock.

7 Results

This section discusses the results for our model with baseline calibration from Table 1.

7.1 Interest Rate Shock

Consider first the monetary authority decreases the nominal interest rate. The impulse response functions are presented in Figures 4 and 5. In the former, the bonding critique is binding, while in the latter it is not.

As a consequence of the lower interest rate, households pull forward consumption. To match the increase in demand, firms expand employment and hence, output. However, since hiring is time consuming and costly, the bulk of additional employment is generated by lowering the critical threshold, which protects less productive workers from being laid-off. Job creation, on the other hand, plays an almost negligible role. Therefore, the model reveals a separation-driven employment adjustment mechanism.

Over time, the system converges to the steady state, being mainly governed by the job creation condition.

Let us turn to the second moments of our model. We consider three cases, with firing costs being (i) only productivity dependent, (ii) only fix and (iii) both. We emphasize that we set both types of firing costs to match 10 % of the idiosyncratic and the aggregate productivity, respectively. In (iii), both types of firing costs are set to 0.1. however, one cannot exactly determine to which extend the dependent and the fix firing costs contribute to overall firing costs. Since our aim is to analyse the importance of the bonding critique, the calibration of (iii) plays only a subordinate role. Our results are presented in Table 2. We find that respecting and non-respecting the bonding critique perform equally well in matching the standard deviations, whereas non-respecting it yields a more precise match of the negative correlation of job creation and destruction.[16] Furthermore, Table 2 reveals that differences in performance, arising from the specific formulations of the firing costs, are negligible.

7.2 Productivity Shock

Next, we discuss a one percent shock to aggregate productivity. The impulse response functions are given by Figures 6 and 7 for a binding and non-binding bonding critique, respectively.

Consequently to the shock, output and employment increase which again forces firms to keep workers, which otherwise would have been fired. As already explained, the model is driven by adjustments along the extensive margin. In addition, vacancy postings increase, which follows immediately from the job creation condition, since expected profits from creating a match increase.

The second moments of the productivity shock are summarized in Table 3. Unlike in the case of the interest shock, the second moments arising from the productivity shock significantly deviate in magnitude from the empirical facts. Furthermore, in neither case the model produces a Beveridge curve or the negative correlation of job creation and job destruction responding a productivity shock. As a general result - in line with the outcomes of the interest rate shock - respecting and non-respecting the bonding

[16] We would like to emphasize that the negative correlation between job creation and job destruction is mainly influenced by the implementation of a Taylor rule and the value of the unemployment rate.

critique perform equally well in matching the standard deviations. Nevertheless, in great contrast to the interest rate shock, for the productivity shock the specification of firing costs matters . Referring to Table 3 yields a qualitative ranking of performance, i.e. the productivity dependent firing costs yield the best and the fixed the worst results. Nevertheless, the quantitative differences are again small.

7.3 Sensitivity Analysis

Concluding from the simulation results, the definition of firing costs marginally influences the dynamics of productivity shocks and is barely affective responding to an interest rate shock. This section focuses on the sensitivity of the model towards the magnitude of the firing costs. Therefore, we compare the dynamics resulting from the shocks described above for different values of firing costs. In particular, we juxtapose the impulse response functions when firing costs are absent, thirty percent, and one hundred percent, respectively. We are aware of the unrealistically high magnitudes of firing costs assumed, however, these extreme numbers serve the purpose of visualization only.

Figure 8 displays the impulse response functions for the interest rate shock. The upper panels show the case where the bonding critique holds and hence, firing costs do not influence the wage bargaining between firm and worker. This panel exhibits that altering the firing costs barely affects the dynamics of the system at all. The lower panels, on the other hand, depict the alternative case when firing costs are included in the bargaining process. In this case, increasing the firing costs results in higher peaks and troughs of the job destruction and job creation rates, respectively. Furthermore, the higher the firing costs, the more vacancies are posted by the firms.[17] Comparing both outcomes reveals that firing costs almost exclusively affect the system dynamics through the different reactions of the wage, which depends on respecting or disrespecting the bonding critique. In the former case, the wage is not influenced by firing costs and vacancy posting takes place as in a setting without firing costs. However, disrespecting the bonding critique yields wages to decline in increasing firing costs. As we can see from first case, firing costs do not alter the firms vacancy posting decisions. Lower wages, on the other hand, raise the present value of a vacancy, giving firms an incentive to extend postings.

Unlike the dynamics following an interest rate shock, the dynamics of a productivity shock are always driven by the presence of firing costs. Nevertheless, the decision for or against the bonding critique has ramifications for the system's direction of action. Figure

[17]When firing costs exceed 100%, the system produces a Beveridge curve.

8 encloses, while - under the bonding critique - vacancy postings are driven upwards by increasing firing costs, they are forced downwards in the absence of the bonding critique. Hence, with unemployment being qualitatively and quantitatively rather unaffected, this results in opposing relative behavioral patterns of job creation and job destruction in the two different cases. This result again is initiated by the different reactions of the real wage. The real wage is strongly increasing in firing costs when the bonding critique is binding, whereas it is decreasing in firing costs, when they do not play a role in the bargaining process.

The sensitivity analysis has shown that firing costs do matter for labor and product market dynamics, however, unfortunately, only for exorbitant values. When low magnitudes of firing costs are applied, they do not seem to matter much.

8 Conclusion

This paper surveys the existing literature about firing costs and discusses empirical evidence about the (un)importance of firing costs. We have analyzed the impact of two types of firing costs (i) productivity dependent and (ii) fix firing costs as well as the ramifications of the bonding critique. While the dependent firing costs mainly work along the exit site, the fix costs also directly influence the entry site. We find that the dynamics of the system vary with the presence of firing costs only for exorbitant values. For reasonable magnitudes, firing costs play an subordinate role. Looking at the second moments reveals that the responses to an interest rate shock change only marginally with the specification of firing costs as well as the decision for or against the bonding critique. Qualitatively and quantitatively, the differences in performance across specifications are negligible for the interest rate shock. To a lesser extend, these results can be assigned to a productivity shock. However, there perceivable differences arise even with reasonable firing costs of ten percent. However, also these differences are quantitatively small. We emphasize that in the endogenous separations model, with a separation driven adjustment mechanism, the exit site effect dominates the entry site effect and consistently, the performance difference between the two types of costs consequentially has to be small. Consistently, only high value of firing costs break this problem. We would like to emphasize that a proper calibration of firing costs is only hardly possible due to a lack of empirical studies. To sum up, the overall performance differences from respecting and non-respecting the bonding critique and the two types of firing costs are relatively small, however, they should not be underestimated.

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Appendix

Table 1: Calibration for the U.S.

Parameter	Meaning	Value
Imposed:		
σ	Risk aversion parameter	2
β	Discounting factor	0.99
ϵ	Elasticity of substitution	11
μ_{LN}	Mean distribution parameter	0
σ_{LN}	Variance distribution parameter	0.12
μ	Search Elasticity of Matches	0.5
η	Worker's bargaining Power	0.5
k	Dependent Firing Costs	0.1
Γ	Fixed Firing Costs	0.1
ψ	Rotemberg Parameter	105
ϕ_π	Taylor Rule Parameter on Inflation	1.5
ϕ_y	Taylor Rule Parameter on Output	0.125
ρ_i	AR(1) Interest Shock Parameter	0.49
σ_i	Standard Deviation of Interest Shock	0.0623
ρ_A	AR(1) Productivity shock Parameter	0.95
σ_A	Standard Deviation of Productivity Shock	0.0049
ρ	Steady State Separations	0.12
q	Steady State Job Filling Rate	0.7
π	Steady State Inflation	1
n	Steady State Employment Rate	0.80

Table 2: Business Cycle Facts and Responses to an Interest Rate Shock

	US	dependent		fixed		both	
	Economy	w	w/o	w	w/o	w	w/o
Standard Deviations:							
Output	$1,62$	0.981	0.989	0.987	0.992	0.984	0.991
Inflation	$1,11$	0.047	0.034	0.037	0.029	0.042	0.031
Real Wage	$0,69$	0.259	0.160	0.198	0.132	0.229	0.146
Unemployment	$6,90$	4.325	4.365	4.349	4.377	4.337	4.371
Vacancies	$8,27$	2.802	2.645	2.855	2.682	2.828	2.664
Tightness	$14,96$	1.563	1.759	1.537	1.737	1.550	1.748
JCR	$2,55$	4.785	4.758	4.831	4.785	4.810	4.771
JDR	$3,73$	7.113	7.212	7.166	7.238	7.139	7.225
Correlations:							
U,V	$-0,95$	0.995	0.994	0.995	0.994	0.995	0.994
JCR,JDR	$-0,36$	-0.248	-0.270	-0.249	-0.270	-0.249	-0.270

Table 3: Business Cycle Facts and Responses to a Productivity

	US Economy	dependent w	dependent w/o	fixed w	fixed w/o	both w	both w/o
Standard Deviations:							
Output	$1,62$	9.898	10.134	11.118	10.649	10.466	10.381
Inflation	$1,11$	4.029	4.131	4.528	4.343	4.261	4.232
Real Wage	$0,69$	0.891	0.611	0.793	0.669	0.846	0.638
Unemployment	$6,90$	28.214	29.223	33.375	31.405	30.616	30.270
Vacancies	$8,27$	3.753	8.398	3.315	9.414	3.537	8.886
Tightness	$14,96$	24.673	20.911	30.461	22.088	27.370	21.476
JCR	$2,55$	20.744	23.516	23.996	25.445	22.257	24.442
JDR	$3,73$	24.401	26.776	28.532	28.919	26.321	27.805
Correlations:							
U,V	$-0,95$	0.951	0.993	0.890	0.993	0.928	0.993
JCR,JDR	$-0,36$	0.619	0.666	0.601	0.668	0.610	0.667

Table 4: Sensitivity Analysis

	US Economy	Interest Rate Shock $\Phi = 0\%$	Interest Rate Shock $\Phi = 30\%$	Interest Rate Shock $\Phi = 100\%$	Productivity Shock $\Phi = 0\%$	Productivity Shock $\Phi = 30\%$	Productivity Shock $\Phi = 100\%$
With BC:							
U,V	-0.95	0.995	0.995	0.996	0.982	-0.696	-0.991
JCR,JDR	-0.36	-0.255	-0.240	-0.220	0.640	0.484	0.387
Without BC:							
U,V	-0.95	0.995	0.991	0.047*	0.981	0.999	1.000
JCR,JDR	-0.36	-0.255	-0.305	-0.517	0.640	0.723	0.933

* For $\Phi > 100\%$ firing costs generate a Beveridge curve.

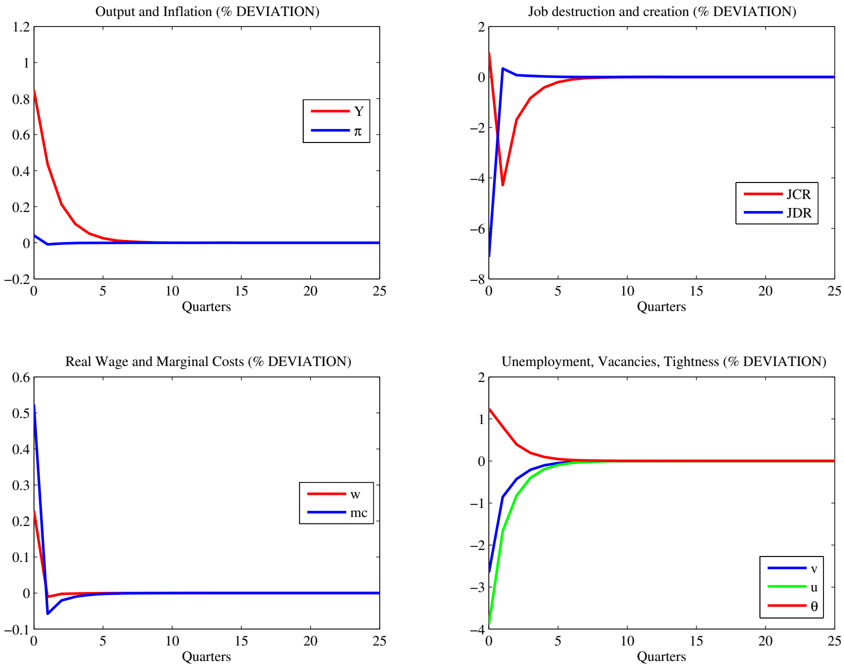

Figure 4: IRFs of a 1% Interest Rate Shock with Bonding Critique

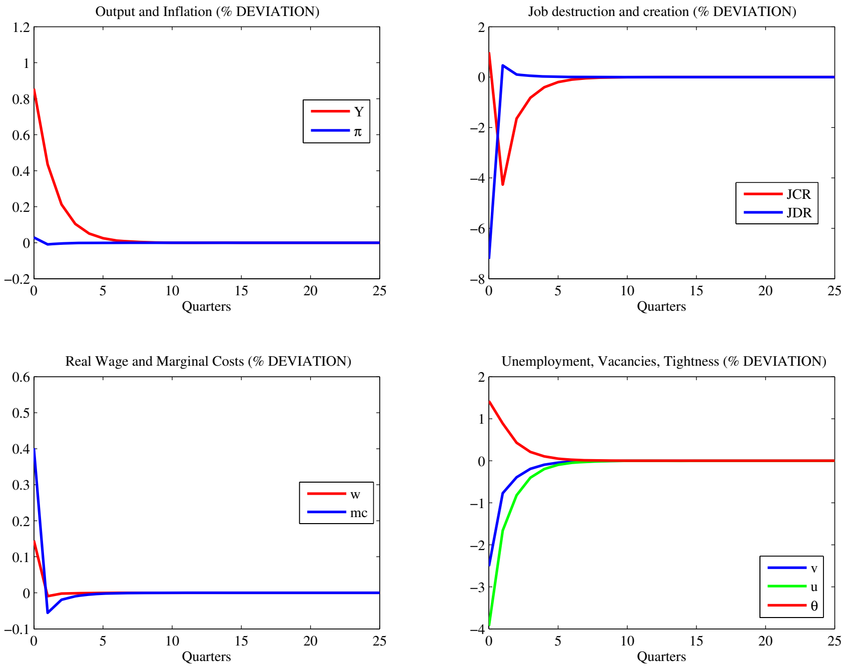

Figure 5: IRFs of a 1% Interest Rate Shock w/o Bonding Critique

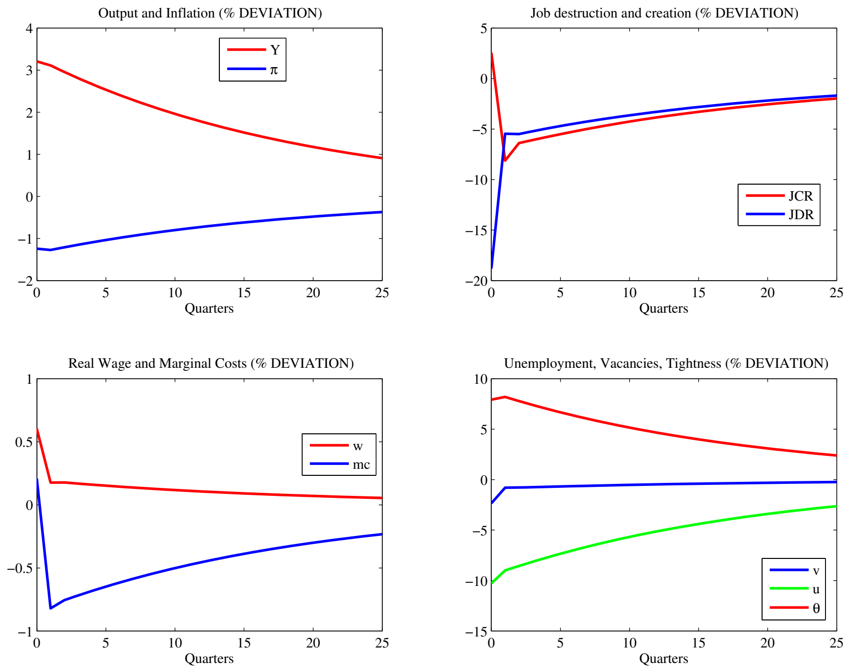

Figure 6: IRFs of a 1% Productivity Shock with Bonding Critique

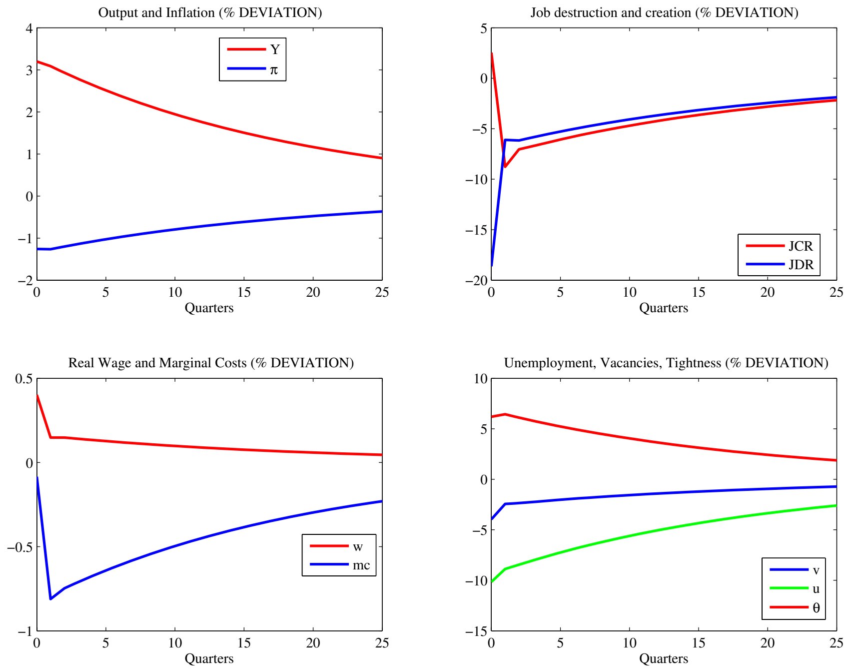

Figure 7: IRFs of a 1% Productivity Shock w/o Bonding Critique

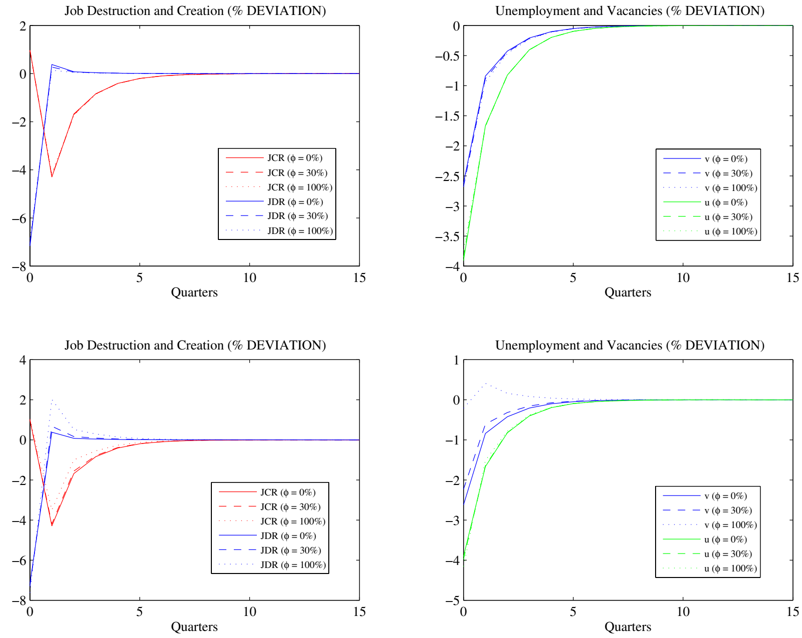

Figure 8: IRFs of a 1% Interest Rate Shock for Different Values of Φ

In the upper charts we respect the bonding critique, while we do not respect the bonding critique in the lower charts.

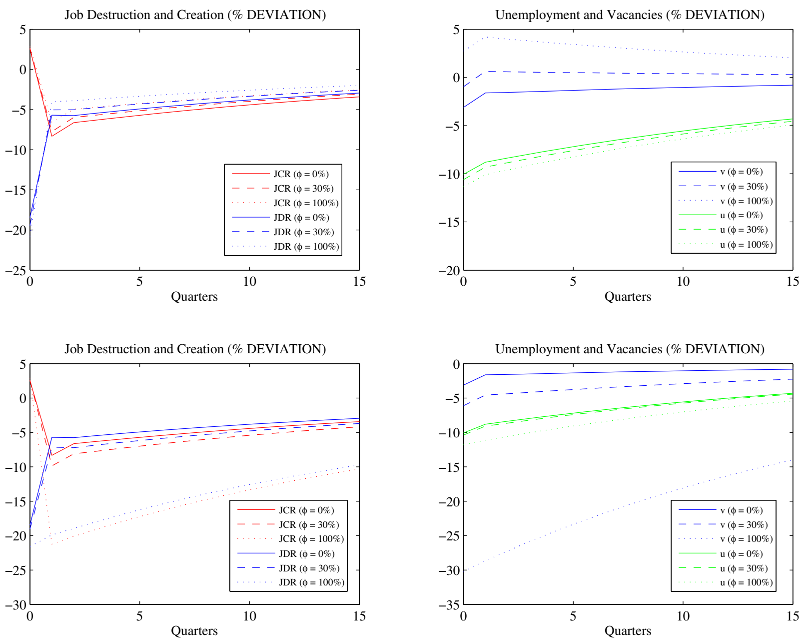

Figure 9: IRFs of a 1% Productivity Shock for Different Values of Φ

In the upper charts we respect the bonding critique, while we do not respect the bonding critique in the lower charts.