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JEL classification: E24, E32, J64.

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

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# On the Introduction of Firing Costs\*

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## Abstract

This paper analysis two types of firing costs in a New Keynesian model with search and matching frictions and purely endogenous separations. We further distinguish between the effects resulting from respecting and non-respecting the bonding critique. We find that the two types of firing costs similarly influence the model dynamics and generate comparable second business cycle moments. However, the decision whether to respect or disrespect the bonding critique is crucial for the evolution of the system dynamics. This is especially true, when comparing American and European calibration.

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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 in more general terms, employment protection legislation (henceforth: EPL). Nickell (1997) propounds that the mission of EPL is to shelter currently employed economic agents from arbitrary, unfair, or discriminatory actions by firms.<sup>1</sup> In this sense, Addison and Teixeira (2003) elaborate that EPL comprises dismissal protection, regulations for fixed-term and temporary work agency contracts, the regulation of hours worked, and the definition of “labor standards,” on e.g., maternity leave, health and safety, equality of treatment, and mandatory sick pay. For the sake of simplicity, in what follows, we refer to EPL exclusively being firing costs, i.e. dismissal protection.

The introduction of firing costs into dynamic equilibrium matching models is essential, since otherwise firms’ decision problems are distorted towards the exit margin. Intuitively, firms facing hiring costs on the entry side with yet costless adjustments along the exit side, prefer to adjust along the destruction rather than the creation margin. The presence of EPL, however, creates countervailing employment adjustment costs along the destruction margin. Furthermore, according to Addison and Teixeira (2003), EPL increases the amortized costs of a new hire and hence reduces the incentives for job creation. Additionally, Cahuc and Postel-Vinay (2001) and Ljungqvist (2001) show that in general firing costs lead to a decrease of hiring and firing rates, i.e. they depress job flows. Messina and Vallanti (2006) empirically buttress these results, showing that firing costs dampen the volatility of job destruction, while having a rather small effect on job creation. Therefore, firing costs reduce short-term and increase long-term unemployment. The firing rate decreases on impact, whereas the hiring rate remains virtually the same. The opposite holds true for long-term unemployment, since the inflow in employment is depressed, resulting in a more sclerotic labor market which leads to higher long-term unemployment.<sup>2</sup> 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 the presence of firing costs. In a general equilibrium context we find discordant outcomes, while Burda (1992), Hopenhayn and Rogerson (1993), Millard (1994), Millard and Mortensen (1994), and

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<sup>1</sup>See also Boeri et al. (2003).

<sup>2</sup>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).

Saint Paul (1995) show that unemployment decreases, Alvarez and Veracierto (1997) reach the opposite conclusion. Nevertheless, Messina and Vallanti (2006) conclude that EPL in fact explains cross-country patterns in cyclicity. This view is supported by Samaniego (2008) and Veracierto (2008), who show that firing costs have a significant influence on business cycle fluctuations. They obtain the result that the employment volatility in Europe is 30% lower relative to the United States.

The impact of firing costs crucially depends on the extent to which the additional expenses can be transferred to the worker due to wage adjustments. Garibaldi and Violante (2005) argue that total firing costs are determined by two components (i) severance payments and (ii) a wasteful tax on layoffs. In this perception, firing costs are paid outside the firm-worker pair and hence, are not included in the wage bargaining process, a phenomenon termed the bonding critique. This stand on firing costs, in the tradition of Bertola and Rogerson (1997), focuses on firing costs being a tax on job destruction.<sup>3</sup> 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.<sup>4</sup> Alternatively, Lazear (1988, 1990) and Nickell (1997) argue that firms reduce the wages for newly hired workers by the present value of future firing costs, which leaves the wage bill of the worker unchanged. Thus, firing costs enter the wage bargaining process. Whether to include or not include firing costs into the bargaining process is not without ramifications and subject to the scope of this paper.

In this paper, 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. Disrespecting the bonding critique, Thomas and Zanetti (2008) show for the Euro area that fixed firing costs also only have a marginal effect on inflation and labor market dynamics. 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

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<sup>3</sup>See Fella (1999) for a critique of this approach.

<sup>4</sup>Delacroix (2003) argues that this tax includes e.g., administrative and procedural costs.

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 at the empirical regularities concerning the relationship of EPL and employment dynamics. Section 3 presents a NK model with search frictions and firing costs. In section 4 we present the calibration. Section 5 solves the model and discusses the results. Finally, section 7 concludes.

## 2 EPL: Empirical Evidence

From our precedent considerations we infer that differences in labor market performances between Europe and the U.S. over the last decades might have been, to some extent, caused by differences in EPL. From this perspective, the stricter the EPL, the higher and more persistent is European unemployment. This syndrome is commonly known as “Eurosclerosis”<sup>5</sup> i.e. the U.S. labor market is less regulated and hence more flexible compared to the rigid, sclerotic European labor market.<sup>6</sup>

Figure 1 presents empirical evidence supporting the above assertion. It shows that the overall strictness of EPL varies significantly between countries; while e.g., Anglo-Saxon countries are characterized by low values of EPL, countries like Portugal or Mexico reveal magnitudes approximately three times as large as compared to the United Kingdom. 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), within country variations occurs amongst others because of differing educational levels, firm sizes, skills and tenures.

Further evidence for OECD countries is presented in Figure 2. Panels A and B of the OECD’s (2004) cross-country analysis give proof to the statement that job flows depress in increasing firing costs. In particular, the relations between the flows into and out of unemployment and EPL, respectively, reveal a significant 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 contention that a stricter EPL increases long-term unemployment. Finally, referring to Figure 3 tells us that firing costs negatively stimulate aggregate employment, while their effect on unemployment is positive, but statistically not signif-

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<sup>5</sup>See e.g. Giersch (1985), Bentolila and Bertola (1990) and Chen et al. (2002).

<sup>6</sup>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.

icant. Summarizing, the OECD's findings are well in line with the predictions of the model. Moreover, the OECD's (2004) regression analysis yields much sharper results. The coefficient of EPL on flows into and out of unemployment are  $-0.165$  and  $-5.030$ , respectively, while EPL yields a coefficient on long-term unemployment of  $3.271$ . Note that all three values are statistically significant at the 1 % level.

Summarizing, we can say that higher EPL has an ambiguous effect on aggregate unemployment but significantly changes the volatility of job flows. Nevertheless, the empirical evidence is in general inconclusive for the relevance of EPL for labor market adjustments.<sup>7</sup>

### 3 A New Keynesian Model with Firing Costs

Insights drawn from the empirics suggest that firing costs play a crucial role in determining labor market dynamics. Therefore, 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), however, with firing costs. 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.

#### 3.1 Household Maximization

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

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

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<sup>7</sup>See e.g. Layard and Nickell (1998), Machin and Manning (1998), Blanchard and Wolfers (2000) and Messina and Vallanti (2006).

where  $\sigma$  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 a Dixit-Stiglitz (1976) aggregator of the different types of goods. It is assumed that a household consists of a continuum of family members, inelastically supplying one unit of labor and being represented by the unit interval. For the sake of simplicity, we assume consumption pooling.<sup>8</sup> The household maximizes consumption subject to the intertemporal period budget constraint

$$C_t + \frac{B_t}{P_t} = \mathcal{W}_t + R_{t-1} \frac{B_{t-1}}{P_t} + bu_t + \Pi_t + T_t, \quad (2)$$

where  $b$  is the value of home production,  $\mathcal{W}_t$  is labor income, and  $B_t$  are Bond holdings, which pay a gross interest rate  $R_t$ . Further,  $\Pi_t$  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, intertemporally maximizing household's utility, we obtain the standard Euler equation for intertemporal consumption flows

$$C_t^{-\sigma} = \beta R_t E_t \left[ \frac{P_t}{P_{t+1}} C_{t+1}^{-\sigma} \right]. \quad (3)$$

### 3.2 The Labor Market and Firm's Maximization

Matching a firm-worker pair on the labor market is time consuming. Firms post vacancies to signal working opportunities and workers actively search for suitable jobs. We assume that matches are governed by a Cobb-Douglas type matching function with constant returns to scale.<sup>9</sup> Explicitly, the matching function is given by  $\Psi(u_t, v_t) = mu_t^\mu v_t^{1-\mu}$ , 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  $\theta_t = v_t/u_t$ .

<sup>8</sup>See Merz (1995) and Andolfatto (1996).

<sup>9</sup>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.



We assume a continuum of firms, where each firm  $i$  consists of a variety of different jobs  $j$ . Aggregate productivity  $A_t$  is common to all firms, while job and firm specific productivity  $a_{ijt}$  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

$$y_{it} = A_t n_{it} \int_{\tilde{a}_{it}}^{\infty} a \frac{f(a)}{1 - F(\tilde{a}_{it})} da \equiv A_t n_{it} H(\tilde{a}_{it}). \quad (4)$$

The variable  $\tilde{a}_{it}$  is an endogenously determined critical threshold and  $H(\tilde{a}_{it})$  is the conditional expectation  $E[a|a \geq \tilde{a}_{it}]$ . 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 different types of firing costs; a fixed value  $\Gamma$  for every worker laid off and a flexible amount  $\phi(a_{it})$ , which relates to the idiosyncratic productivity of the fired worker. We assume that  $\phi(a_{it})$  is a linear real-valued function  $\phi(a_{it}) = ka_{it}$ <sup>10</sup>, which is twice continuously differentiable, strictly convex and strictly increasing in  $a$ . Thus, aggregate total firing costs are

$$\Phi(a_{it}) = \rho_{it} n_{it} \Gamma + k \int_0^{\tilde{a}_{it}} a \frac{f(a)}{1 - F(\tilde{a}_{it})} da \quad \text{for} \quad \Gamma, k \geq 0 \quad (5)$$

The first term of equation (5) 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

$$\Pi_{i0} = E_0 \sum_{t=0}^{\infty} \beta^t \frac{\lambda_t}{\lambda_0} \left[ \frac{P_{it}}{P_t} y_{it} - \mathcal{W}_{it} - cv_{it} - \Phi(a_{it}) - \frac{\psi}{2} \left( \frac{P_{it}}{P_{it-1}} - \pi \right)^2 Y_t \right], \quad (6)$$

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

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<sup>10</sup>Abowd and Kramarz (2003) and Kramarz and Michaud (2004) empirically find a roughly linear relationship between severance payments and productivity.

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

$$\mathcal{W}_{it} = n_{it} \int_{\tilde{a}_{it}}^{\infty} w_t(a) \frac{f(a)}{1 - F(\tilde{a}_{it})} da. \quad (7)$$

For simplicity, we assume that firms are identical and drop the subscript  $i$ . From the first order conditions with respect to labor and vacancies, we directly derive the representative firm's job creation condition

$$\frac{c}{q(\theta_t)} = E_t \beta_{t+1} (1 - \rho_{t+1}) \left[ \varphi_{t+1} A_{t+1} H(\tilde{a}_{t+1}) - \frac{\partial \mathcal{W}_{t+1}}{\partial n_{t+1}} + \frac{c}{q(\theta_{t+1})} - \rho_{t+1} \Gamma \right], \quad (8)$$

where  $\xi_t$  denotes the current period's average value of workers across job-specific productivities and  $\varphi_t$  are real marginal costs. Equation (8) governs the hiring decisions, which reveal to be a trade-off between the costs of posting a vacancy (left hand side of (8)) and its discounted expected return (right hand side of (8)). 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 firm's job destruction condition

$$\varphi_t A_t \tilde{a}_t + \frac{c}{q(\theta_t)} - w_t(\tilde{a}_t) + \Gamma(1 - 2\rho_t) = 0. \quad (9)$$

Again, firing costs decrease the firm's incentives to become active. Consequently, firing costs dampen hiring as well as the firing margin. Hence, equation (10) determines the evolution of employment at the representative firm.

$$n_{it+1} = (1 - \rho_{it+1})(n_{it} + v_{it}q(\theta_t)) \quad (10)$$

Note that the evolution of employment depends crucially on the firms decisions to post vacancies and to set the critical threshold.

Finally, it follows from the maximization problem that the firm's real marginal costs are given by

$$\varphi_t = \frac{\partial \mathcal{W}_t / \partial n_t}{A_t H(\tilde{a}_t)} + \frac{\xi_t - c/q(\theta_t)}{A_t H(\tilde{a}_t)} + \frac{\rho_{t+1} \Gamma}{A_t H(\tilde{a}_t)}. \quad (11)$$

Intuitively, the presence of firing costs increase the real marginal costs, which directly translates into inflation dynamics via a standard New Keynesian Phillips curve. The latter arises from the assumption of sticky prices.

### 3.3 Wage Setting

#### 3.3.1 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. When a firm and a worker match, the job shares an economic rent which is split according to individual Nash bargaining, that maximizes the Nash product

$$\Lambda_t = \operatorname{argmax}_{w_t} \left\{ (W_t - U_t)^\eta (J_t - V_t)^{1-\eta} \right\}, \quad (12)$$

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.<sup>11</sup> 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

$$W_t(a_t) - U_t = \frac{\eta}{1-\eta} J_t(a_t). \quad (13)$$

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 (13).

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 incurs firing costs. We can write this relation in form of a Bellman equation given by

$$J_t(a_t) = \varphi_t A_t a_t - w_t(a_t) + E_t \beta_{t+1} \left( (1 - \rho_{t+1}) \int_{\tilde{a}_{t+1}}^{\infty} J_{t+1}(a) \frac{f(a)}{1 - F(\tilde{a}_{t+1})} da - \rho_{t+1} (\Gamma + ka_t) \right) \quad (14)$$

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<sup>11</sup>Due to a free entry condition the equilibrium value of  $V_t$  is zero.

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

$$W_t(a_t) = w_t(a_t) + E_t \beta_{t+1} (1 - \rho_{t+1}) \int_{\tilde{a}_{t+1}}^{\infty} W_{t+1}(a) \frac{f(a)}{1 - F(\tilde{a}_{t+1})} da + E_t \beta_{t+1} \rho_{t+1} U_{t+1}. \quad (15)$$

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

$$U_t = b + E_t \beta_{t+1} \theta_t q(\theta_t) (1 - \rho_{t+1}) \int_{\tilde{a}_{t+1}}^{\infty} W_{t+1} \frac{f(a)}{1 - F(\tilde{a}_{t+1})} da + E_t \beta_{t+1} (1 - \theta_t q(\theta_t) (1 - \rho_{t+1})) U_{t+1}. \quad (16)$$

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

$$w_t(a_t) = \eta (\varphi_t A_t a_t + c \theta_t - \beta_{t+1} \rho_{t+1} (\Gamma + k a_t)) + (1 - \eta) b. \quad (17)$$

The aggregate wage is given by

$$w_t(a_t) = \eta \varphi_t A_t H(\tilde{a}_t) + \eta (c \theta_t - \beta_{t+1} \rho_{t+1} (\Gamma + k H(\tilde{a}_t))) + (1 - \eta) b. \quad (18)$$

The firm will endogenously separates from a worker if and only if

$$J_t(a_t) < -(\Gamma + k a_t), \quad (19)$$

i.e., if the worker's asset value is lower than the associated firing costs.<sup>12</sup> Condition (19) allows us to explicitly derive the destruction threshold. Consequently, the resulting threshold is

$$\tilde{a}_t = \frac{\eta c \theta_t + (1 - \eta) b - \frac{c}{q(\theta_t)} + [(1 - \eta) \beta_{t+1} \rho_{t+1} - 1] \Gamma}{(1 - \eta) \varphi_t A_t + [1 - (1 - \eta) \beta_{t+1} \rho_{t+1}] k}, \quad (20)$$

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

In the very strict sense of the bonding critique, firing costs do not play a role in the bargaining process as a whole. Under such scenario, we omit firing costs in the firm's

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<sup>12</sup>See Kugler and Saint-Paul (2000, 2004) and Lechthaler et al. (2008).

asset value function (14). This assumptions has large ramifications for wages as well as the critical threshold, which become  $w_t = \eta\varphi_t A_t H(\tilde{a}_t) + \eta c\theta_t + (1 - \eta)b$  and  $\tilde{a}_t = ((1 - \eta)b + \eta c\theta_t - \frac{c}{q(\theta_t)} - \Gamma) / ((1 - \eta)\varphi_t A_t + k)$ , respectively. Even though this assumption is highly debateable, we juxtapose the dynamics resulting from both assumptions.

### 3.3.2 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

$$\Lambda_t = \operatorname{argmax}_{w_t} \left\{ (W_t - U_t)^\eta (J_t - V_t + \Gamma + ka_t)^{1-\eta} \right\}, \quad (21)$$

where the firm's altered fall back position now additionally entails  $-\Gamma$  and  $-ka_t$ . The associated optimality condition is given by

$$W_t(a_t) - U_t = \frac{\eta}{1 - \eta} (J_t(a_t) + \Gamma + ka_t), \quad (22)$$

Again, applying the asset value functions (14), (15), and (16) yields the altered expression for the individual real wage

$$w_t(a_t) = \eta(\varphi_t A_t a_t + c\theta_t + (1 - \beta_{t+1}\rho_{t+1})(\Gamma + ka_t)) + (1 - \eta)b. \quad (23)$$

Hence, the aggregate wage follows

$$w_t(a_t) = \eta\varphi_t A_t H(\tilde{a}_t) + \eta(c\theta_t + (1 - \beta_{t+1}\rho_{t+1})(\Gamma + kH(\tilde{a}_t))) + (1 - \eta)b. \quad (24)$$

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 (19) still governs endogenous separations, independently, if we respect or disrespect the bonding critique. Applying the altered asset value functions to (19), we derive the new critical threshold

$$\tilde{a}_t = \frac{\eta c\theta_t + (1 - \eta)b - \frac{c}{q(\theta_t)} + [(1 - \eta)\beta_{t+1}\rho_{t+1} - 1 + \eta]\Gamma}{(1 - \eta)\varphi_t A_t + [1 - \eta - (1 - \eta)\beta_{t+1}\rho_{t+1}]k}, \quad (25)$$

where  $(1 - \eta - (1 - \eta)\beta_{t+1}\rho_{t+1})k > 0$  and  $((1 - \eta)\beta_{t+1}\rho_{t+1} - 1 + \eta) < 0$ . Also in this environment, firing costs protect less productive worker by lowering the threshold,

however, by not as much compared to the case of the bonding critique.

### 3.4 Closing the Model

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

$$Y_t = \mathcal{W}_t + \Pi_t = A_t n_t \int_{\tilde{a}_{it}}^{\infty} a \frac{f(a)}{1 - F(\tilde{a}_{it})} da \quad (26)$$

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

$$i_t = \phi_{\pi} \pi_t + \phi_y Y_t + \varrho_t, \quad (27)$$

where  $\phi_{\pi}$  and  $\phi_y$  are the reaction parameters for variations in inflation and output, respectively. The interest rate shock  $\varrho_t$  follows an AR(1) process

$$\varrho_t = \rho_i \varrho_{t-1} + \epsilon, \quad (28)$$

with  $\rho_i$  being the persistence of the shock. In the remainder of the paper, we calibrate and solve the model.

## 4 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  $\beta$  to be 0.99, corresponding a real interest rate 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 to 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  $\mu$  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 dependent 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  $\rho$  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 remarkably 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  $\kappa$  are computed from several steady state representations.

To 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. Finally, the European calibration is taken from Thomas and Zanetti (2008).

## 5 Simulation

This section discusses the results for our model with baseline calibration from Table 1. The monetary authority decreases the nominal interest rate. Consider the case of costless firing first. The impulse response functions are given by Figure 4.

As a consequence of the lower interest rate, households pull forward consumption. To match the increase in demand, firms expand employment and thus output. However, since hiring is time consuming and costly, on impact, job creation plays an almost negligible role. The bulk of additional employment is generated by lowering the critical threshold, which protects less productive workers from being laid-off. Therefore, the model reveals a separation-driven employment adjustment mechanism. Unemployment falling reduces the probability for a firm to fill their vacancies in the future and thus, firms perceive expected profits from a newly hired worker to be lower. As a consequence, they reduce vacancy creation. This reduction, however, is relatively smaller than the decrease of unemployment, which in return results in an overall increase of the labor market tightness. A tighter labor market puts upward pressure on the wage bill, which, together with retention of less productive workers, increases the real marginal costs. Furthermore, costly job creation, however to a small extent, also puts upward pressure on real marginal costs. The latter, finally, positively transmit into a rise of inflation.

### 5.1 The Influence of Firing Costs

The influence of firing costs on this model crucially depends on the particular setup chosen. In order to visualize the effects of increasing firing costs, refer to Figures 5, which present the impulse response function to an interest rate shock at zero and seventy percent firing costs.<sup>13</sup> Figure 6, in particular, plots impulse response functions for seventy percent productivity dependent and seventy percent fixed firing costs, respectively.

First, we look at the least realistic case, where we strictly respect the bonding critique, i.e. we omit firing costs from the wage bargaining as well as the asset value functions. In such scenario, increasing firing costs lead firms to be more reluctant in creating jobs and posting vacancies. Additionally, less job destruction occurs. Nevertheless, the former effect dominates the latter, such that there is a negative impact on the reduction of unemployment. With vacancies being less influenced by firing costs than unemployment, the labor market tightens to a lesser extent than in the absence of firing costs and

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<sup>13</sup>Both firing cost measures are calibrated to be 0.35.



hence, puts less pressure on the wage bill. However, there is a countervailing effect that yields an increase in the wage bill. Fixed firing costs directly influence the real marginal costs. The sharp inclination in real marginal costs increase the firm's value of a worker - consider e.g. (14) where the former term (the profit) increase - which results in a larger surplus to share in the bargaining process and thus, higher individual wages. All workers combined, the wage bill increases. This wage effect dominates the former, such that the overall wage bill increases. Finally, the amplified inclination of real marginal cost leads to a larger positive movement of inflation. These dynamic movements are, however, quantitatively negligible even for very large firing costs.

Furthermore, the preceding result changes only marginally, when firing costs are also considered in the asset function of the firms, but still remain outside the firm-worker-Nash-bargaining. The impulse response functions of such scenario are displayed in the upper charts of Figure 5. A firm discounting the occurrence of future firing costs in equation (14) diminishes the asset value of the worker, which in consequently decreases the surplus that firm and worker bargain about. Consequently, individual wages - and hence the aggregate wage bill - decrease, giving an incentive for firms to post more vacancies. With unemployment remaining mainly untouched, the increase in vacancies strongly tightens the labor market. However, the positive wage effect of such a tightening is strongly dominated by the former wage reduction. Furthermore, the overall reduction in wages cuts real marginal costs and hence reduces inflationary pressure. On the labor market, job creation increases only slightly, while job destruction is once again cut back notably.

Finally, we disrespect the bonding critique completely and introduce firing costs into the firm-worker-bargaining-process, as indicated by the equation (21). The impulse response functions of this exercise are shown in the lower panels of Figure 5. Since the surplus to share in the bargaining process increases firms have an incentive to increase vacancy posting even further. This tightens the labor market to a large extend making hiring much more costly. In turn wages must fall to compensate the firm for higher hiring costs. The latter effect seems to dominate and aggregate wages fall. Consequently, real marginal cost decline and thus also inflation. Following the initial reactions, 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 either case, firing costs being only productivity dependent or only fix. Any combination of fixed and productivity dependent firing costs is simply a linear combinations of the results presented in Table

2 and hence, lie in between both extremes. We find that both scenarios - respecting and non-respecting the bonding critique - perform almost equally well in matching the standard deviations of the U.S. economy. Note, however, that we obtain more precise matches of the negative correlation of job creation and destruction when the bonding critique is not binding.<sup>14</sup> Furthermore, Table 2 reveals that differences in performance, arising from the specific formulations of the firing costs, are negligibly small.

Summing up, increasing firing costs results in higher peaks and troughs of the job destruction and job creation rates, respectively. Furthermore, vacancy posting is increasing in firing costs, while unemployment is only slightly altered. As a result, the labor market tightens. For very large firing costs, the system even produces a Beveridge curve. Comparing the single outcomes reveals that firing costs almost exclusively affect the system dynamics through the different reactions of the aggregate wage, which crucially depends on both respecting/disrespecting the bonding critique and dependent/fixed firing costs. 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.

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.

## 6 Cross Country Analysis

As indicated in Section 2, international differences in labor market performances are often accredited to differences in the severity of employment protection legislation. In order to assess this wisdom, this section compares the impact of increasing firing costs in the U.S. and Europe. For this purpose, we use the European calibration from Thomas and Zanetti (2008). Note that the major difference between the two calibrations is given by the magnitudes of labor market flows. While the U.S. economy shows a separation rate of 0.12, the European value is 0.0312. In addition, we have less unemployment in steady state and a higher value of the worker's bargaining power in Europe. The results of the simulation exercise are presented in Table 4.

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<sup>14</sup>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.

Table 4 reveals that in case the bonding critique is binding the the dynamics in the U.S. and Europe are affected differently. While for instance one variable becomes more volatile in the U.S. it becomes less volatile in Europe.

For the opposing case, when the bonding critique is not binding, Table 4 shows that increasing firing costs influences the dynamics of both economies only quantitatively. While unemployment and the job destruction rate become more volatile, vacancies and job creation become less volatile.

Causative for the differences is the wage channel. While in the non-respecting case the wage decreases with increasing firing costs (becoming even negative for  $\Gamma = 0.5, k = 0.5$ ) for the U.S., the European wage bill increases even further. The stronger reaction of wages in Europe is driven by the higher bargaining power of worker's and most importantly by smaller worker flows. Since the probability of being laid-off is much smaller in Europe relative to the U.S., the future value of a posted vacancy raises. Therefore, more vacancies are posted by the firm which induces an increase in labor market tightness. Thus, wages increase due to the higher costs afflicted with search in the labor market.

From our cross-country comparison we can deduce that the effects of firing costs varies significantly with country specific parameters as well as the size of the firing costs.

## 7 Conclusion

This paper discusses empirical and theoretical 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 side, the fix costs also directly influence the entry side. For the U.S. we find that the dynamics of the system vary significantly with the presence of firing costs only for exorbitant values. For reasonable magnitudes, firing costs play a 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 almost negligible for the interest rate shock. Moreover, we obtain similar results for Europe as well.

We emphasize that in the endogenous separations model, with a separation driven adjustment mechanism, the exit side effect dominates the entry side effect and consistently,

the performance difference between the two types of costs consequentially has to be small. Consistently, only high values 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

Parameter	Meaning	US Value	EU Value
Imposed:			
$\sigma$	Risk aversion parameter	2	2
$\beta$	Discounting factor	0.99	0.99
$\epsilon$	Elasticity of substitution	11	6
$\mu_{LN}$	Mean distribution parameter	0	0
$\sigma_{LN}$	Variance distribution parameter	0.12	0.12
$\mu$	Search Elasticity of Matches	0.5	0.6
$\eta$	Worker's bargaining Power	0.5	0.6
$k$	Dependent Firing Costs	[0,1]	[0,1]
$\Gamma$	Fixed Firing Costs	[0,1]	[0,1]
$\psi$	Rotemberg Parameter	105	105
$\phi_\pi$	Taylor Rule Parameter on Inflation	1.5	1.5
$\phi_y$	Taylor Rule Parameter on Output	0.125	0.125
$\rho_i$	AR(1) Interest Shock Parameter	0.49	0.49
$\sigma_i$	Standard Deviation of Interest Shock	0.0623	0.0623
$\rho$	Steady State Separations	0.12	0.0312
$q$	Steady State Job Filling Rate	0.7	0.9
$\pi$	Steady State Inflation	1	1
$n$	Steady State Employment Rate	0.8	0.9

Table 2: Business Cycle Facts and Responses to an Interest Rate Shock in the U.S.

	US	$\Phi = 0$	dependent $\Phi$		fixed $\Phi$	
	Economy		w	w/o	w	w/o
Standard Deviations: Output	1.62	0.988	0.984	0.997	1.000	1.003
Inflation	1.11	0.036	0.043	0.024	0.009	0.008
Real Wage	0.69	0.183	0.213	0.067	0.019	0.020
Unemployment	6.90	4.358	4.346	4.416	4.422	4.439
Vacancies	8.27	2.725	2.345	1.893	2.510	2.185
Tightness	14.96	1.667	2.046	2.555	1.975	2.304
Job Creation	2.55	4.784	4.609	4.487	4.758	4.636
Job Destruction	3.73	7.189	7.184	7.375	7.366	7.423
Correlations:						
U,V	-0.95	0.995	0.991	0.990	0.989	0.988
JCR,JDR	-0.36	-0.261	-0.291	-0.341	-0.297	-0.326

Firing cost are calibrated to  $\Phi = 0.35$

Table 3: Sensitivity Analysis

	US		Dependent Firing Costs		Fixed Firing Costs	
	Economy	$\Phi = 0\%$	$\Phi = 35\%$	$\Phi = 70\%$	$\Phi = 35\%$	$\Phi = 70\%$
With BC:						
U,V	-0.95	0.995	0.991	0.985	0.990	—*
JCR,JDR	-0.36	-0.261	-0.291	-0.320	-0.297	—*
Without BC:						
U,V	-0.95	0.995	0.990	-0.165	0.988	0.946
JCR,JDR	-0.36	-0.261	-0.341	-0.508	-0.326	-0.410

\* For  $\Gamma > 0.35$  Indeterminacy.

Table 4: European vs. U.S. Calibration

	U.S.				Europe			
	u	v	jdr	jcr	u	v	jdr	jcr
$\Gamma = 0, k = 0$	4.36	2.72	7.19	4.78	10.12	12.38	33.42	12.49
With BC:								
$\Gamma = 0.1, k = 0.1$	4.37	2.56	7.24	4.73	10.02	12.98	32.83	12.64
$\Gamma = 0.3, k = 0.3$	4.39	2.29	7.32	4.64	9.85	13.87	31.82	12.83
$\Gamma = 0.5, k = 0.5$	—*	—*	—*	—*	9.69	14.46	30.96	12.92
Without BC:								
$\Gamma = 0.1, k = 0.1$	4.40	2.38	7.30	4.68	10.16	12.10	33.63	12.41
$\Gamma = 0.3, k = 0.3$	4.48	1.26	7.60	4.28	10.23	11.51	34.07	12.24
$\Gamma = 0.5, k = 0.5$	4.56	1.37	8.24	3.35	10.31	10.88	34.54	12.06

\* Indeterminacy.

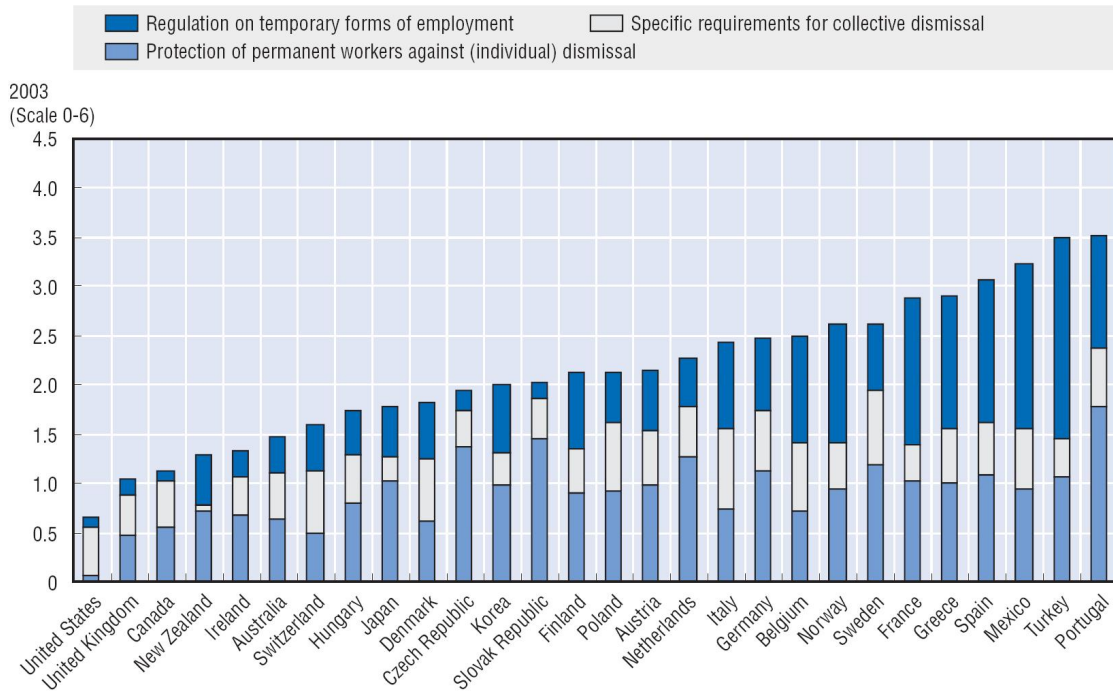


Figure 1: Strictness of EPL.  
Source: OECD (2004).

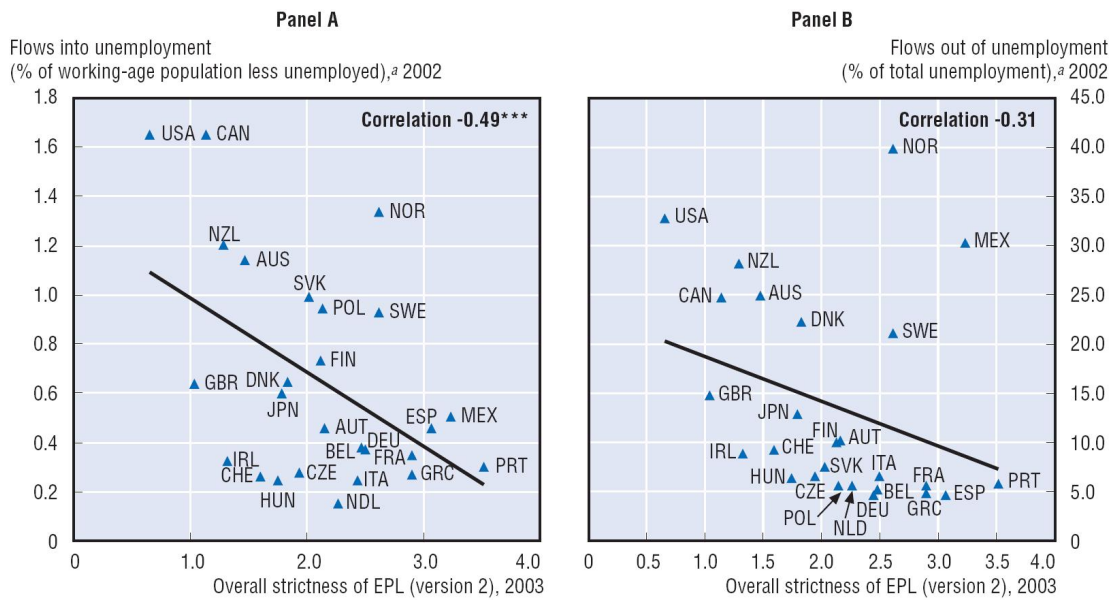
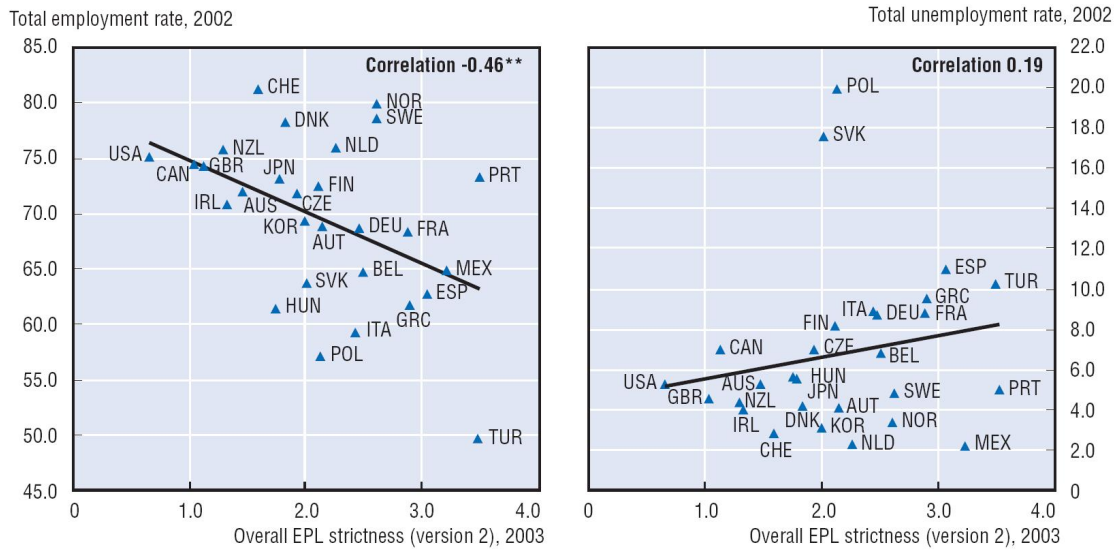


Figure 2: Correlations between EPL and Labor Market Dynamics.  
Source: OECD (2004).



\*\*\*, \*\*, \* means statistically significant at 1%, 5% and 10% levels, respectively.

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

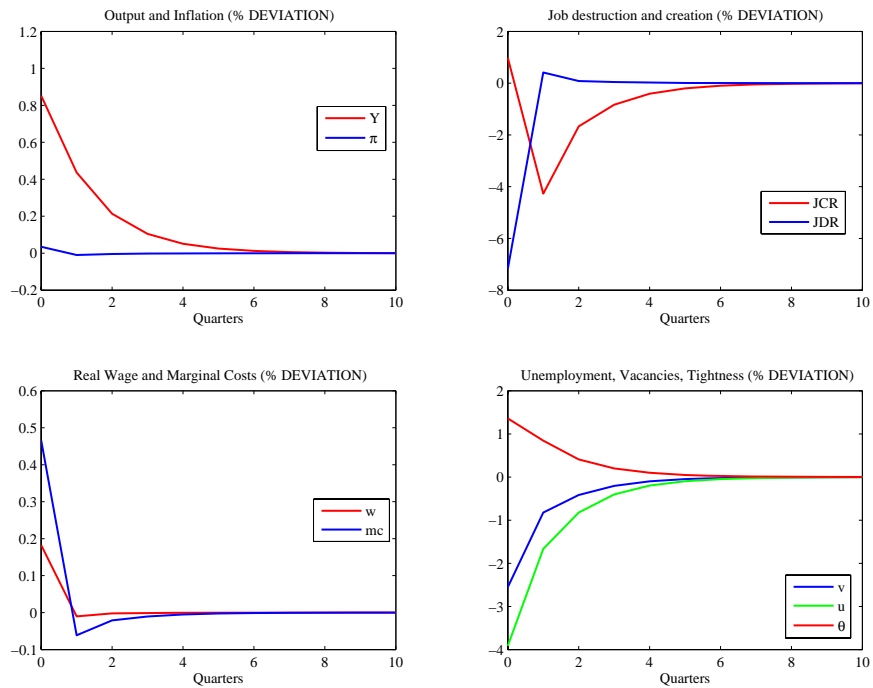


Figure 4: IRFs of a 1% Interest Rate Shock in the Model without Firing Costs.

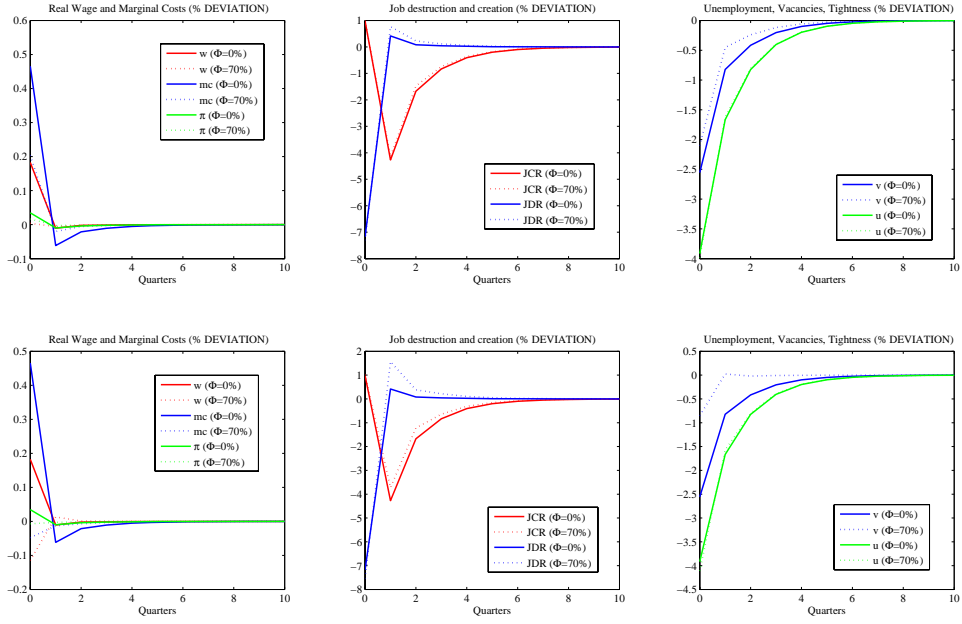


Figure 5: IRFs of a 1% Interest Rate Shock with Firing Costs.

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

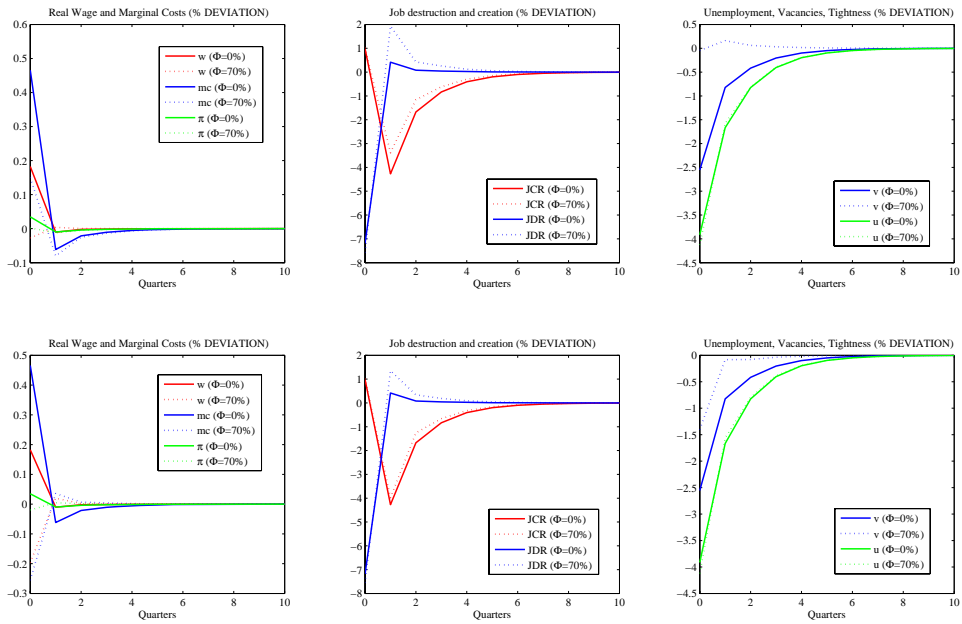


Figure 6: IRFs of a 1% Interest Rate Shock with Firing Costs.

In the upper charts firing costs are productivity dependent, while they are fixed in the lower charts.