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by Dennis Wesselbaum

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Firing Costs in a Business Cycle Model with Endogenous Separations[*]

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Abstract

This paper introduces productivity-dependent firing costs into an otherwise standard enodgenous separations matching model. We suggest an alternative to the standard fix cost approach and account for empirical evidence emphasizing that firing costs vary across workers. We show that the model with firing costs outperformes the model without firing costs and replicates the empirical facts fairly well. Furthermore, we present cross-country evidence that countries with stricter employment protection have a weaker Beveridge curve relation and surprisingly more volatile job flow rates.

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Introduction

It is controversially discussed whether the standard search and matching model reveals shortcomings in explaining labor market dynamics. Shimer's (2005) seminal contribution about the potential failure of the search and matching model to replicate stylized facts of key labor market variables originated a huge and continuing debate. Various authors came to the aid of the model and tried to solve this persistent problem.[1]

A different highly discussed issue is the question whether fluctuations in the separation rate or in the job finding rate can explain the variability of unemployment. The empirical analysis in Shimer (2005) suggest that "In the last two decades, however, the separation rate has varied little over the business cycle". This finding has been used to justify the assumption of exogenous separation rates in matching models. However, there is no consensus in the literature on the proper determination of the separation margin, following Fujita and Ramey (2007, 2008) and Ramey (2008) empirical evidence seems to favor endogenous separations.

Besides these questions, labor market regulations are often blamed to be causative for the different labor market performances in Europe and the United States. While many European countries are noted for high and persistent unemployment, the Anglo-Saxon complement performed relatively well as shown by Ljungqvist (2001) and L'Haridon and Malherbet (2006). This phenomenon is widely known as "Eurosclerosis", i.e. the more strict employment protection legislation (EPL, for short) in Europe - generating higher labor turnover costs - and the coherently more rigid labor market, depress business cycle fluctuations. We begin our analysis at the intersection of labor and product markets. For this purpose, we derive a real business cycle model with search and matching frictions and endogenous separations. We enrich this set-up by introducing productivity dependent firing costs. The idea to introduce productivity-dependent firing cost is motivated by the fact that firing costs vary across workers, as for instance shown by Dolado et al. (2005, 2007). Therefore, we need to relate firing costs to a worker-specific variable. In the model, the only worker-specific variable is her (idiosyncratic) productivity. Straightforward, this variable captures differences across workers and is a natural choice. It can be stressed that firing costs are often expressed in terms of wages. However, in our stylized model, wages are just a scaling of idiosyncratic productivity. In addition, they capture macroeconomic issues. The choice of idiosyncratic productivity allows us to isolate the firing costs from those macroeconomic effects and, therefore, we are able to focus on the idiosyncratic elements of those costs.

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[1] An incomplete list contains Hall's (2005) real wage rigidity attempt, Hagedorn and Manovskii's (2008) recalibration of the model, or Balleer's (2009) empirical assessment.

Krause and Lubik (2007) show, that the endogenous separation matching model with sticky prices is not able to replicate stylized facts such as the Beveridge curve, i.e. the negative correlation between unemployment and vacancies. This is caused by a separation driven adjustment mechanism, i.e. the firm has an incentive to adjust by firing workers, because the model reveals a distortion of the firm's decision process. The entry site is afflicted with costs, namely hiring costs, while adjustments along the exit site are costless. Therefore, job creation and destruction are positively correlated which is in contradiction to empirical estimates.

By introducing firing costs, we brake the distorted decision problem and afflict the exit site with adjustment costs. Hence, the firm has less incentives to use the exit site and the model should replicate stylized facts. We show that the performance increase along the labor market dimension depends on the size of the firing costs and conclude that the model needs a small degree of firing costs to replicate the empirically observed Beveridge curve. However, this implication - the interrelation between the size of the firing costs and the Beveridge curve - can not be verified in a stylized cross-country empirical analysis. In addition, we analyze the impact of higher EPL on the volatility and cyclicality of job flows. Gartner et al. (2009) find that volatilities of key labor market variables in Germany (with a high EPL) are almost twice as volatile as their U.S. (with a low EPL) counterparts. While this question has not been addressed so far, we find that in a cross-country analysis - in contrast, to what one might expect - higher EPL implies a higher volatility of job flows. Furthermore, higher protection implies less cyclical job creation and destruction. The model shows the latter, but is not able to replicate the former.

The paper proceeds as follows. Section 2 derives the model. Section 3 discusses the dynamics and the results of the model for different degrees of firing costs. Section 4 scrutinizes the effect of EPL on the Beveridge curve relation and the volatility as well as cyclicality of job flows. In section 5, we briefly conclude.

1 The Model

The description of our model economy proceeds in three steps. First, we define the economy's preferences and technology and we then present the model's assumed market structure. Finally, we conclude with the definition of an equilibrium.

1.1 Preferences and Technology

We now present a general equilibrium model with flexible prices and labor market frictions. Our economy inhibts two different agents; households and firms. The labor market is imperfect due to

the assumption of search and matching frictions following Mortensen and Pissarides (1994). Besides hiring costs created by the search and matching process, we introduce productivity-dependent firing costs.

1.1.1 Households

We assume a discrete-time economy with an infinite living representative household whose preferences are given by the following utility function

$$U = E_t \sum_{t=0}^{\infty} \beta^t \frac{C_t^{1-\sigma}}{1-\sigma}, \tag{1}$$

where $\beta \in (0,1)$ is the discount factor and $\sigma > 0$, gives the degree. C_t is a standard Dixit-Stiglitz aggregator of differentiated goods

$$C_t = \int_0^1 \left[C_{it}^{\frac{e-1}{\varepsilon}} di \right]^{\frac{\varepsilon}{\varepsilon-1}}, \tag{2}$$

where $\varepsilon > 0$ gives the elasticity of substitution. It is assumed that a household consists of a continuum of members, inelastically suppling one unit of labor and being represented by the unit interval. In addition, household members insure each other against income fluctuations and have free and unlimited access to complete markets for state-contingent claims to avoid the problem of heterogeneity.

1.1.2 Firms

There exists a continuum of firms with names $i \in [0,1]$. While aggregate productivity, Z_t, is common to all firms, the specific productivity, z_{it}, is idiosyncratic and every period it is drawn in advance of the production process from a time-invariant distribution with c.d.f. $F(z)$ and positive support $f(z)$. Its mean is given by μ_{LN} and the variance is determined by σ_{LN}. The firm specific production function is the product of aggregate productivity, the number of jobs and the aggregate over individual jobs and can be written as

$$Y_{it} = Z_t N_{it} \int_{\tilde{z}_{it}} z \frac{f(z)}{1 - F(\tilde{z}_{it})} da \equiv Z_t N_{it} \Psi(\tilde{z}_{it}), \tag{3}$$

where $\tilde{z}_{it}$ is an endogenously determined critical threshold. If the specific productivity of a job is below this threshold, it is not profitable and separation takes place. Here, Z_t is a Hicks-neutral aggregate technology shock following a first-order autoregressive process,

$$\ln Z_t = \rho^Z \ln (Z_{t-1}) + e_{Z,t}, \tag{4}$$

where $0 < \rho_Z < 1$ is the autocorrelation term and its innovation is i.i.d. over time and normally distributed

$$e_{Z,t} \sim N\left(0, \sigma_Z\right). \tag{5}$$

1.2 Market Structure

While the good market is perfectly competitive, the labor market is imperfect due to the assumption of search and matching frictions. Trade in the labor market is uncoordinated, costly and time-consuming. Search takes place on a discrete and closed market. Workers can be either employed or unemployed, such that there is no out of labor force option. Similarly, each firm has one job that is either filled, or vacant. If the job is filled, it is subject to the probability of being either exogenously destructed, $\rho^x > 0$, or being endogenously destructed, $\rho_t^n = F(\tilde{z}_t)$. Then, total separations are given by

$$\rho_t = \rho^x + (1 - \rho^x)F(\tilde{z}_t). \tag{6}$$

In addition, firms create jobs at the rate $M\left(U_t, V_t\right)$ at the non-state-contingent cost of $c > 0$ units of output per vacancy, where M is the homogeneous-of-degree-one-matching-function,

$$M\left(U_t, V_t\right) = m U_t^\mu V_t^{1-\mu}, \tag{7}$$

where $m > 0$ gives the match efficiency, $\mu > 0$ is the elasticity of the matching function with respect to unemployment and V_t is the vacancy rate. The vacancy-to-unemployment ratio

$$\theta_t = V_t/U_t, \tag{8}$$

reflects labor market tightness. Then, the vacancy filling probability is $q\left(\theta_t\right) = M\left(U_t, V_t\right)/V_t$. Combining entry and exit definitions yields the evolution of employment

$$N_t = (1 - \rho_t)\left(N_{t-1} + M_{t-1}\right). \tag{9}$$

Similarly, the evolution of aggregate unemployment can be written as

$$U_t = 1 - N_t. \tag{10}$$

Finally, households own all shares in the firm and receive any of their profits as dividends each quarter.

1.3 Optimization and Equilibrium

Optimization of all agents defines equilibrium. We start with the households utility maximization problem and continue with the firms profit maximization problem. Then, we solve the bargaining problem between firm and worker and determine wages and the cut-off point. We conclude with a definition of the equilibrium.

1.3.1 Households

We assume that the economy begins with all households having identical financial wealth and consumption histories. This assumption assures that together with the optimal use of the available contingent claims markets, this homogeneity will continue. Moreover, this allows us to only consider the consumption and savings decisions of a representative household. The representative household faces the following budget constraint

$$C_t + T_t = W_t N_t + b U_t + \Pi_t, \tag{11}$$

where benefits b are financed by lump-sum taxes, T_t. Π_t are dividends and W_{it} is the real wage. Then, the household maximizes (1) subject to (11), which gives the standard first order condition

$$C_t^{-\sigma} = \lambda_t, \tag{12}$$

where λ_t is the multiplier on the budget constraint.

1.3.2 Firms

The representative firm in our economy solves its profit maximization problem by choosing the optimal path for $\{N_t, V_t, p_t\}_{t=0}^{\infty}$ by maximizing

$$E_t \sum_{t=0}^{\infty} \beta^t \lambda_t \left[p_t \left(\frac{p_t}{P_t} \right)^{-(1+\epsilon)} Y_t - \mathcal{W}_{it} - cV_t - G(\tilde{a}_t) \right], \tag{13}$$

subject to the evolution of employment (9) and the production function 3. p_t is the price choosen by the firm and P_t is the aggregate price index, $P_t = \left[\int_0^1 P_{it}^{1-\epsilon} di \right]^{\frac{1}{1-\epsilon}}$. The first term in parenthesis gives real revenue depleted by total wage costs, being the aggregate of individual wages

$$\mathcal{W}_{it} = N_{it} \int_{\tilde{z}_{it}} W_t(z) \frac{f(z)}{1 - F(\tilde{z}_{it})} dz. \tag{14}$$

The third term gives total vacancy posting costs. $G(\tilde{z}_t)$ gives the total amount of firing costs, which is the integral over those workers idiosyncratic productivities falling below the threshold.

For a worker with the idiosyncratic producitivity z_{it}, the firm has to pay $g(z_{it}) = k z_{it}$, $k \geq 0$, as purely wasted firing costs. Following the interpretation from den Haan et al. (2000), i.e. exogenous separations are worker-initiated and only endogenous separations are involuntarily, we associate firing costs only to endogenously separated workers.[2]

Finally, the first-order conditions are

$$\partial N_t : \tau_t = \frac{Y_t}{N_t}\varphi_t - \frac{\partial \mathcal{W}_t}{\partial N_t} + (1 - \rho_t)E_t\beta_{t+1}\tau_{t+1}, \tag{15}$$

$$\partial V_t : c = (1 - \rho_t)q(\theta_t)E_t\beta_{t+1}\tau_{t+1}, \tag{16}$$

$\beta_{t+1} = \beta \frac{\lambda_{t+1}}{\lambda_t}$ is the stochastic discount factor, τ_t is the multiplier on the evolution of employment and φ_t is the Lagrangian multiplier on the production function, representing real marginal cost. Using these two equations yields the job creation condition

$$\frac{c}{q(\theta_t)} = (1 - \rho_t)E_t\beta_{t+1}\left[\frac{Y_{t+1}}{N_{t+1}}\varphi_{t+1} - \frac{\partial \mathcal{W}_{t+1}}{\partial N_{t+1}} + \frac{c}{q(\theta_{t+1})}\right]. \tag{17}$$

The left-hand side of this equation gives the hiring costs which equal the benefits of creating a new job. The latter depends on the marginal product of labor depleted by the wage and increased by saved hiring costs in the next period in case of non-separation.

1.3.3 Bargaining

If a firm and a worker have matched, the job shares an economic rent which is splitted in individual Nash bargaining by maximizing the Nash product[3]

$$W_t = \arg\max_{W_t}\left\{(\mathcal{H}_t - \mathcal{U}_t)^\eta (\mathcal{J}_t - \mathcal{V}_t)^{1-\eta}\right\}. \tag{18}$$

The first term is the worker's surplus, the latter term is the firm's surplus and $0 \leq \eta \leq 1$ is the exogenously determined, constant relative bargaining power. $\mathcal{U}_t$ and $\mathcal{V}_t$ are the worker's and the firm's threat points, respectively.[4] $\mathcal{J}_t$ is the asset value of a filled job for the firm and for the worker $\mathcal{H}_t$ is the asset value of being employed and accordingly $\mathcal{U}_t$ is the asset value of being unemployed.

Straightforward, the individual real wage satisfies the optimality condition

$$\mathcal{H}_t - \mathcal{U}_t = \frac{\eta}{1 - \eta}\mathcal{J}_t. \tag{19}$$

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[2] Since all separations take place simultaneously an identification problem arises due to moral hazard. The firm is not able to identify whether the endogenously separated worker would have quitted himself and hence has to pay firing costs. Therefore, this assumption is for the sake of completeness.

[3] It has to be emphasized that we treat firing costs as a wasteful tax paid outside the firm-worker pair. 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, since this component is non-Coasean. We therefore isolate the implications of firing costs from counteracting wage effects.

[4] Due to a free entry condition the equilibrium value of $\mathcal{V}_t$ is zero.

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 eq. (19). For the firm the asset value of the job depends on the real revenue, the real wage and if the job is not destroyed, the discounted future value. Otherwise the job is destroyed and hence has zero value and the firm has to pay firing costs. In terms of a Bellman equation the asset value is given by

$$\mathcal{J}_t = \varphi_t Z_t z_t - W_t + E_t \beta_{t+1} \left[(1 - \rho_{t+1}) \int_{\tilde{z}_{t+1}} \mathcal{J}_{t+1} \frac{f(z)}{1 - F(\tilde{z}_{t+1})} dz - \rho_{t+1} k z_t \right], \tag{20}$$

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

$$\mathcal{H}_t = W_t + E_t \beta_{t+1} \left[(1 - \rho_{t+1}) \int_{\tilde{z}_{t+1}} W_{t+1} \frac{f(z)}{1 - F(\tilde{z}_{t+1})} dz + \rho_{t+1} \mathcal{U}_{t+1} \right]. \tag{21}$$

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

$$\mathcal{U}_t = b + E_t \beta_{t+1} \left[\theta_t q \left(\theta_{t+1} \right) \left(1 - \rho_{t+1} \right) \int_{\tilde{z}_{t+1}} W_{t+1} \frac{f(z)}{1 - F(\tilde{z}_{t+1})} dz + \left(1 - \theta_t q \left(\theta_{t+1} \right) \left(1 - \rho_{t+1} \right) \right) \mathcal{U}_{t+1} \right]. \tag{22}$$

Unemployed worker receive the value of home production b, the discounted continuation value of being unemployed and if she is matched she receives the value of future employment.

Inserting these value functions into the Nash bargaining solution yields the individual real wage

$$W_t = \eta \left[\varphi_t Z_t z_t + c \theta_t - E_t \beta_{t+1} \rho_{t+1} k z_t \right] + (1 - \eta) b. \tag{23}$$

The wedge between the real wage and the reservation wage is increasing in every time-dependent component and the worker's bargaining power.

Now, we want to determine $\tilde{z}_t$, the cut-off point for idiosyncratic productivity. Notice that the firm will endogenously separate from a worker if and only if

$$\mathcal{J}_t < -k z_t, \tag{24}$$

i.e. if the worker's asset value is lower than the associated firing costs.

The threshold is then defined by[5]

$$\tilde{z}_t = \frac{(1 - \eta) b + \eta c \theta_t - \frac{c}{q(\theta_t)}}{(1 - \eta) \varphi_t Z_t z_t + \left(1 - (1 - \eta) E_t \beta_{t+1} \rho_{t+1} k \right)}. \tag{25}$$

By assumption, $\left(1 - (1 - \eta) E_t \beta_{t+1} \rho_{t+1} k \right) > 0$, such that the threshold is unambiguously lower than in the case without firing costs which is a quite intuitive result if one remembers that whenever

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[5]This equation can be derived by using eq. (20) in equilibrium, the individual real wage and the separation condition.

the firm wants to adjust the evolution of employment it changes the critical threshold. Hence, if workers are afflicted with firing costs the firm will decrease the number of laid-off workers, since some workers are protected by these additional costs, making the retaining option the preferred one.

Therefore this equation is able to verify the stylized fact of depressed job destruction flows and since $\frac{\partial \tilde{z}_t}{\partial k} < 0$, we infer that the more strict EPL, the larger the effect on job destruction will be. This result gives proof for the relevance of EPL for cross-country differences.

1.3.4 Equilibrium

In the symmetric equilibrium, factor and goods market clear and the resource constraint is

$$Y_t = C_t + cV_t. \tag{26}$$

In addition, the consumption good is used to pay vacancy posting costs. We assume that the government collects these costs and re-distributes them to the household via lump-sum transfers. Furthermore, the government pays unemployment benefits and finances them by collecting lump-sum transfers.

For the given stochastic process, a determined equilibrium is a state-contingent sequence of $\{C_t, Y_t, V_t, M_t, N_t, U_t, W_t, \theta_t, \tilde{z}_t, \lambda_t, \rho_t\}_{t=0}^{\infty}$ which for given initial conditions satisfies equations (2) to (4), (6) to (10), (12), (17), (23), (25) and (26). Then, the set of equations forming the equilibrium is linearized around the non-stochastic steady-state.

The calibration of the model is on a quarterly basis for the United States and parameter values are set according to stylized facts and the relevant literature.

Risk aversion σ is set to the value 2, the discount factor β is 0.99. The markup on real marginal costs is set to 10 % as in Krause and Lubik (2007), which leads ε to be 11. For the sake of simplicity we assume symmetric bargaining such that $\eta = 0.5$. Such that the wage is linearly depending on labor market tightness. We set $\mu = 0.4$ according to the empirical estimation by Blanchard and Diamond (1989). Exogenous job destruction ρ^x is set to 0.068 according to den Haan et al. (2000). The steady state separation rate $\bar{\rho}$ is 0.10 according to den Haan et al. (2000). The endogenous separation rate in steady state can be computed to 0.034. The critical threshold can be computed by building the inverse function, i.e. $\tilde{z} = F^{-1}(\rho^n)$. The steady state unemployment rate is set to $\bar{u} = 0.1$ reflecting the shortcoming of the unemployment rate namely the nonconformity of effective searchers and unemployed workers discussed in Cole and Rogerson (1999). Steady state firm matching rate is $\bar{q} = 0.7$ according to den Haan et al. (2000). Since idiosyncratic productivity

follows a lognormal c.d.f., the parameters μ_{LN} and σ_{LN} have to be calibrated. Based on Krause and Lubik (2007), the distribution function is normalized, such that $\mu_{LN} = 0$, while the parameter for the variance σ_{LN} is 0.12. Finally, we the autocorrelation ρ_A is 0.95 like in Cooley and Quadrini (1999).

As a starting point, we set $k = 0.1$, i.e. 10 % of the worker's productivity is paid as a firing tax.[6] This value reflects the low level of EPL observable in the U.S. labor market, while later on we will provide a robustness check of this and other pivotal parameters.

2   Discussion

In this section, we hit our economy with a one percent favorable technology shock. The response of our economy is presented in Figure 1.

The increase in productivity results in an increase in output. Firms decrease firing and increase vacancy posting in order to adjust to the changed economic environment. They do so in decreasing the productivity cut-off point and protect even less productive workers. Therefore, unemployment falls and converges from below to its steady state. On the flipside, firms start to post more vacancies and we observe the Beveridge curve. The benchmark search and matching model with endogenous separations reveals a separation driven adjustment mechanism, as for instance in Krause and Lubik (2007). We also obtain this mechanism, if we set the firing cost paramter to zero. In contrast, if we increase firing costs, we observe that firms switch from adjusting along the destruction margin to posting more vacancies. As the firing margin becomes more costly, firms avoid these costs and have stronger incentives to adjust along the hiring margin. At this point, it is worth to have a closer look on what drives the hiring incentives. Here, we identify three main channels. First, labor market tightness drives hiring and re-hiring costs. As tightness stays rather constant for different degrees of firing costs - as the response of unemployment offsets the change in vacancies - this channel is rather uninteresting for us. Second, higher firing costs imply higher wages, such that firms have ceteris paribus less incentives to post vacancies. The third and last channel works along the destruction margin. As job destruction goes down, discounted profits from posting vacancies increase and this channel dominates the disincentives from higher wages.

The second moments of our simulation are shown in Table 2. Data values shown are for the United States taken from Shimer (2005) and Krause and Lubik (2007). Values for the job creation and destruction rate are based on own computations, to be discussed in the empirical section of this paper.

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[6]See Brown et al. (2009) for a closer explanation of the determination of this parameter
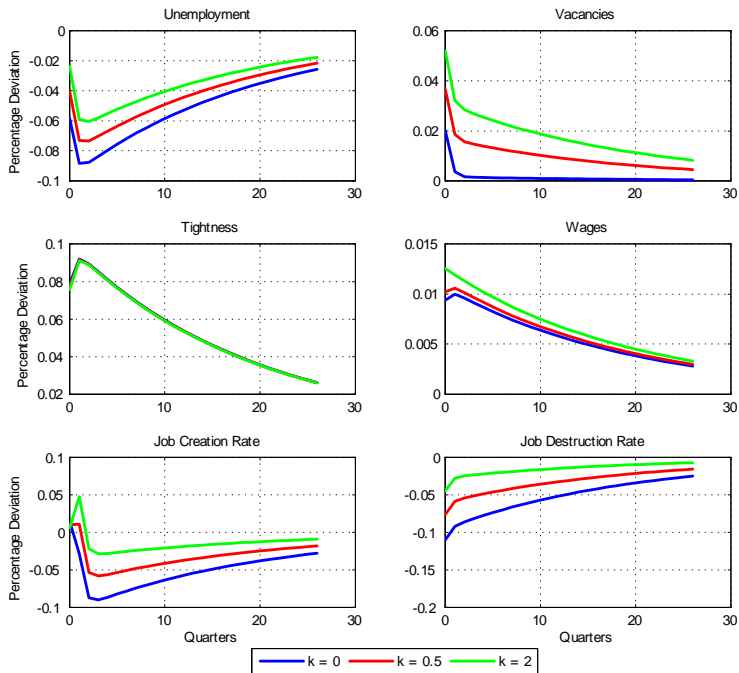
Figure 1: Impulse responses for different degrees of firing costs

Let us begin with the benchmark model, without firing costs. We find that the model creates too much volatility of unemployment compared with the data. In contrast, the model fails to replicate enough volatility of vacancies. This can be traced back to the separation driven adjustment mechanism and low incentives to adjust the hiring margin. The value for labor market tightness fits its empirical counterpart rather well, which is driven by the large volatility of unemployment. The model creates too much volatility of job flows. For instance, the standard deviation of the destruction rate is 0.23, while it is 0.03 in the data. Furthermore, we find a small Beverdige curve of -0.45 even in the case of no firing costs.[7] However, we find that the model fails to replicate the negative corelation of job creation and destruction found in the data. Moreover, while we find a strong negative correlation of job destruction and GDP, the model also creates a negative correlation of job creation and GDP, which is contradicted by the data.

If we now switch on firing costs, we find that the model's performance is increased along every dimension. As discussed, firing costs raise incentives to post vacancies and hence the volatility of vacancies increases with increasig firing costs. This also explains why the volatility of unemployment decreases. As we have seen before, labor market tightness is rather unaffected, because the increase

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[7]Notice that the sticky price version of this model would not generate the Beveridge curve.

in the volatility of vacancies is offset by a decrease in the volatility of unemployment. While the model without firing costs replicated much too high standard deviations of job flow variables, the firing cost model significantly decreases those values. However, still generating too much volatility. In addition, we still find a strong negative relation between the job destruction rate and GDP. The relation between the job creation rate and GDP is now less countercyclical as before, such that the model works in the right direction. The same holds for the - still - positive correlation from job creation and destruction rate. Higher firing costs generate a much more realistic Beveridge curve relation.

Table 1:

Standard Dev.	U.S. Data	$k = 0$	$k = 0.1$	$k = 0.5$	$k = 1$	$k = 2$
U	0.18	0.30	0.29	0.25	0.23	0.21
V	0.20	0.02	0.03	0.06	0.09	0.11
θ	0.37	0.31	0.31	0.31	0.31	0.31
ρ	0.01	0.13	0.12	0.09	0.06	0.04
jfr	0.03	0.23	0.23	0.23	0.23	0.23
jcr	0.003	0.31	0.27	0.20	0.15	0.11
jdr	0.004	0.31	0.28	0.20	0.15	0.09
Correlation						
U, V	-0.89	-0.45	-0.74	-0.90	-0.92	-0.93
jcr, jdr	-0.36	0.89	0.88	0.83	0.76	0.59
jcr, Y	0.12	-0.93	-0.93	-0.89	-0.83	-0.69
jdr, Y	-0.70	-0.99	-0.99	-0.99	-0.98	-0.97

Table 2: Notes: Theoretical moments. Data values are taken from Shimer (2005) and Krause and Lubik (2007).

Finally, we also simulate the model using a European calibration (taken from Thomas and Zanetti (2009)). We find that our qualitative results hold. To be precise, we find that the benchmark case, without firing costs, creates even more volatility compared to the U.S. calibration. On the flipside, the Beveridge curve relation is smaller, being only -0.29. Increasing firing costs has the same qualitative effects, i.e. firing costs decrease the volatility of unemployment and increase the volatility of vacancies and strengthens the Beveridge curve relation. While we know from Gartner et al. (2009) that the German labor market is more volatile than the U.S. labor market, our model with the European calibration captures this feature fairly well and replicates those larger values.

3 Empirical Analysis

In this section, we provide cross-country evidence for the relation between the employment protection and (i) the Beveridge curve relation, (ii) the volatility of job flows.

3.1 The Beveridge Curve

In the precedent section, we concluded that the Beveridge curve relation is improved by assuming higher firing costs. This implies that the stricter employment protection, the stronger the Beveridge curve relation. We want to put this theorem to the test. For this purpose, we consider a cross-country analysis of the Beveridge curve relation containing 15 OECD countries. We use quarterly data for unemployment and vacancies from 1970:Q1 to 2008:Q4 provided by the OECD. We generate artificial data for the vacancy rate by dividing the number of registered unfilled job vacancies through total civilian employment. In addition, we use a harmonized unemployment rate being the number of unemployed persons as a percentage of the civilian labor force with two exemptions. For Austria and Germany we use the registered unemployment rate by reason of superior data availability. The value for the United States is taken from Krause and Lubik (2007), as the OECD does not provide consistent data for vacancies in the United States. With this two time series we are able to compute the order of correlation between unemployment and vacancies. Our results are presented in Table 3.

For the strictness of employment protection, we use the employment protection legislation (EPL, for short) index for 2003 from the OECD. This index is generated in a more precise way compared to other potential measures. We use version 1 of this index and since numbers for collective dismissals are only available since the late 1990s, version 1 is an unweighted average of the summary measures for regular and temporary contracts only. As a final step, we generate the order of correlation between the Beveridge curve and EPL. The corresponding figure is presented in Figure 2.

Recall that the model's prediction is a negatively sloped regression line, with a higher value of EPL resulting in a more strict Beveridge curve relation. However, the empirical analysis yields a positively sloped regression line. The R^2 of the regression is 0.15. Leaving out the positive outlier - Japan - increases the model fit considerably, raising the R^2 to 0.28. The data predicts that the Beveridge curve relation will decrease in the strictness of EPL. Countries with a stronger employment protection legislation therefore have a weaker Beveridge curve relation. The model fails to generate this finding, as the separation driven adjustment mechanism can only be broken by higher firing costs.

The simulation with the European calibration helps to explain the difference in the size of the

Table 3: Beveridge Curve Relation and EPL.

Country	BC	EPL
Australia	-0.69	1.19
Austria	-0.58	1.94
Belgium	-0.54	2.18
Czech Republic	-0.71	1.9
Finland	-0.27	2.0
Germany	-0.24	2.21
Hungary	-0.46	1.52
Japan	0.26	1.84
Netherlands	-0.4	2.12
Norway	-0.18	2.56
Portugal	-0.46	3.46
Spain	-0.19	3.05
Sweden	-0.62	2.24
Switzerland	-0.43	1.14
United Kingdom	-0.35	0.75
United States	-0.95	0.21

Beveridge curve relation found in our dataset. Obviously, our empirical analysis focuses on the role of labor adjustment costs, leaving aside other factors such as wage rigidity, the role of institutions or other country specific effects. As our European simulation shows a smaller Beveridge curve relation compared with the U.S. calibration, but also a negatively sloped line, we can draw the conclusion that a model with labor adjustment costs can not replicate the empirical finding presented in this section. It appears that labor adjustment costs are not the decisive factor to explain our finding.

3.2 Second Moments of Job Flows

It is not disputed that labor market regulations reduce labor turnover rates (see e.g. OECD (2004)), however, does this hold for the volatility of job flows? To answer this question, we proceed in two steps. First, we analyze the behavior of job flow volatilities measured by the volatility of the job creation and the job destruction rate for different firing costs, i.e. for strikter employment protection. Second, we empirically investigate whether there is a robust relationship between EPL and the volatility of job flows in a cross-country analysis. First, we need to define both job ow rates
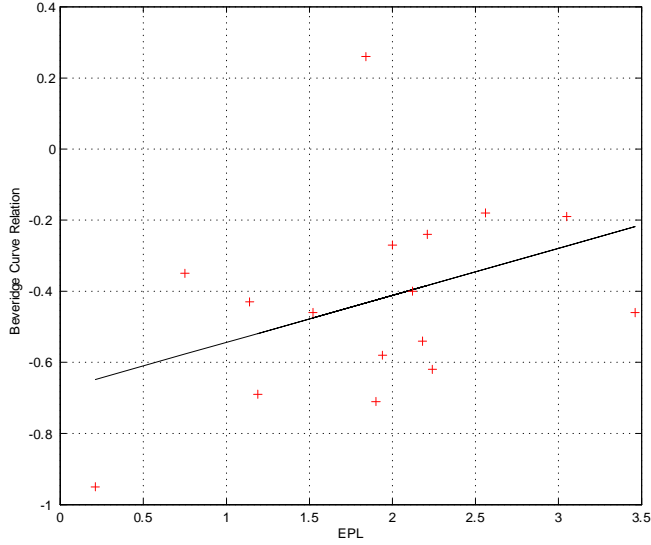
Figure 2: Regression: Beveridge curve on EPL.

in our model. The job destruction rate is given by

$$jdr_t = \rho_t - \rho^x. \tag{27}$$

We need to subtract the second term, because it is not relevant for the gross destruction of employment opportunities.

Along this line, the job creation rate can be written as

$$jcr_t = \frac{(1 - \rho_t)\, V_{t-1} q\, (\theta_{t-1})}{N_{t-1}} - \rho^x.$$

The results from varying the degree of firing costs, viz. changing k, on those two rates are presented in Table 2.

We find that both volatilities are decreasing in the degree of employment protection. For the job creation rate this result is driven by the fact that the volatility of unemployment and the separation rate is decreasing in k. Also, as the separation rate drives the job destruction rate, its volatility decreases. Furthermore, both rates become less countercyclical with increasing the firing cost parameter. The intuition behind this results is straightforward. On the one hand, higher firing costs shift the cut-off point to the left, protecting even less productive workers, while on the other hand, the present value of posting a vacancy is increased. This implies that the volatility of key variables is driven closer to their empirical counterparts, with increasing employment protection.
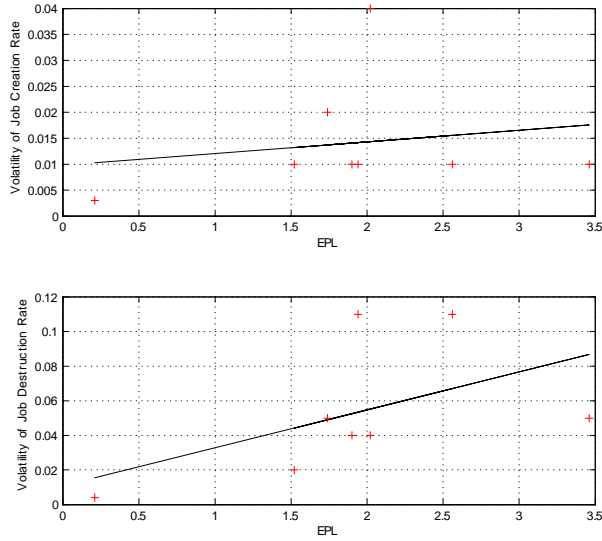
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Figure 3: Regression: Volatility of job flow rates on EPL.

Having discussed the predictions for the volatility and the cyclicality of job flow variables, we want to perform a cross-country analysis to verify these predictions. For this purpose, we use time series available from the OECD database. Due to the very limited availability of reliable data for job vacancies, we are left with eight countries. Time series are on a quarterly basis from 1998:Q1 to 2009:Q4. All series are written in logarithmic scale and are detrended using a Hodrick-Prescott filter with $\lambda = 10^5$. Our results are presented in Figures 3 and 4.

Surprisingly, we find that the volatility of both rates is increasing in the degree of employment protection. The result for the job creation rate is significant, with a R^2 of 0.27. EPL plotted against the volatility of the job destruction rate reveals a positive correlation significant at the 5 % level, with a R^2 of 0.03. This result also confirms the finding from Gartner et al. (2009), showing that the volatility of key labor market variables is larger in Germany (with a relatively high EPL) as in the United States (with a relatively low EPL). They suggest that higher volatilities might be driven by a higher expected duration of a job in Germany, i.e. in a country with higher labor turnover costs. Now, let us consider the impact of strikter EPL on the cyclicality of both rates. We find that the job creation rate is procyclical for the United States, while it is countercyclical for Portugal. We find that higher EPL countries tend to have a countercyclical job creation rate. For the job destruction rate, we observe that higher EPL clearly implies less countercyclical job destruction. Againg, we find that the regression for the job creation rate shows a higher R^2, with
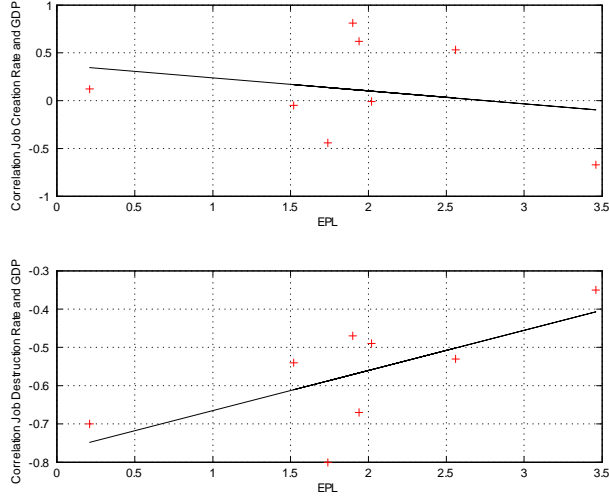
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Figure 4: Regression: Correlation of job flow rates with GDP on EPL.

0.44 compared to 0.06 for the destruction rate. These two results are in line with the intuition we gained from the consideration of the productivity shock in our model. As higher firing costs decrease incentives to fire workers (and to hire workers) as a reaction to a shock, it makes job destruction and creation less cyclical. However, we can not explain the increasing volatility of job flows with the search and matching model developed above. Besides these insights, we find that the job destruction rate is for almost all countries much more volatile (by factors between 2 and 11) than the job creation rate (see Table 4). This gives support to endogenize the separation margin. As before, we also simulated the model with a European calibration, We find that our results are

Table 4: Empirical Second Moments.

	EPL	$Vol(JCR)$	$Vol(JDR)$	$Corr(JCR, GDP)$	$Corr(JDR, GDP)$
Austria	1.94	0.01	0.11	0.62	-0.67
Czech	1.90	0.01	0.04	0.81	-0.47
Finland	2.02	0.04	0.04	-0.01	-0.49
Hungary	1.52	0.01	0.02	-0.05	-0.54
Norway	2.56	0.01	0.11	0.53	-0.53
Polen	1.74	0.02	0.05	-0.44	-0.80
Portugal	3.46	0.01	0.05	-0.67	-0.35
US	0.21	0.003	0.004	0.12	-0.70

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not affected by the change in the calibration. There is almost no difference in the cyclicality of the job creation and destruction rate. However, we find that this calibration generates an even more volatile job creation and destruction rate, decreasing in the degree of firing costs, as before.

4   Conclusion

In this paper, we develop a real business cycle matching model with endogenous separations. We enrich the framework by introducing productivity-dependent firing costs to acount for differences of firing costs across workers. We find that the model with firing costs outperformes the benchmark model without firing costs. To be precise, the model with firing costs amplifies standard deviations and correlations and helps to generate the empirically observed values. The model breaks the separation driven adjustment mechanism by afflicting the firm's exit site with costs. As a consequence, firms are more reluctant to adjust along the exit site and shift parts of the adjustment to the entry site. Therefore, the model has a stronger incentive mechanism to post vacancies.

The second contribution is a cross-country evidence that countries with higher employment protection reveal a weaker Beveridge curve relation. This finding can not be explained by our model with labor turnover costs.

Finally, we provide evidence that the volatility of tje job creation and destruction rate are increasing in the degree of employment protection. This finding confirms the empirical finding from Gartner et al. (2009). Furthermore, we show that the job creation rate becomes less cyclical with higher turnover costs, while the job destruction rate becomes less countercyclical. The model is able to replicate the latter finding, but is not able to replicate the finding of increasing volatility with increasing EPL.

We can draw the conclusion that heterogeneity in firing costs helps to understand the response of the economy and increases the performance of the baseline search and matching model with enodgenous separations. Our surprising empirical findings offer various directions for future research.

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