

Zaveh, Fakhraldin

**Preprint**

## Search, Rigidities and Unemployment Dynamics

*Suggested Citation:* Zaveh, Fakhraldin (2014) : Search, Rigidities and Unemployment Dynamics, ZBW - Deutsche Zentralbibliothek für Wirtschaftswissenschaften, Leibniz-Informationszentrum Wirtschaft, Kiel und Hamburg

This Version is available at:

<https://hdl.handle.net/10419/157661>

**Standard-Nutzungsbedingungen:**

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

**Terms of use:**

*Documents in EconStor may be saved and copied for your personal and scholarly purposes.*

*You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.*

*If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.*

# Search, Rigidities and Unemployment Dynamics\*

Fakhraldin Zaveh<sup>†</sup>

Universitat Autònoma de Barcelona, I.D.E.A.

## Abstract

In this paper, I study the sources of cross-country differences in unemployment dynamics. Elsby, Hobijn and Sahin (2013) find that in Anglo-Saxon economies unemployment fluctuations are mainly driven by changes in the outflows out of unemployment, while in continental European and Nordic countries changes in inflows into unemployment are almost equally important. I provide evidence that a category of labor market regulations which I refer to as the *restrictive regulations* raise contributions of inflows into unemployment. On the contrary, higher firing costs reduce the importance of this driver of unemployment dynamics which is in line with the literature. I introduce an aggregate regulatory rigidity into a Mortensen and Pissarides search model with endogenous job destruction. I calibrate the model to the US. Introducing rigidity and firing costs together explain about half of cross-country variations.

---

\*This version: April 2014

<sup>†</sup>I am thankful to Sekyu Choi for his advice and encouragement. I am also grateful for comments from José Ignacio Silva, Arnau Valladares-Esteban and seminar participants at Warwick PhD Conference. I also thank Jan Grobovsek for sharing Matlab codes. All errors are mine.

*Keywords:* Unemployment Dynamics, Search and Matching, Rigidity, Restrictive Regulations.

## 1 Introduction

Why the dynamics of unemployment is so different among Anglo-Saxon and continental European countries? On average, inflows into unemployment in the latter countries contribute to the unemployment fluctuations almost three times more than in the former group (Elsby, Hobijn and Sahin, 2013). This pattern holds despite the fact that European countries typically are known to have relatively higher firing costs. Most of theoretical and empirical literature shows that higher firing costs dampen volatility of separation of workers at the marginal jobs, from which one may expect a lower contribution of inflows to the unemployment fluctuations in European countries.

The distinct behavior of those clubs of countries raises the question about possible sources and explanations of this pattern. Among different explanations, this paper focuses on a specific class of the labor market regulations. In particular, I show that a class of less studied regulations can be a potential explanation for the above mentioned cross country discrepancies. I construct an index of the restrictiveness of those regulations using the "Rigidity of Employment index" of World Bank's Doing Business, which contains country specific information about various restrictions on the working arrangements. The constructed index exhibits a strong correlation with the dynamics of unemployment.

On the other hand, throughout the past decade the Diamond-Mortensen-Pissarides

(DMP) search and matching model has been the dominant theoretical framework to study unemployment. Many recent dynamic stochastic models use this framework to study contributions of specific types of regulations such as unemployment benefits, hiring and firing costs, employment protections, contractual environment, etc. to the labor market outcome. Nevertheless, the ability of the model to generate reasonable unemployment volatility has been questioned by the influential work of Shimer (2005a). Therefore the main question I try to address in this paper is “Whether the mentioned cross country differences can be explained by a DMP search and matching model?”. To answer this question, I take a reduced form approach to introduce the described index of restrictive regulations into a DMP search model. Cross country variations in the index, in addition to the firing costs, explains about half of the cross country variations in the unemployment dynamics, as described earlier.

The remainder of the paper is organized as follows. I first provide an empirical motivation. In the third section I briefly address the related literature. The fourth section explains the model. The calibration methodology is described in section five. Section six presents the results. The last section concludes.

## 2 Empirical motivation

In a two-state worker model, where workers move between employment and unemployment, changes in either inflows into the employment pool (separations<sup>1</sup>) or outflows from the unemployment (job findings) could generate fluctuations in the

---

<sup>1</sup>By the term “separation” I actually mean inflow to unemployment. These are not exact substitutes when either on the job search or the transmission from non-participation to unemployment is allowed. Since this paper abstracts from on the job search and non-participation, I use separation and inflow into unemployment interchangeably.

unemployment rate. In other words, unemployment goes up either because the probability that employed workers are losing their jobs is going up or because it is harder for the unemployed to find a job, or both. Despite quantitative disagreement among the researchers, the common message from decomposition of the U.S. unemployment is that in the U.S. the contribution of inflows to unemployment fluctuations is non-trivial, however outflows changes are the dominant driver of unemployment. Elsby, Hobijn and Sahin (2013), hereafter EHS, generalize Shimer’s (2007) measurement and decomposition methods and apply them to lower frequency data - quarterly and annually - of fourteen OECD countries, including the U.S., therefore provide a set of comparable cross country statistics. Table 1 reports their main findings. In the table  $\beta_f$  and  $\beta_s$  are contributions of job finding and separation rates to the unemployment volatilities, respectively. Their results show that variations in the job finding rates can explain around 85% of unemployment fluctuations in Anglo-Saxon economies, while in Continental Europe, Nordic countries and Japan generally separation rates are equally important. In the latter group, on average, job finding rates and separation rates contribute 55% and 45% to unemployment variations respectively. For brevity I refer to the latter set of countries as *rigid economies*.

There are couple of additional points, I would like to emphasis. First, I split the underlying time series of EHS for each country<sup>2</sup> and recalculate the decomposition for these subsamples. In almost all countries –except Japan–, the results do not substantially differ between the split subsamples. Second, the decomposition results show no clear relation neither to the unemployment levels nor to the flows rates. For

---

<sup>2</sup>I would like to thank Elsby, Hobijn and Sahin for making the detail data of their calculations available online.

example, with regard to the flows, as reported by EHS, the United States has by far the highest average outflows rate (56.5%) followed by Norway (38.5%) and Sweden (29.2%). On the other extreme, Italy with the lowest outflows rate in the sample (4.3%) has a  $\beta_f$  very similar to Anglo-Saxon economies (0.85).

The focus of this paper is on the potential role of differences in labor market institutions. Several empirical papers study either steady state or business cycle effects of different regulations (e.g. Nickel and Layard (1999) and Gnocchi and Pappa (2011)). There are also numerous theoretical papers study contributions of specific regulations to the labor market. Throughout the past decade the DMP search and matching model has been the dominant theoretical framework to study unemployment. Many recent theoretical papers use this framework to study contributions of one particular regulation, such as unemployment benefits, hiring and firing costs, employment protections, contractual environment, etc. A common feature of most of these policies, especially those used in general equilibrium models, is that they impose restrictions only on employment decision of the firm and not explicitly on the outcome of a match for the firm. I argue that, in general, regulations that restrict free working arrangement of a match may affect the dynamics of unemployment. Restrictive regulations refer to regulations that in one way or another prevent firms from freely choosing among different working arrangements. The idea is that restrictions on work arrangements have kind of asymmetric effects on a match during the business cycle. At good times the restrictions could reduce the profitability of a match; however the match still could be profitable enough to survive. At bad times, however, the small profits of less productive matches fade away by imposing

restrictions. This triggers more job destruction than otherwise. Those restrictions, in general, include regulations that explicitly prohibit some working arrangements (e.g. explicit restrictions on weekly hours worked, forbidding temporary employment under certain conditions) or restrictions that makes some arrangements costlier for the firm (e.g. setting a premium for extra hours worker, or discriminating at firing cost among full time and temporary workers).

In this paper I calculate a proxy of these restrictions using "Rigidity of Employment index" of World Bank's Doing Business. The World Bank's index is a simple average of three subindices: hiring index, a rigidity of hours index and a difficulty of redundancy index, each takes a value between zero and one hundred, where a lower value indicates less restriction. These indices contain information on restrictive regulations such as working days, working hours and also restrictions on using different types of contracts. For example, a country receives a high index if it restricts weekend, night work and/or workday hours<sup>3</sup>. To construct the "Restrictive Regulation index" I calculate the first principal component of hiring and rigidity of hours indices. For comparability of the coefficients in coming regressions, through a linear transformation I scale the extracted components to the same range as the firing costs.

Figure 1 compares indicators of the three categories of regulations (a measure of firing costs, an index of restrictiveness of regulations, and the level of unemployment insurance) for the fourteen OECD countries of table 1 . The left, middle and right columns report the job security index of Heckman and Pages (2004), the constructed

---

<sup>3</sup>Difficulty of redundancy index has information on firing. Therefore is not appropriate for the purpose of restrictive regulation index.

proxy for restrictive regulations (calculated using employment rigidity index of the World Bank Doing Business (2005)) and the unemployment replacement ratio of Nickel and Layard (1999). As one may expect, countries remarkably differ among all these dimensions, which extends to the subcategories of Anglo-Saxons and the rigid economies, too. In the case of the job security index, among Anglo-Saxons the U.S., New Zealand and to some extent Canada have very low indices, while Australia can be considered having relatively a high index and the UK stands somewhere in the middle of the fourteen countries. The job security index of rigid economies varies from lower than Canada's index for the case of Japan, to very high for Portugal, Spain and Italy. In the case of unemployment replacement ratio, the rigid economies generally show higher ratios than Anglo-Saxons, with the notable exception of Canada. In the case of the restrictive regulation index Anglo-Saxons have lowest indices. The lowest index among rigid economies (Norway) equates highest among Anglo-Saxons (the UK).

In general, Anglo-Saxon economies are usually known to be more flexible than Continental Europe and Nordic economies. In particular, they usually have relatively lower unemployment benefits, lower or no severance payment at the moment of employment reduction, more flexible regulations for signing and exerting different types of contracts and more flexible hours of working, etc. To investigate the potential relation among these variables and the illustrated fact by EHS, I regress  $\beta_f$  of the countries in table 1 over the three variables reported in figure 1. I also regress over the possible combinations of these three variables. Table 2 provides the results. Since  $\beta_s$  is almost equal to  $1 - \beta_f$ , regressions with  $\beta_s$  instead of  $\beta_f$  in the left hand



side will provide very similar results. I emphasize that the aim here is not to provide a rigorous causality test, but to illustrate a potential relation between the right hand side variables and the  $\beta_f$ , especially considering the small sample size. But still there are a couple of interesting results. First, despite small sample size, as shown in the first column (model I), in the regression with the three variables, all variables are significant at 5%. From the main regression (model I), one expects that countries with higher firing costs should have higher  $\beta_s$  (lower  $\beta_f$ ). This is in accordance with the literature, nonetheless cannot be found by regressing  $\beta_f$  over firing costs only, such a regression (model V) gives a coefficient with the opposite sign and insignificant<sup>4</sup> and generates an incredibly low R-squared of zero. Furthermore, regressing over any pair of the three variables leads to at least one insignificant<sup>5</sup> coefficient. In particular, removing the rigidity index from the right hand side variables makes the coefficient of firing costs insignificant<sup>6</sup>. Moreover, model (I) produces by far the highest adjusted R-squared. Also the three models with highest adjusted R-squared share the rigidity index. Lastly, if instead of using the first principal component, one calculates an alternative index by averaging the two indexes of rigidity of hours and employment rigidity, the regressions give similar results but with marginally lower R-squared<sup>7</sup>. This goes in favor of using principal component analysis, and also in favor of the choice of these variables, because the principal component analysis reserves the information better than simple average.

---

<sup>4</sup>At 87% significance level compare to standard significance levels of 10%, 5% or 1%.

<sup>5</sup>At 10% significance level.

<sup>6</sup>At 39% significance level.

<sup>7</sup>The results of regressions with the "simple averaged index" are not reported here, but are available upon request.

All in all this primary study suggests that the restrictive regulations could play a significant role in driving the dynamics of unemployment. To my knowledge, however, no dynamic stochastic model of unemployment incorporates this family of variables as a whole. An important feature of this invented variable is that it represents a group of different regulations. Modelling each regulations separately makes the workhorse model of study unemployment, the DMP framework, very complex. That is why I choose a reduced form approach to introduce this class of regulations into the DMP search models.

It is worth noting that this paper aims to address the impacts of those restrictive regulations on unemployment dynamics only; measuring potential benefits or disadvantages associated with such policies is beyond the scope of this paper.

### **3 Related Literature**

A vast literature studies the gross flows of workers between unemployment and employment after the seminal work of Blanchard and Diamond (1990). However, more relevant to this study is the contribution of the flows into and out of unemployment in unemployment movements. Hall (2005a,b) and Shimer (2005b) measure unemployment flows and argue that separations are almost acyclical. The same is reported in early versions of Shimer (2007). A number of studies, e.g. Elsby, Michaels, and Solon (2009), Elsby, Hobijn, and Sahin (2011), Fujita and Ramey (2009), and Yashiv

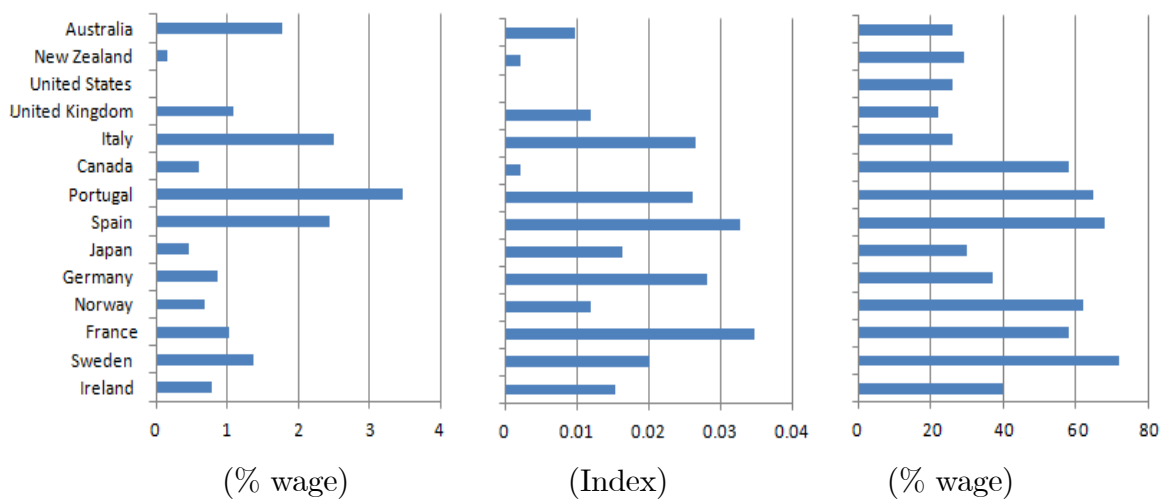


Figure 1: Regulations. Left: Job Security Index (Heckman and Pages, 2004). Middle: Restrictive Regulation Index (Own-calculation using World Bank Doing Business, 2005). Right: Unemployment Replacement Ratio (Nickell and layard, 1999)

Table 1: Unemployment Fluctuations Decomposition

Anglo-Saxon	$\beta_f$	$\beta_s$	Continental Europe and Nordic	$\beta_f$	$\beta_s$
Australia	93	10	France	54	45
Canada	79	23	Germany	56	47
New Zealand	88	13	Ireland	47	55
U.K.	85	17	Italy	83	15
U.S.	85	16	Japan	56	45
			Norway	54	45
			Portugal	68	32
			Spain	57	43
			Sweden	50	51

Note:  $\beta_f$  and  $\beta_s$  are contributions of job finding rates and separation to the unemployment volatilities, calculated using non-steady state decomposition method proposed by EHS. Source: Elsby, Hobijn and Sahin (2013).

Table 2: OLS regression result

	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)
Firing costs	10.1**	8.2	3.6		-0.77		
Restr. Reg.	-10.3**	-12.6**		-5.3		-8.0**	
U.I.	-0.49**		-0.6**	-0.4*			-0.54**
Constant	yes	yes	yes	yes	yes	yes	yes
Obs.	14	14	14	14	14	14	14
$R^2$	0.71	0.46	0.42	0.49	0.00	0.31	0.38
$\overline{R^2}$	0.62	0.37	0.31	0.39	-0.08	0.25	0.32

Notes: Firing costs: from Heckman and Pagés (2004) in percentage of monthly salary; Restrictive Regulation: own-calculation (see the text); UI: unemployment benefit replacement ratio from Nickell and Layard (1999). \* and \*\* are significance levels at 10% and 5% respectively.

(2007), criticized the claim either by different measurement of flows or by different methods to measure the contribution of unemployment flows to the volatility of the U.S. unemployment rate. It is worth mentioning that different methodologies for assessing the relative contribution of flows in unemployment fluctuations gives different results even when applied to a similar time series of flows. Shimer (2007) to decompose the contributions of flows to the unemployment movements applies a method originally proposed by Pissarides (1986) for the UK data. This decomposition method assumes unemployment at each period reaches its steady-state. The assumption mimics the data well when the flows are high and therefore after realization of new rates adjustment to the steady-state level of unemployment happens quickly. The assumption specially does a good job for the U.S. data, since the U.S. economy has an extraordinary high flows. While when it comes to the economies with low flows rates, the slow adjustment of unemployment is in contrast to the steady-state assumption of this decomposition method. EHS extend the model in this dimension and allow for sluggish unemployment adjustment. As a result, when applied to economies with low flow rates, EHS non-steady state decomposition method produces smaller residuals compare to the steady-state method.

Compare to relatively large literature on the U.S. data, cross country literature are few. I already talked about EHS. Petrongolo and Pissarides (2008) study the dynamics of unemployment in three European countries: the U.K., France and Spain. Since they use the steady-state decomposition, to deal with the problem of not fitting the data they drop observations with large deviations from steady-state. Justiniano and Michelacci (2011) develop a real business cycle model augmented with search

and matching frictions for six countries: the U.S. and the UK, France and Germany, and Norway and Sweden. They calibrate each country separately and allow for six different sources of shocks: neutral technology, Investment, job destruction, discount factor, matching function and aggregate demand. They introduce wage rigidity by allowing only a fraction of matches to negotiate the wage at each period. There are not other labor market rigidities, e.g. firing cost, in their model. They find that technology shocks are the main driver of labor market dynamics in the U.S. and some European economies like Sweden, however they affect comparatively weaker the labor market dynamics in France; they find mixed results for other countries in their study. Rogerson and Shimer (2011) survey the studies of three and four state model transitions.

My paper is also related to a branch of literature which incorporates labor market regulatory rigidities into the Mortensen and Pissarides search model. I briefly review some of the related studies<sup>8</sup>. Garibaldi (1998) explores the equilibrium job destruction and job creation in a search and matching model incorporating firing costs and firing permissions. He shows that tighter firing restrictions make the job destruction less volatile. Mortensen and Pissarides (2003) study labor market policies effects to the steady state of search and matching models. Thomas (2006) finds that within the search and matching framework firing costs reduce the volatility of business cycle fluctuations. Veracierto (2008) reaches similar results with firing costs in a RBC model. Pries and Rogerson (2005) show that imperfect information about match

---

<sup>8</sup>A growing literature, not mentioned in the main text, deals with wage rigidity. However this type of rigidity is not directly addressed in this paper. See Rogerson and Shimer (2011) for a recent survey.

quality in the presence of rigidities can generate observed lower worker turnover in Europe than in the U.S., despite similar job turnover. Guell (2010) theoretically discusses opposite effects of firing costs, depending on the modeling assumptions. Hobijn and Sahin (2013) study the effect of rigidities in terms of firing costs, entry costs, and a tax wedge between wages and labor costs on the firm-size distribution and dynamics. Silva and Toledo (2011) show that introducing training costs besides separation costs improves the behavior of the Mortensen and Pissarides model in replicating the observed volatility of unemployment and vacancies. Sala, Silva and Toledo (2012) find that introducing temporary jobs with no firing cost, in presence of permanent jobs facing firing costs, increases the volatility of unemployment. Llosa et al. (2012) show that dismissal costs can explain the cross country differences in intensive and extensive margin of labor supply over the business cycle. In a study parallel to this paper Murin and Robin (2014) take a reduced form approach to introduce different labor market institutions simultaneously into a search model. They assume that changes in the policies affect the long run equilibrium through changing the structural parameters of the model, while the cyclical movements are driven by aggregate productivity shocks. Applying the model to a subsample of countries in the paper, they estimate the effect of different policies on the labor market outcomes.

## **4 The model**

## 4.1 The economy

The economy consists of a unit mass of infinitively lived workers and an infinite mass of firms. Worker and firms discount future payoffs at a rate  $\beta$ . Worker are either employed or unemployed. An unemployed worker benefits from a constant pay off  $b$  each period, which contains unemployment insurance, utility of leisure, and home production.

Each firm consists of an either filled or unfilled vacancy. A filled vacancy have access to potential production technology of  $z_t x_t$ , where  $z_t$  is the aggregate productivity level, common to all matches, and  $x_t$  is the match specific quality. The aggregate productivity follows an AR(1) process

$$\ln(z_t) = \rho \ln(z_{t-1}) + \varepsilon_t \quad (1)$$

where  $\varepsilon_t$  is i.i.d. normal disturbances with mean zero and standard deviation  $\sigma_z$ . Dynamics of  $x_t$  is as following: all new matches start at highest possible match specific productivity level, say  $x^N$ . Each period with probability  $\lambda$  the match specific productivity remains constant, and with the remained probability of  $1 - \lambda$  the specific productivity switches to a new level; it is drawn randomly according to the c.d.f  $G(x)$ . A firm pays a cost of  $c$  per period to post a vacancy. The number of matches is assumed to have a Cobb-Douglas form of

$$m(u_t, v_t) = Au_t^\alpha v_t^{1-\alpha} \quad (2)$$

where  $u_t$  is the number of unemployed and  $v_t$  is the number of posted vacancies



at period  $t$ . Thus, an unemployed worker finds a job each period with probability of

$$F_t = F(\theta_t) = m(u_t, v_t)/u_t = A\theta_t^{1-\alpha} \quad (3)$$

where  $\theta_t = v_t/u_t$  is the labor market tightness. On the other hand the probability that a firm finds a worker to fill its vacancy is

$$Q_t = Q(\theta_t) = m(u_t, v_t)/v_t = A\theta_t^{-\alpha} = F(\theta_t)/\theta_t. \quad (4)$$

Thus when the labor market is tighter, it is easier for an unemployed worker to find a job, while it is harder for a firm to find a worker.

Figure 2 illustrates the timing of the events in the model. At the beginning of each period the aggregate productivity realizes. Then, non-productive firms may decide to post vacancies and the unemployed workers meet vacancies. Simultaneously, a fraction  $s^x$  of matches from the previous period break exogenously and existing matches learn whether their match specific productivity has changed, and decide to produce or dissolve the match endogenously. Afterwards, production takes place.

*Modelling the rigidities.* There are two types of regulatory rigidities: firing costs and restrictive rigidities. The distinction stems from the way each of those rigidities affect the decision of a firm. Firing costs realizes only at endogenous separations while restrictive rigidities could have direct effects during any period of production. In other words, as it is standard in the literature, I model the firing costs as firing taxes that firm has to pay; whenever a firm decides to dissolve the match endoge-

nously it must pay the firing cost  $\mathcal{F}$ . Restrictive rigidities consist of those regulatory rigidities that prevent matches from responding flexibly to their economic state. More precisely, a worker-firm match in a fully flexible economy has the option to adjust features of the match, such as time and hours of work or type of contract, etc., to respond optimally to its state. However, regulations in a rigid environment may restrict an active firm to adjust those different features of the match. Adding all of these features together to a Mortensen-Pissarides search and matching model makes the model very complex, also one must take stand about the timing and the bargaining methods over each of this features. Since my goal here is not to study the allocative equilibrium of those features, I consider a reduced form approach to introduce an aggregate index of all those rigidity indices into the model. Another advantage of this approach is that it keeps the door open for using other indices fitting in the category of restrictive regulations.

I assume that in a flexible economy a match optimally arranges set up of production requirements, including the working hours, working days, type of contract, etc., corresponding to its state. The basic idea of modeling the restrictive rigidities is that the set of flexible economy arrangements nests those of a less flexible economy. Therefore, a firm in a rigid economy can do at most as good as its counterpart in the flexible economy. When the regulatory restrictions are binding the firm in the rigid economy might gain less profit relative to its counterpart firm in the flexible economy. I assume the regulations are not contradictory, in the sense that there is a non-empty set of production levels,  $p^{ref}$ , from the point of view of the regulator such that the regulations are in favor of this reference point. In other words, if a firm produces at

that reference level then it is not burdened by the regulations. One can think of it as a very regular match in a rigid economy with the typical work arrangements in terms of working hours, working days and the type of contract which both parties would agree on the same arrangements if they were active in the flexible economy. However any deviation from this reference point is penalized by regulations in the rigid economy. In the following clarifying examples, for simplicity I assume that the rigid economy has no firing costs but it has other restrictive regulations. Suppose a match faces a low production state (a low combination of idiosyncratic and aggregate shock). If the firm operates in a flexible economy it may find it optimal to keep on producing, for example, with few hours of worked per period or under a temporary contract. However the optimal amount of work or temporary contracts in the rigid economy may be restricted by law. Therefore, if the firm is going to produce, it has to produce its state production by more paid hours than optimal, which translates to higher costs<sup>9</sup>. Since there is no firing cost, there would be levels of productivity that a firm in the flexible economy optimally decides to produce but counterpart firm in the rigid economy optimally decides to dissolve the match, because of excess cost implied by the law. Another example of binding regulations in bad times (in the real world, and not in the model) could be a situation where the production required a sunk cost, e.g. a stock of capital. Therefore, a dissolving match that generates slightly negative surplus may generate positive surplus by more days/hours of work, if hourly wages do not rise too much, however again this work arrangement could

---

<sup>9</sup>Wages generally could change by hours of work to a large extent, but the argument may hold if there is kind of wage stickiness. Particularly restrictive regulations may bind the negotiated wages also, which seems to be the case at least for many European countries.

be prohibited by the law. On the other extend, in a very good productivity level, the firm in a flexible environment again can decide to produce through any optimal arrangements, but in the rigid economy the firm may not extract all potential profit by the restrictive regulations on night work, working days, working at holidays and temporary and fixed term contracts, and so on. I model this lost profit as a virtual cost deducted from the optimal profit in the flexible economy.

Denote by  $R(\cdot)$  the (proportional) regressive effect of the restrictive regulations on the profit, therefore the revenue of a firm, with the potential output of  $z_t x_t$ , net of the subtractive effects of the restrictive regulations is of the form

$$p(z_t x_t) = \begin{cases} z_t x_t & ,if \quad z_t x_t \in p^{ref} \\ (1 - \mathcal{R}(\Delta(z_t x_t, p^{ref}))) z_t x_t & otherwise \end{cases} \quad (5)$$

where

$$\Delta(z_t x_t, p^{ref}) = \begin{cases} z_t x_t - \max(p^{ref}) & ,if \quad z_t x_t > \max(p^{ref}) \\ z_t x_t - \min(p^{ref}) & ,if \quad z_t x_t < \min(p^{ref}) \end{cases}$$

$p(\cdot)$  can be interpreted as the reduced or the *virtual* production function of the firm in the rigid economy. The implicit assumption is that  $\mathcal{R}(\cdot)$  is a function of the state of the firm, not the realized output, i.e. firm cannot reduce the implied restrictive cost by choosing a different production level. Therefore, if the match finds it optimal to produce, it also optimally decides to produce at  $z_t x_t$  and enjoys the net

revenue of  $p(z_t x_t)$ . Notice that if the  $p(\cdot)$  is monotonically increasing, a firm in the rigid economy indeed decides to produce at the production frontier  $z_t x_t$ . Also notice that equation 5 can be written as a single line equation with  $\mathcal{R}(0) = 0$ , and  $\Delta = 0$  if  $z_t x_t \in p^{ref}$ .

I assume that  $\mathcal{R}(\Delta)$  is second order differentiable at non-zero values of  $\Delta$ , with the following characteristics

$$\begin{aligned} 0 &\leq \mathcal{R}(\cdot) \leq 1 \\ \mathcal{R}' &\geq 0 \quad , \mathcal{R}'(0) = 0 \\ \mathcal{R}'' &\geq 0 \end{aligned}$$

The first condition insures that there would be a non negative left over after applying rigidities i.e. a positive production/profit is achievable after applying rigidities. The second condition tells that very close but outside of the  $p^{ref}$  the cost of applying rigidities is very small, and the third condition means that the more the deviation of the firm potential production from the reference point, the larger the induced loss by rigidities is.

Figure 3 illustrates an arbitrary virtual production function in a rigid economy. The horizontal line is the state of productivity and the vertical line indicates the realized production according to the virtual production function. A firm operating in a flexible economy for any state of productivity fulfills all the production, hence its locus would be the 45 degree line. A firm in the rigid economy can extract all the

rent only if it is operating in the reference state, but for all other states the virtual production is less than the productivity state. The further the productivity deviates from the reference state, the more the deduction.

After explaining the environment, I write down the value functions. The Bellman value function of being an unemployed worker,  $U_t$ , and a new and old employed worker,  $W_t^N$  and  $W_t$  respectively, are as followings

$$U_t = b + \beta \mathbb{E}_t \{ F_t W_{t+1}^N + (1 - F_t) U_{t+1} \} \quad (6)$$

$$W_t^N = w_t^N + \beta \mathbb{E}_t \left\{ (1 - s) \left[ \lambda W_{t+1}^N(x^N) + (1 - \lambda) \int_{\underline{x}_{t+1}}^{x^N} W_{t+1}(x) + (1 - \lambda) G(\underline{x}_{t+1}) U_{t+1} \right] + s^x U_{t+1} \right\} \quad (7)$$

$$W_t(x) = w_t(x) + \beta \mathbb{E}_t \left\{ (1 - s) \left[ \lambda W_{t+1}(x) + (1 - \lambda) \int_{\underline{x}_{t+1}}^{x^N} W_{t+1}(x) + (1 - \lambda) G(\underline{x}_{t+1}) U_{t+1} \right] + s^x U_{t+1} \right\} \quad (8)$$

where  $w_t^N$  and  $w_t(x)$  are earnings of a new and old worker with specific productivities of  $x^N$  and  $x$  respectively. The match specific productivity threshold  $\underline{x}_{t+1}$  is such that a match with productivity below this threshold dissolves, since such a match

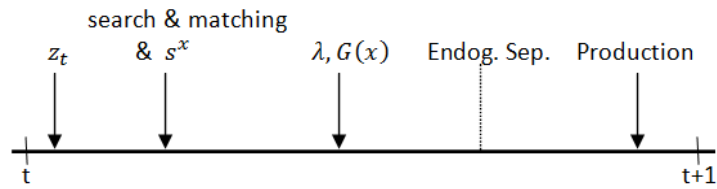


Figure 2: Time line of events in the model

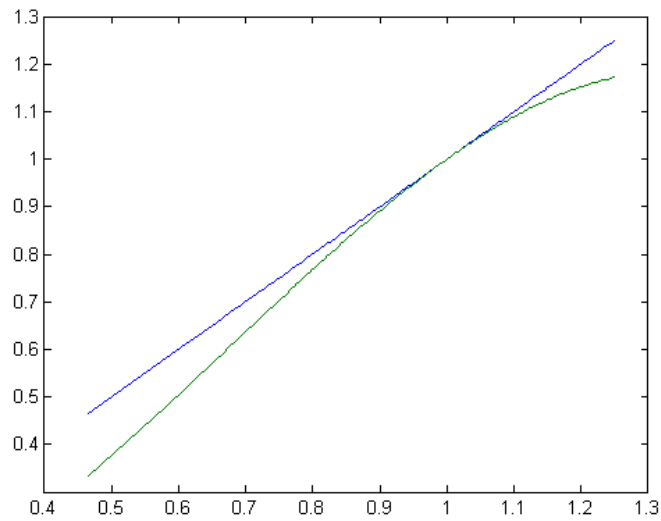


Figure 3: An arbitrary virtual production function in a rigid economy (green line) vs. production function in a flexible economy (blue line)

produces negative surplus.

The value function of a new filled vacancy,  $J_t^N$ , an old match,  $J_t$ , and the vacancy value satisfy

$$V_t = -c + \beta \mathbb{E}_t \{ Q_t J_{t+1}^N + (1 - Q_t) V_{t+1} \} \quad (9)$$

$$J_t^N = p_t(z_t x^N) - w_t^N + \beta \mathbb{E} \left\{ (1 - s^x) \left[ \lambda J_{t+1}(x^N) + (1 - \lambda) \int_{\underline{x}_{t+1}}^{x^N} J_{t+1}(x) + (1 - \lambda) G(\underline{x}_{t+1}) (V_{t+1} - \mathcal{F}) \right] + s^x V_{t+1} \right\} \quad (10)$$

$$J_t(x) = p_t(z_t x) - w_t + \beta \mathbb{E}_t \left\{ (1 - s^x) \left[ \lambda J_{t+1}(x) + (1 - \lambda) \int_{\underline{x}_{t+1}}^{x^N} J_{t+1}(x) + (1 - \lambda) G(\underline{x}_{t+1}) (V_{t+1} - \mathcal{F}) \right] + s^x V_{t+1} \right\} \quad (11)$$

I assume free entry condition for firms, therefore firms post vacancies while there is a positive rent. This gives

$$V_t = 0 \quad (12)$$



*Wage setting.* Firms and workers each period negotiate over wages, and split the surplus of the match according to the Nash bargaining rule, where a worker enters into the bargaining with a bargaining power of  $\pi$ . Surplus of a match for the worker is  $W_t^N(x) - U_t$ , if the match is new, and  $W_t(x) - U_t$  otherwise. The surplus of a new match for a firm is  $J_t^N$ , while a continuing match provides a surplus of  $J_t + \mathcal{F}$ , which indicates that in case of no agreement firm has to pay the firing cost  $\mathcal{F}$ . The FOCs of maximization problems read

$$\pi J_t^N = (1 - \pi)(W_t^N(x) - U_t) \quad (13)$$

$$\pi(J_t + \mathcal{F}) = (1 - \pi)(W_t(x) - U_t). \quad (14)$$

Substituting firm and worker's value functions into the equations and solving for the wages one can derive

$$w_t^N = \pi \left( (1 - \mathcal{R}) z_t x^N + c\theta_t \right) + (1 - \pi)b - \pi\beta(1 - s^x) \mathcal{F} \quad (15)$$

$$w_t(x) = \pi \left( (1 - \mathcal{R}) z_t x + c\theta_t \right) + (1 - \pi)b + \pi(1 - \beta(1 - s^x)) \mathcal{F} \quad (16)$$

Remember that rigidities are non-linear functions of potential production, by deviating from the reference production the wages become smaller than the flexible economy. In the absence of the firing costs the two equations are similar. However if there are firing costs in the economy, as it is well-known in the literature, the

firm and worker bargain over the firing costs as it is presented in the equations. At the first period, when no firing cost applies, workers agree on a lower wage, compensating future possible firing cost in case of endogenous separation. While later, any endogenous separation would cost the firm  $\mathcal{F}$ , if no separation happens firm and worker share the amount, again considering the fact that a future break would cost  $\mathcal{F}$  for the firm. Therefore a worker in a continuing match enjoys the positive additional last term in his wage.

I close the model by unemployment dynamics

$$u_{t+1} = S_t (1 - u_t) - F_t u_t \quad (17)$$

where  $S_t = s^x + (1 - s^x) G(\underline{x}_t)$  is the total separation probability at time  $t$ .

## 4.2 Unemployment flows analysis

I apply EHS unemployment flows decomposition to the model. Here I summarize the basic assumptions and equations of the EHS model. The EHS decomposition links the discrete time observations to the unemployment rate which assumes to evolve in a continuous time frame work. Unemployment evolution in the EHS reads

$$\frac{du}{dt} = s_t (1 - u_t) - f_t u_t \quad (18)$$

where  $s_t$  and  $f_t$  are the flows hazard rates corresponding the probabilities  $S_t$  and  $F_t$ , respectively. Therefore the unemployment at the end of a period is

$$u_t = \lambda_t u_t^* + (1 - \lambda_t) u_{t-1} \quad (19)$$

where

$$u_t^* = \frac{s_t}{s_t + f_t} \quad (20)$$

denotes steady-state unemployment rate, and

$$\lambda_t = 1 - e^{-(s_t+f_t)} \quad (21)$$

is the rate of convergence towards the steady-state. If the rates are high  $\lambda_t$  is close to one, the unemployment adjusts quickly to its steady-state and  $u_t^*$  is a good approximation of the unemployment rates at each period. This is the case of U.S. which motivates the use of steady-state decomposition as proposed by Fujita and Ramey (2009). However, for most of the countries the flows rates are not high enough to make  $\lambda_t$  close to one, hence the  $u_t$  for those countries depends on both  $u_t^*$  and  $u_{t-1}$  (eq. 19). This is the basic idea for non-steady state decomposition method of EHS. They decompose the unemployment fluctuations into three components, contribution of job finding rates, separation rates and past unemployment,  $\beta_f$ ,  $\beta_s$  and  $\beta_0$  respectively.

$$\beta_f = \frac{cov(\Delta \ln u_t, C_{ft})}{var(\Delta \ln u_t)}, \beta_s = \frac{cov(\Delta \ln u_t, C_{st})}{var(\Delta \ln u_t)}, \beta_0 = \frac{cov(\Delta \ln u_t, C_{0t})}{var(\Delta \ln u_t)} \quad (22)$$

where

$$C_{ft} = \lambda_{t-1} \left[ - (1 - u_{t-1}^*) \Delta \ln f_t + \frac{1 - \lambda_{t-2}}{\lambda_{t-2}} C_{ft-1} \right]$$

$$C_{st} = \lambda_{t-1} \left[ (1 - u_{t-1}^*) \Delta \ln s_t + \frac{1 - \lambda_{t-2}}{\lambda_{t-2}} C_{st-1} \right]$$

and

$$C_{0t} = \lambda_{t-1} \frac{1 - \lambda_{t-2}}{\lambda_{t-2}} C_{0t-1}$$

with  $C_{f0} = 0$ ,  $C_{s0} = 0$ , and  $C_{00} = \Delta \ln u_0$ .

## 5 Calibration

### 5.1 Flexible economy

At the first step, I target the U.S. as the bench mark of a flexible economy, since according to the data set the U.S. has no firing costs besides an employment rigidity index of zero. The frequency of the model is monthly, which coincides with the highest observed frequency of unemployment data (for the U.S.). This implies that the shortest period of unemployment is one month, later it is discussed how I treat this shortcoming of the model, in measuring the flows.

Table 3 summarizes choices of parameters for calibration of the flexible economy. The discount factor  $\beta$  is chosen to be consistent with an annual interest rate of 4%. Hall and Milgrom (2008) estimate the unemployment benefit in the U.S. equal to 0.71. Following Fujita and Ramey (2012)  $G(x)$  is lognormal with parameters  $\mu_x$

and  $\sigma_x$  when  $x < x^N$ , and  $G(x^N) = 1$ .  $\mu_x$  set to zero, representing that average of match specific productivities is approximately one. Standard deviation of match specific productivities,  $\sigma_x$  is taken from Sala *et. al.* (2012). They set  $\sigma_x$  equal to 0.2 as an intermediate value within the range of 0.1 (den Haan *et. al.*, 2000) and 0.4 (Trigari, 2009) used in the literature. This is also within the range of 0.16 and 0.214 used by Fujita and Ramey (2012). The parameters of AR(1) process of aggregate productivity is chosen such that the quarterly average of monthly simulated data of model matches the variance and autocorrelation of the cyclical component of labor productivity data. Using the U.S. data I find a quarterly autocorrelation and variance of 0.745 and 0.0022 respectively. This requires  $\rho$  and  $\sigma_\varepsilon$  equal to 0.995 and 0.001 respectively.

The matching function elasticity,  $\alpha$  is set to 0.7. This is close to Shimer's (2005a) choice of 0.72. Some authors argue that this is too high (see for example Mortensen and Nagypal, 2007), however, recently Justiniano and Michelacci (2011) using a Bayesian approach estimate it 0.79 for the U.S. in a rich RBC model augmented by search. They also find that for their sample of six countries (France, Germany, Norway, Sweden, the U.K., and the U.S.) this parameter lies in the range of 0.69 (Germany) and 0.82 (France).

$x^N$  in each case is set such that provides average productivity of 1. To calibrate the rest of parameters five statistics of the U.S. economy are targeted. First, I target average unemployment rate of 6%. Shimer (2005a) using CPS data calculates an average job finding probability of 0.45. I choose this as the second target. Third, Hagedorn and Manovskii (2008) calculate and target an average tightness of 0.6 for

the U.S., I use this as the third target. And finally I target the contribution of job finding and separation rates in the unemployment volatilities, 85% and 16%, as reported by EHS. These provides the set of five targets. To match these facts I calibrate exogenous separation  $s^x$ , the matching function multiplier  $A$ , the cost of posting a vacancy  $c$ , the bargaining power of workers  $\pi$ , and the persistency of match quality  $\lambda$ . I set the  $\lambda$  to 0.383, the monthly equivalent choice of Fujita and Ramey (2012) is about 0.7; for comparison their choice implies a mean waiting time of about three months between switches of math specific productivity while this statistic turns out to be slightly less than two months in my calibration. By and large, the rest of four parameters are within the ranges used in the literature.

It is worth noting that data restrictions allow EHS to infer flows at annual frequency. To estimate the monthly rates  $s_t$  and  $f_t$  they assume that flow hazards are constant within years. Therefore eq. 19 and 21 change to

$$u_t = \lambda_t u_t^* + (1 - \lambda_t) u_{t-12}$$

$$\lambda_t = 1 - e^{-12(s_t+f_t)}$$

Substituting the later in the former gives

$$u_t = (1 - e^{-12(s_t+f_t)}) u_t^* + e^{-12(s_t+f_t)} u_{t-12} \tag{23}$$

EHS obtain the monthly job finding hazard rate from the monthly job finding probability, which in turn calculates from unemployment and short term unemploy-

ment data. Using the non-linear equation 23, they obtain the separation hazard rate as well. My model is monthly and allows to directly use eq. 19 and 21, however since I target EHS results I prefer to use eq. 23. Since the exact monthly flow rates from simulation of the discrete-time model are not compatible with this equation, I re-construct the corresponding monthly flow rates from simulation. For each year the monthly job finding rate is calculated by averaging rates of the first three simulated months<sup>10</sup>, then using the unemployment data of start and end of that year, the separation rate calculated from eq. 23. Table 4 shows the performance of the calibrated model in matching the targets.

## 6 Results

Table 5 compares simulated flexible economy with data. Panel A reports the standard and deviations (auto)correlations in the data as reported by Shimer (2005a). Panel B shows the simulation results of my model. Quarterly variables are constructed by averaging monthly variables. Notice that the model, like other standard MP search and matching models, is not immune to Shimer (2005a) puzzle. As panel B of table shows the model generates too little volatility of unemployment, which is accompanied by little volatility in job finding and separation rates. However, the model is able to generate considerably higher volatilities than the basic model of

---

<sup>10</sup>The first three months averaging provides similar results of  $\beta_f$  compare to case one applies the monthly data to equations 19 and 21.

Table 3: Calibration of the flexible economy

Parameter		Value	Source
Discount factor	$\beta$	0.9967	
Unemployment benefit	$b$	0.71	Hall-Milgrom (2008)
Persistence of the aggr. prod.	$\rho$	0.995	Calibration
St. dev. of aggr. prod. shock	$\sigma_\varepsilon$	0.001	Calibration
St. dev. of idiosyncratic shock	$\sigma_x$	0.2	Sala et. al. (2012)
Mean of the idiosyncratic prod.	$\mu_x$	0	
Highest value of idiosyncratic prod.	$x^N$	1.22	Calibration
Matching func. multiplier	$A$	0.525	Calibration
Elasticity of matching func.	$\alpha$	0.7	Fujita-Ramey (2012)
Worker's bargaining power	$\pi$	0.49	Calibration
Exog. separation prob.	$s^x$	0.03	Calibration
Vacancy posting cost	$c$	0.443	Calibration
Persistence of idiosyncratic shock	$\lambda$	0.383	Calibration

Frequency: Monthly.

Table 4: Flexible economy: Calibration targets and matches

	Data	Model
Ave. Productivity	norm. to 1	0.994
Quarterly A.C. of Productivity	0.745	0.747
Quarterly St. dev. of Productivity	0.0022	0.0021
Ave. Unemployment	0.06	0.06
Ave. J.F.P.	0.45	0.45
Ave. Tightness	0.60	0.59
$\beta_f$	0.85	0.86
$\beta_s$	0.16	0.16



Table 5: Flexible economy: Model performance

Panel A: Data (Source: Shimer, 2005a)						
	$u$	$v$	$v/u$	$f$	$s$	
St. dev.	0.190	0.202	0.382	0.118	0.075	
Quart. A.C.	0.936	0.940	0.941	0.908	0.733	
	$u$	1	-0.894	-0.971	-0.949	0.709
	$v$		1	0.975	0.897	-0.684
Corr.	$v/u$			1	0.948	-0.715
	$f$				1	-0.574
	$s$					1

Panel B: Model Performance						
	$u$	$v$	$v/u$	$f$	$s$	
St. dev.	0.068	0.012	0.012	0.004	0.008	
Quart. A.C.	0.851	0.850	0.902	0.902	0.854	
	$u$	1	-0.345	-0.801	-0.801	0.314
	$v$		1	0.674	0.674	0.285
Corr.	$v/u$			1	1.000	-0.155
	$f$				1	-0.155
	$s$					1

Shimer (2005a), mainly because I chose a higher unemployment benefit and also because of idiosyncratic productivities.

Having the flexible economy model in hand, I run some experiments.

## 6.1 Adding firing costs to the flexible economy

In the first experiment I add different levels of firing costs to the bench mark flexible economy. Figure 4 depicts the evolution of  $\beta_f$  for different levels of firing costs. Consistent with the statistical evidence at table 1, the model predicts that higher firing costs increase (decrease) the contribution of job finding (separation) rate to unemployment fluctuations. This is also consistent with empirical evidence of Messina and Vallanti (2007) that firing costs dampen the firm's response of job destruction to the cycle. A decrease in volatility of job destruction and job creation after an increase in firing costs theoretically has already been shown by Garibaldi (1998) and Thomas (2006). However, I am not aware of any study that directly explores what happens to the relative contributions to unemployment fluctuations. According to figure 3, for the calibrated flexible economy, adding firing costs of only 0.04 percent of average wage is enough to make the job finding rates' changes responsible for almost all fluctuations in unemployment.

Table 6 reports what happens within the simulated models. Consider a match with a productivity level slightly below endogenous separation threshold in an economy with no (trivial) firing costs. Everything equal, if the firing costs increases, the cost of dissolving the match increases more than the cost of production (wage). Hence, such a marginal match finds it optimal to produce if the firing costs increase. This dampens the volatility of separation rates, which in turn lowers the volatility of unemployment. On the other extreme, increasing the firing costs decreases the value of new matches as well, making firms less willing to post vacancies. Since

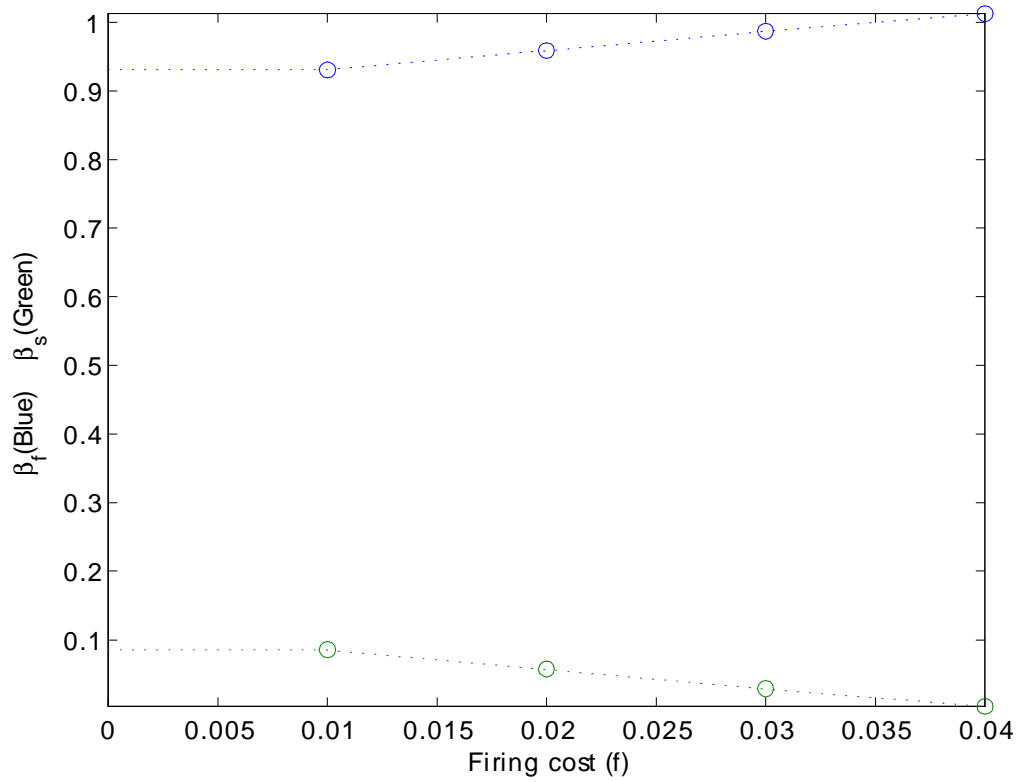


Figure 4: Adding firing costs to the flexible economyl

Table 6: Adding firing costs to the calibrated flexible economy

	$\mathcal{F}$ (% of average wage)				
	0	0.01	0.02	0.03	0.04
u					
(%)	6.3	6.3	6.3	6.3	6.3
$-\ln f$	0.524	0.524	0.524	0.524	0.524
$-\ln s$	3.216	3.218	3.218	3.218	3.219
sd(u)	0.16	0.14	0.13	0.13	0.12
sd( $\ln f$ )					
( $\times e^{-4}$ )	107	107	105	105	105
sd( $\ln s$ )					
( $\times e^{-4}$ )	206	176	166	164	154

in the model all matches start at highest idiosyncratic productivity level, given the parameters, whenever a worker meets a vacancy regardless of aggregate productivity shock they find it optimal to produce, however the volatility of job finding rates decreases.

## 6.2 Adding restrictive rigidities to the flexible economy

I assume  $\mathcal{R}(\Delta^-)$  of equation 5 takes the following functional form of

$$\mathcal{R}(\Delta^-) = \mathcal{K}(\Delta^-)^2 \tag{24}$$

For simplicity, I assume that the absolute value of loss is symmetric both sides of

the  $p^{ref}$ , i.e. for any deviation  $\Delta^+ = |\Delta^-|$  the proportional loss function is

$$\mathcal{R}(\Delta^+) = \frac{\min(p^{ref}) - \Delta^+}{\max(p^{ref}) + \Delta^+} \mathcal{R}(\Delta^-) \quad (25)$$

Absolute value symmetricity helps to have a monotonically increasing  $p(\cdot)$  for a wide range of  $\mathcal{K}$ 's<sup>11</sup>.  $\mathcal{K}$  is the parameter for entering different levels of rigidities. The case of  $\mathcal{K} = 0$  is no rigidity case. Assigning a positive number to  $\mathcal{K}$  generates a level of restrictive rigidities. For any positive  $\mathcal{K}$  the functional form implies that further deviations from  $p^{ref}$  are restricted more by regulations, therefore accompany with higher lost profit and/or imposed operational cost. A larger  $\mathcal{K}$  represents more stringent laws.

Figure 5 shows the results of adding different levels of restrictive rigidities ( $\mathcal{K}$ ) into the flexible model. The larger the level of restrictive rigidities, the higher (lower) the  $\beta_s$  ( $\beta_f$ ). Adding a restrictive rigidity level of  $\mathcal{K}$  almost equal to 0.05~0.06 to the flexible economy gives relative contributions of an average European economy in the table 1. Figure 6 illustrates what a virtual production function with  $\mathcal{K} = 0.06$  stands for. It shows that for the calibrated flexible economy, relatively small rigidity is enough to generate the European case.

Table 7 provides a more detailed look into the simulations. Introduction/increase of restrictive rigidities pushes the marginal match, which before was indifferent between production and exit, to leave the market, because it works as a cost; However given the set up this situation prevails among more firms when the aggregate produc-

---

<sup>11</sup>The monotonicity is violated easier if I assume proportional symmetricity, i.e.  $\mathcal{R}^h(\Delta) = \mathcal{R}^l(\Delta)$ .

Table 7: Adding restrictive rigidities to the calibrated flexible economy

	$\mathcal{K}$					
	0	0.02	0.04	0.06	0.08	0.10
u						
(%)	6.3	6.4	6.4	6.4	6.5	6.5
$-\ln f$	0.524	0.524	0.525	0.527	0.527	0.528
$-\ln s$	3.216	3.214	3.213	3.204	3.199	3.193
sd(u)	0.16	0.18	0.20	0.26	0.28	0.30
sd( $\ln f$ )						
( $\times e^{-4}$ )	102	101	101	100	102	101
sd( $\ln s$ )						
( $\times e^{-4}$ )	126	155	182	274	305	360

tivity shock is low, simply because in a bad aggregate state a larger mass of matches is located in the neighborhood of threshold idiosyncratic productivity level. Those discrepancies intensify the volatility of separations compare to bench mark set up, and magnifies the contribution of separations to the unemployment volatilities. It is worth noting that these restrictive rigidities increase the volatility of unemployment as well as its level.

### 6.3 Cross country performance

In this experiment I like to quantify the effects of restrictive rigidities on the unemployment dynamics. I proceed by introduce firing costs and rigidities simultaneously

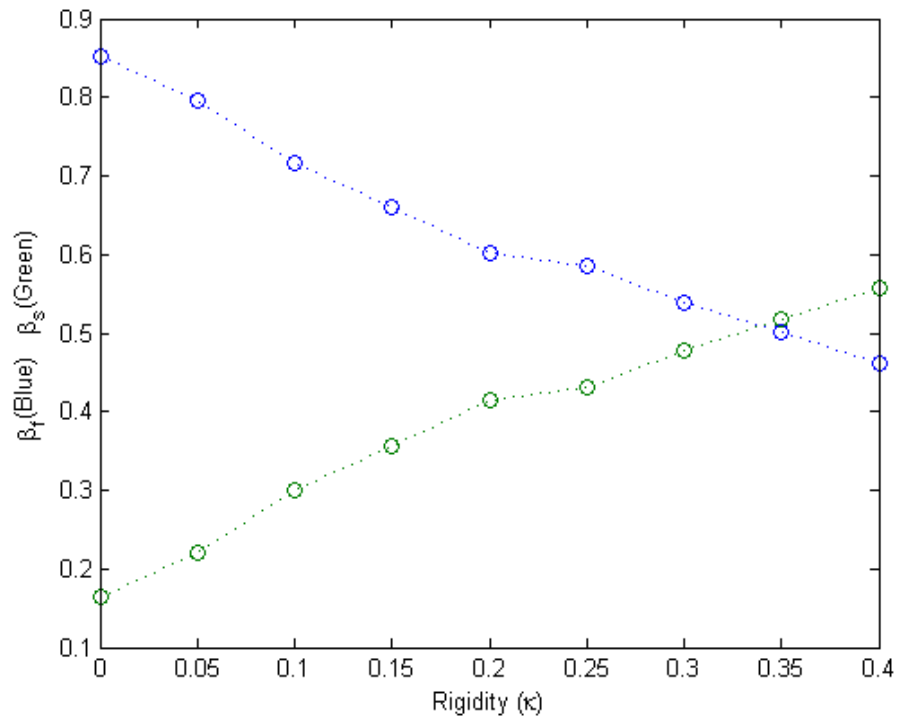


Figure 5: Adding Rigidities to the flexible economy

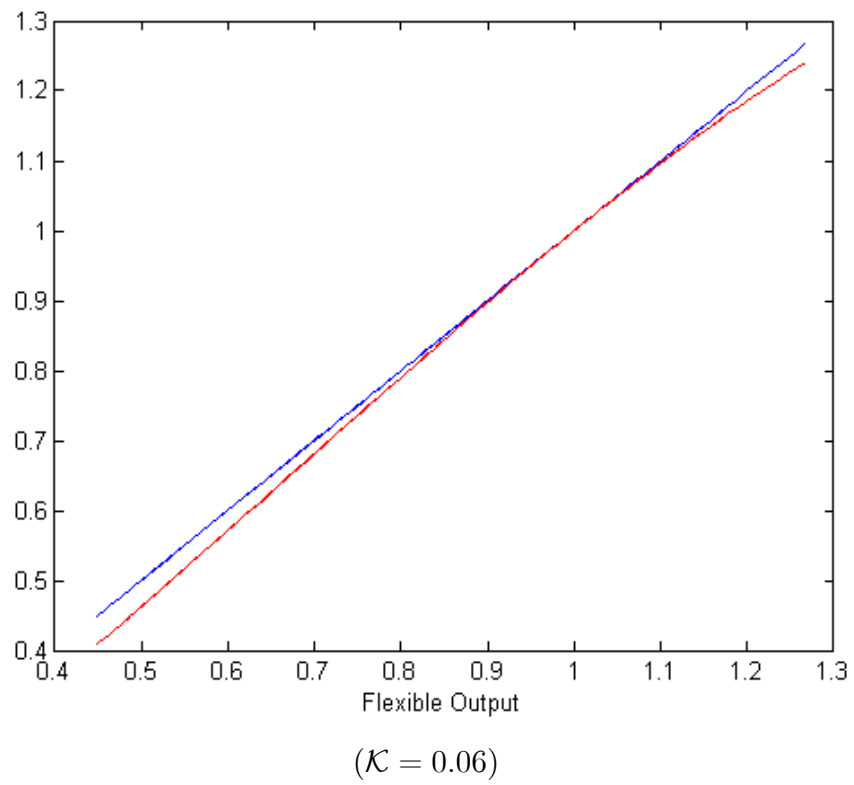


Figure 6: Illustration of virtual production functionl



to the bench mark flexible economy and fitting the cross country data. I simply substitute  $\mathcal{F}$  in the model with the monthly amount of the firing costs. Entering the rigidity index is not a trivial job. To deal with introduction of indices of rigidity into the model, I consider the same functional form as equations 24 and 25. I assume that the multiplier,  $\mathcal{K}$ , is a linear transformation of the indexes, .i.e. in equation 24,  $\mathcal{K} = \zeta R$ ; hence,  $\mathcal{R}(\Delta^-) = \zeta R(\Delta^-)^2$ . With regard to the reference production level, I assume that the restrictive regulations never bind an average worker with productivity one.

Figure 7 illustrates the results for  $\zeta = 0.19$ . Considering the simplicity of the model, the overall fit is reasonable; the least successful cases are Ireland and Norway, where the mode overpredict the contribution of outflows rates, and the underprediction in the case of Italy. In particular, the model replicates the pattern observed in the data well; the correlation between the predicted contributions of job finding rates,  $\widehat{\beta}_f$ , and the data is about 0.7. By introducing only two parameters, the model is able to explain about 48% of cross country variations. Recall that the firing costs are given, so the only calibrated parameter is the multiplier of the rigidity index,  $\zeta$ .

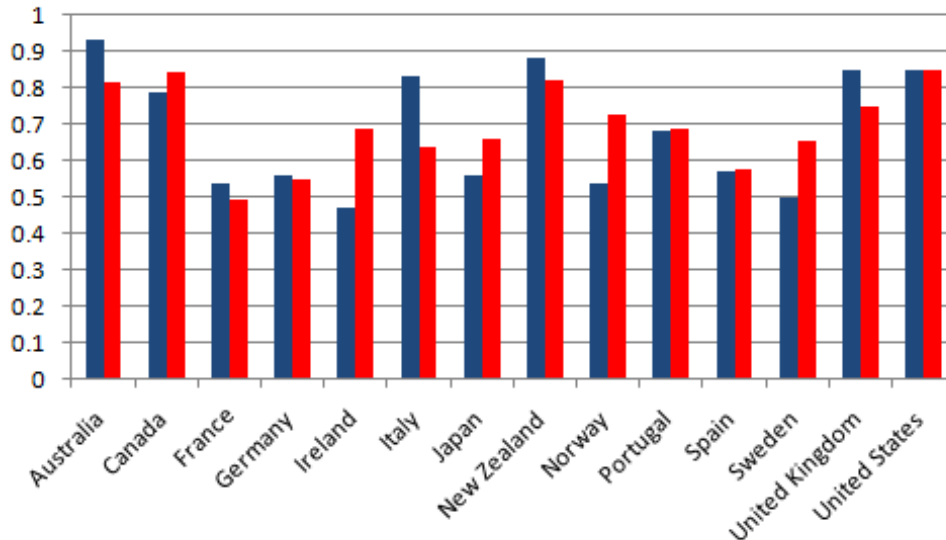


Figure 7: Cross country performance of the model. Blue: real data ( $\beta_f$ ),  
 Red: Simulation ( $\hat{\beta}_f$ )

*The role of unemployment benefit.* It is worth noting the role of changing unemployment benefits in the model. Almost all countries in the sample have higher unemployment replacement ratio than the bench mark economy (the U.S.). Increasing the unemployment benefit in the model lowers  $\beta_f$ , since the surplus is relatively smaller. As the surplus is smaller, firms are more sensitive to changes in the surplus, and more low quality jobs dissolve. This all resembles Hagedorn and Manovskii (2008) remedy to the unemployment volatility puzzle of the Mortensen and Pissarides search model (Shimer, 2005a). Costain and Reiter (2008) investigate this behavior of

MP search and conclude that the model exhibits the volatility puzzle at low values of unemployment benefit, while it is too sensitive to the policy for higher values. The model in this paper, which is basically a MP search model, has the same shortcoming. This is the main reason why I cannot provide a simple quantitative cross country analysis based on the differences in unemployment replacement ratio. As described in the calibration section, in the case of the flexible economy, I took Hall and Milgrom (2008) value of 0.71. With regard to using the same value for all the countries I should say that this value (0.71) lies well in the range of unemployment benefits for the six countries studied by Justiniano and Michelacci (2011)<sup>12</sup>, as well as of the nine countries in Murin and Robin (2014)<sup>13</sup>. In earlier versions I used different values for the countries, for example using the value proposed by Hobijn and Sahin (2013) for France, but because I did not calibrate for each country separately, the model works well only around the targeted economy. This again resembles findings of Costain and Reiter (2008).

Finally, related to the last point, another important issue with this study is the interaction of unemployment benefit with the functional form of productivities at the firing threshold. In a sense, the results hinge on the functional form of productivities, especially the left tail of the productivity. If threshold productivities are closer to the center (i.e. higher average unemployment rate) then only because of using lognormal distributions model generates higher volatility of separations. As Thomas (2006) argues there is no reason to believe that all countries in this study have the same distribution of productivities. Estimations of worker's heterogeneity in the

---

<sup>12</sup>From 0.69 (Germany) to 0.82 (France); with 0.79 for the US.

<sup>13</sup>From 0.683 (Germany) to 0.834 (Portugal); with 0.693 for the US.

calibration of Murtin and Robin (2014) seems to support cross country differences in workers distributions.

## 7 Conclusion

In this paper I studied how different categories of labor market regulations can affect the dynamics of unemployment. I find that restrictive regulations, a class of labor market regulations that disturb flexible adjustment of work arrangements, could increase the contributions of separations to unemployment fluctuations. I use cross-country data on restrictions on working time and hours, and on signing different types of contracts as a representative of this class of regulations. I use the first principal component of these variables as the restrictive regulative index. The more restrictions on the work arrangement, the higher of inflows into unemployment contributes to unemployment fluctuations. Higher unemployment benefits play the same role as restrictive regulations. On the contrary, higher firing costs tend to amplify the importance of inflow rates.

Simulations based on a standard Mortensen-Pissarides search and matching model suggests that the main mechanism that firing costs affect the dynamics of unemployment is through termination decision. Firing costs dampen sensitivity of the response of a match to productivity shocks, since firms are less willing to layoff the redundant workers. This decreases the contribution of outflows to unemployment fluctuations. In contrast, a higher unemployment benefit provides a larger opportunity cost of employment. This makes a match more vulnerable to endogenous break, which in turn corresponds to a larger contribution of outflows to the fluctuations of unemploy-

ment. My proposed explanation for the observed effect of restrictive regulations –in the empirical part as well as in the simulations- has the same flavor. The restrictive regulations create more fluctuations in separations, since they impose additional operational costs to the threshold firms. In the bad times, a match may need to change some of its work arrangements to survive. However, restrictive regulations could make those arrangements too expensive -or even infeasible- for the match. Consequently, a firm bounded with those restrictive regulations, even in the presence of high firing costs, finds it optimal to terminate a match to not bear the excess costs implied by restrictive regulations.

Consistent with this explanation, I propose a reduced form framework to introduce the aggregate restrictive rigidities into Mortensen-Pissarides search and matching model. Introducing firing costs and the restrictions separately generates effects in the same direction as expected. Adding both firing costs and the restrictive rigidities simultaneously to model can explain about 48% of cross country variations in unemployment dynamics. As a result, despite of its shortcoming in generating reasonable unemployment volatility, the Mortensen-Pissarides search model is able to explain the described pattern of the sources of the cross country discrepancies in the unemployment dynamics.

## References

- [1] Blanchard, Olivier, and Peter Diamond, (1990), “The Cyclical Behavior of the Gross Flows of US Workers,” *Brookings Papers on Economic Activity*, 1990 (2), 85–143.

- [2] Bentolila, Samuel, Pierre Cahuc, Juan J. Dolado, and Thomas Le Barbachon, (2010), Two-Tier Labor Markets in the Great Recession: France vs. Spain, IZA Discussion Papers 5340.
- [3] Costain, James S. and Michael Reiter, (2008), “Business Cycles, Unemployment Insurance, and the Calibration of Matching Models,” *Journal of Economic Dynamics and Control*, 32 (4), 1120– 1155.
- [4] den Haan, W.J., Ramey, G., and Watson, J. (2000). “Job Destruction and Propagation of Shocks,” *The American Economic Review* 90, 482-498.
- [5] Elsby, Michael W. L., Bart Hobijn, and Aysegül Şahin (2010). “The Labor Market in the Great Recession,” *Brookings Papers on Economic Activity*, Spring 2010, 1.48.
- [6] Elsby, Michael W. L., Bart Hobijn, and Aysegül Şahin, (2013). “Unemployment Dynamics in the OECD,” *Review of Economics and Statistics*.
- [7] Elsby, Michael W.L., Ryan Michaels, and Gary Solon, (2009). “The Ins and Outs of Cyclical Unemployment,” *American Economic Journal: Macroeconomics*, 1 (1), 84–110
- [8] Fujita, Shigeru and Garey Ramey (2009). “The Cyclicity of Job Loss and Hiring,” *International Economic Review*, 50: 415-430.
- [9] Fujita, S., & Ramey, G. (2012). Exogenous versus endogenous separation. *American Economic Journal: Macroeconomics*, 4(4), 68-93.
- [10] Garibaldi, Pietro, (1998). “Job Flow Dynamics and Firing Restrictions,” *European Economic Review*, 42 (2), 245–275.
- [11] Gnocchi, Stefano, and Evi Pappa. "Do labor market rigidities matter for busi-

- ness cycles?." (2011).
- [12] Guell, Maia (2010), "Firing Costs, Dismissal Conflicts and Labour Market Outcomes," *Els Opuscles del CREI*.
- [13] Hagedorn, M., and Manovskii, I. (2008). "The Cyclical Behavior of Equilibrium Unemployment and Vacancies Revisited," *The American Economic Review* 98, 1692-1706.
- [14] Hall, Robert E. (2005a). "Job Loss, Job finding, and Unemployment in the U.S. Economy over the Past Fifty Years," *NBER Macroeconomics Annual*, 101-137.
- [15] Hall, Robert E. (2005b). "Employment Efficiency and Sticky Wages: Evidence from Flows in the Labor Market," *Review of Economics and Statistics*, 87(3): 397-407.
- [16] Hall, Robert E., and Paul R. Milgrom, (2008). "The limited influence of unemployment on the wage bargain," *American Economic Review*, 98 (4), 1653–1674.
- [17] Heckman, James, and Carmen Pages, eds. (2004). *Law and Employment: Lessons from Latin America and the Caribbean*. Chicago, IL: University of Chicago Press.
- [18] Hobijn, B., & Şahin, A. (2013). Firms and flexibility. *Economic Inquiry*, 51(1), 922-940.
- [19] Justiniano, A., and C. Michelacci (2011). "The Cyclical Behavior of Equilibrium Unemployment and Vacancies in the US and Europe," *NBER Working Papers* 17429, National Bureau of Economic Research.
- [20] Llosa, G., Ohanian, L., Raffo, A., & Rogerson, R. (2012, October). *Firing Costs and Labor Market Fluctuations: A Cross-Country Analysis*. In 9th joint

ECB/CEPR Workshop on Labour Market Policies and the Crisis held in Frankfurt.

- [21] Messina, J., and Vallanti, G. (2007). “Job Flow Dynamics and Firing Restrictions: Evidence from Europe,” *The Economic Journal* 117, 279-301.
- [22] Mortensen, Dale T. and Christopher A. Pissarides. “Taxes, Subsidies and Equilibrium Labor Market Outcomes,” in Edmund S. Phelps, ed., *Designing Inclusion*. Cambridge University Press, 2003.
- [23] Mortensen, Dale T. and Eva Nagypal, “More on Unemployment and Vacancy Fluctuations,” *Review of Economic Dynamics*, 2007, 10 (3), 327–347.
- [24] Nickell, Stephen and Richard Layard, “Labor Market Institutions and Economic Performance,” in Orley Ashenfelter and David E. Card, eds., *Handbook of Labor Economics*, Vol. 3, Elsevier, 1999, chapter 46, pp. 3029–3084.
- [25] Petrongolo, Barbara, and Christopher A. Pissarides (2008). “The Ins and Outs of European Unemployment,” *American Economic Review* 98(2): 256-262.
- [26] Pissarides, Christopher (1986): “Unemployment and Vacancies in Britain,” *Economic Policy*, 1(3), 499–559.
- [27] Pries, Michael and Richard Rogerson, “Hiring Policies, Labor Market Institutions, and Labor Market Flows,” *Journal of Political Economy*, 2005, 113 (4), 811–839.
- [28] Rogerson, Richard & Shimer, Robert, 2011. “Search in Macroeconomic Models of the Labor Market,” *Handbook of Labor Economics*, Elsevier.
- [29] Sala, Hector, and Silva, José I. (2009). “Flexibility at the Margin and Labour Market Volatility: The Case of Spain,” *Investigaciones Econ\_omicas* 33, 145-



178.

- [30] Sala, H., Silva, J. I., & Toledo, M. (2012). Flexibility at the Margin and Labor Market Volatility in OECD Countries\*. *The Scandinavian Journal of Economics*, 114(3), 991-1017.
- [31] Shimer, Robert, (2005a). "The Cyclical Behavior of Equilibrium Unemployment and Vacancies," *American Economic Review*, 95 (1), 25–49.
- [32] Shimer, Robert, (2005b). "The cyclicality of hires, separations, and job-to-job transitions," *Review*, Federal Reserve Bank of St. Louis, issue Jul, pages 493-508.
- [33] Shimer, Robert, (2007). "Reassessing the Ins and Outs of Unemployment," Mimeo.
- [34] The World Bank, *Doing Business*, 2011,
- [35] Thomas, C. (2006). "Firing costs, labor market search and the business cycle," manuscript.
- [36] Trigari, A. (2009). "Equilibrium Unemployment, Job Flows and Inflation Dynamics," *Journal of Money, Credit and Banking* 41 , 1-33.
- [37] Veracierto, M. (2008), "Firing Costs and Business Cycle Fluctuations," *International Economic Review* 49, 1-39.
- [38] Yashiv, Eran (2007). "U.S. Labor Market Dynamics Revisited," *Scandinavian Journal of Economics*, 109(4), 779-806.