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A Positive Analysis of Targeted Employment Protection Legislation*

Juan Dolado, Marcel Jansen, and Juan Jimeno Serrano

Abstract

In many countries, Employment Protection Legislation (EPL) establishes less strict dismissal procedures for specific groups of workers. This paper builds a simple matching model with heterogeneous workers in order to analyze this feature of EPL. We use the model to analyze the effects of reforms targeted at lowering the firing costs of a particular group of workers, and compare the results with those stemming from a comprehensive reform that reduces firing costs for all workers. The model is calibrated for the Spanish economy, where an important reform of this kind took place in 1997. Overall, our results point out that EPL reforms achieve the largest reduction in unemployment when they are targeted to workers with lower and more volatile productivity.

KEYWORDS: firing costs, unemployment, matching

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1. Introduction

In many countries, Employment Protection Legislation (EPL) gives differential treatment to different groups of workers. In particular, dismissal procedures may vary depending on age, skill, unemployment duration, etc, providing a wedge in firing costs across workers. This is, for instance, the case of a series of EPL reforms in Europe and Latin America since the 1980s where firms have been restricted in their use of “flexible contracts” (part-time, fixed-term, seasonal, new jobs contracts) to hire exclusively workers in some population groups, while prime-age workers are not eligible for these contracts.¹

While there may be good political economy reasons for reforming the labor market through two-tier schemes in order to avoid workers’ resistance to reforms (see e.g., Saint-Paul, 1996, 2000), the analysis of the economic consequences of allowing for targeted EPL regulations have received less attention. In effect, to the best of our knowledge, most papers dealing with the effects of EPL reforms on labor market outcomes have concentrated on comprehensive reforms, overlooking the fact that EPL may be targeted. This focus would be correct if the targeted reforms only affected the targeted groups. However, they would miss an important element in the analysis if this type of reform gives rise to spillover effects on non-targeted workers.

To fill this gap in the literature, we build a simple model where two groups of workers with different productivity levels interact through the matching process in a labor market subject to search frictions. We use the model to compare the effects of a targeted reduction of firing costs concerning only one group of workers with the effects of a comprehensive reform that reduces the firing costs for all workers. In order to stress the beneficial effects of EPL reforms, we assume throughout the analysis that firing costs imply a pure waste of resources like e.g., those stemming from judicial red-tape costs in the process of dismissals (see Burda, 1992). In a more general model in which severance payments could provide some insurance to workers or enhance productivity, the losses originating from their reduction ought to be weighed against the gains obtained under our restrictive assumption. Yet, the spillover effects analyzed here are likely to remain the same.

Our model draws on the seminal work of Mortensen and Pissarides (1994) about the determinants of equilibrium unemployment in labor markets with search frictions. In particular, our contribution falls into the “search and matching”

¹ See Booth, Dolado and Frank (2002) for an overview of targeted EPL reforms in Europe. An illustrative example of this type of reform is the recent (failed) attempt by the French government to introduce *first job* contracts for young workers up to age 26. This reform would allow employers to shed young workers without justification during the first two years of their contract, though with notice and subject to a small compensation.

literature that examines the effects of comprehensive changes in firing costs (e.g. Mortensen and Pissarides, 1999, and Ljungqvist, 2002, Garibaldi and Violante, 2005) and, more specifically, the effects of EPL reforms in dual labor markets (e.g., Wasmer, 1999 Blanchard and Landier, 2002, Cahuc and Postel-Vinay, 2002).² This last stream of the literature has analyzed the consequences of the unrestricted option to convert fixed-term into permanent contracts for unemployment and job turnover³. Therefore, the spillover effects of targeted EPL have been generally ignored.⁴

In principle, there are two ways in which these interaction effects may arise. First, they can operate through technological complementarities, whereby employment changes of the targeted workers may affect productivity and employment of non-targeted workers in different markets. Accordingly, the outcome of differentiated EPL depends crucially upon the elasticity of substitution among workers. Since this is a well-documented effect, we will not tackle it here (see, e.g., Cardullo and Van der Linden, 2006). Secondly, changes in the overall labor market tightness following targeted EPL reforms affect the exit rate out of unemployment of *all* workers as long as the labor markets are not completely segmented by population groups. Further, inasmuch as these variations in labor market tightness affect workers' reservation wages, we may also expect to have changes in firms' hiring and firing decisions as a result of these reforms.⁵ These are the key channels we explore in the sequel.

To do so, we require a model with two main ingredients: (I) heterogeneous workers and (possibly) jobs, albeit with incomplete segmentation of labor markets; and (II) endogenous job creation and job destruction decisions by firms. In general, the combination of these two ingredients makes the model highly untractable, as reflected by the lack of studies that analyze models with

² These studies find that a reduction of firing costs in entry-level jobs stimulates hiring. However, employers also become more reluctant to convert these entry-level jobs into permanent employment contracts. This feature leads to more workers' turnover and, if the severance pay gap is sufficiently large, to more unemployment.

³ Belot, Boone and van Ours (2002) also analyze the trade-off between productivity and flexibility. This trade-off may influence the firm's decision to convert a temporary job into a permanent one when job stability is productivity-enhancing.

⁴ Cahuc and Postel-Vinay (2002) and Nunziata and Staffolani (2001) analyze the role of restrictions on the use of fixed-term contracts by imposing a maximum value for the proportion of fixed-term employees that firms can hire. Note, however, that this restriction does not capture the targeted nature of "employment promotion" contracts.

⁵ A third possibility is that firms decide to rank eligible applicants ahead of non-eligible ones, even though the latter are more productive. This direct substitution effect is absent in our model. Nonetheless, the changes in the hiring strategies of firms do allow for indirect substitution effects as a larger proportion of the matches of eligible workers will result in a match.

heterogeneous agents and endogenous hiring and firing.⁶ Hence, in order to achieve analytical tractability, we adopt the strong, yet useful, assumption of complete random matching in the baseline version of the model. Specifically, we consider two groups of workers, labeled as high and low-productivity workers, respectively, who compete for the *same* jobs, with initial and subsequent productivity levels being drawn from different distributions with overlapping supports. Thus, workers differ with respect to their *expected* productivity, while the *actual* productivity of a low-productivity worker may exceed that of some of the high-productivity workers. Moreover, the model allows for differences in the arrival rate of shocks across the two types of workers. In equilibrium, firms will therefore use different hiring and firing rules for each group of workers and our aim is to establish how these rules are affected by different types of EPL reforms in a setup where spillover effects are amplified. Finally, in order to analyze the consequences of this assumption, a comparison between the outcomes of the baseline model and those obtained from a model where markets are completely segmented (i.e., directed search) is also performed as a way to derive an upper bound for the magnitude of the spillover effects.

To obtain reasonable predictions, we calibrate our model to the Spanish labor market in the late 1990s, since Spain has been traditionally considered as a prototypical case study regarding asymmetric EPL. In particular, we focus on a reform approved in 1997 where a new type of permanent contract (with substantially lower firing costs) was introduced for specific groups of workers (see Section 2). Our results provide an *economic* rationale for this choice by predicting that EPL reforms achieve the largest reduction in unemployment are those targeted to workers with relatively low and volatile levels of productivity, like in the case of that reform. Finally, the model predicts that, although the *absolute* size of the spillover effects is relatively small (slightly less than 1 p.p. in an economy with an unemployment rate of 20% before the reform), they become more sizeable in *relative* terms (explaining about 20% of the fall in the aggregate unemployment rate resulting from the targeted EPL reform). These figures, however, ought to be interpreted as upper bounds on the true effects.

The plan for the rest of the paper is as follows. Section 2 motivates the analysis by both describing some salient features of targeted EPL regulations in several countries and presenting a brief overview of the main findings in the empirical literature about the effects of targeted EPL, which hints at the existence of spillover effects. This leads us to the empirical counterparts of the main ingredients of the model that we use for calibration. Section 3 lays out the model, while Section 4 contains the positive analysis of the effects of firing costs in labor

⁶ For example, the well-known studies by Mortensen and Pissarides (1994, 1999) and Garibaldi and Violante (2005) assume full segmentation by skills into sub-markets.

markets with heterogeneous workers competing for identical jobs. More concretely, we compare the effects of three alternative EPL policies: i) a targeted reduction of firing costs for the *low-productivity* workers, ii) a targeted reduction of firings costs for the *high-productivity* workers, and iii) a comprehensive reduction of firing costs for *all* workers. Finally, Section 6 contains some concluding remarks. Appendix A presents proofs for some comparative statics results of the model, whereas Appendix B offers the detailed results of the calibration exercise in the case where markets are assumed to be completely segmented.

2. Targeted EPL: Institutional details and some empirical evidence

2.1 Institutional details

It is a well-known fact that EPL varies significantly *across* countries. However, much less attention has been devoted to the fact that EPL also varies *within* countries depending on firms' and worker's characteristics - such as firm size, existence of collective agreement, tenure, skill, educational level, etc.⁷ In this regard, there are two sources of variation in the enforcement of EPL. First, procedural requirements for dismissals, advanced notice/severance pay provisions, and prevailing standards of penalties for unfair dismissals are usually stricter for prime-age and older workers. For instance, EPL provisions are less strict for blue-collar workers in some European countries like Austria, Belgium, Denmark, France, Greece and Italy. With the exception of France, the required notice period is shorter for blue-collar workers than for white-collar workers. Typically, severance pay for individual/ unjustified dismissals is similar for both types of workers, except in Belgium, Denmark and Greece, where the former are entitled to lower indemnities.⁸

Secondly, prime-age, adult workers are not always entitled to be hired under "atypical" employment contracts involving less strict EPL provisions. The

⁷ OECD (1994, Annex 2.A) presents a detailed and comprehensive description of EPL in several countries and its variation by worker skills, tenure, the existence of collective agreements, and firm size. For a justification and the implications of variable enforcement of EPL by firm size, see Boeri and Jimeno (2005).

⁸ The information in the text refers to the end of the 1990s and focuses on the differential dismissal procedures for specific groups. Other aspects such as the dependence of EPL on tenure or age are not captured by our model and are therefore not discussed in detail. Strictly speaking, as will become clearer in the calibration exercises, the structure of our model most carefully reflects targeted EPL when there are no transitions across groups, like e.g. gender or skill/educational differences that cannot be overcome. As we argue below, some of these characteristics hold for the groups affected by targeted EPL in Spain, which is the economy we try to calibrate in section 4.

country where this type of contracts is more prevalent is Spain.⁹ Since the mid-1980s, when temporary employment contracts were liberalized, the proportion of temporary employees in total (salaried) employment is about 33%. Several reforms in the 1990s aimed at reducing temporary employment, by further differentiating firing costs. The most important one took place in 1997, when a new permanent contract was introduced entailing lower firing costs than the standard permanent contracts in case of “unfair” dismissals”. However, the eligible groups were limited to young workers (aged 18-29), long-term unemployed registered at the public employment office for at least twelve months, unemployed above 45 years of age, disabled people and workers whose contracts were transformed from temporary into permanent ones. Conversely, prime-aged workers in the age bracket 30-45 with unemployment spells shorter than a year were excluded.¹⁰ Yet, Spain is not the only European country that has liberalized atypical employment contracts or reduced firing costs contingent on some workers’ characteristics. In 1984, Italy also introduced “employment promotion contracts” (*Contratti di Formazione e Lavoro*) aimed at the hiring and firm-based training of young workers (between 15 and 29 years of age). Likewise, fixed-term contracts were first introduced in France in 1979 but their scope was very much reduced by the socialist government in 1982. After a reform in 1990, these contracts can only be used for seasonal activities, replacements of employees on leave, temporary increases in activity *and* for facilitating employment for targeted groups, ranging from the young to the long-term unemployed workers (see Blanchard and Landier, 2002). More recently (see footnote 1), there was the proposal to introduce a new jobs contract under which employers may fire at will workers under 26 employed for less than two years, paying those fired 8% of their salary to date, with a further 2% payment to organizations that help job-seekers. However, this reform was withdrawn.

In Latin America as well there have been targeted EPL reforms, some aimed at decreasing firing costs (Colombia and Peru at the end of the 1980s) and others at increasing them (Brazil, Venezuela, Chile, the Dominican Republic, Nicaragua, and Panama)¹¹. However, the only country which significantly liberalized the use of atypical contracts targeted at some demographic groups was Argentina, where a reform in 1991 introduced both fixed-term and training

⁹ See Dolado, García-Serrano and Jimeno (2002) for a detailed description of reforms leading to the surge of temporary employment in Spain.

¹⁰ Besides the economic and political motives for a partial reform, the restrictions on the use of these contracts also have a legal basis. Namely, the Spanish law does not allow two identical workers to hold open-ended contracts that are identical except for their severance payments. This feature obliged the government to restrict the use of the newly created contracts to the above-mentioned groups for which it was legal to provide less stringent EPL.

¹¹ See IDB (2003), chapter 7.

contracts for young workers, while a new reform in 1995 introduced other types of flexible contracts to promote employment of certain population groups.

Thus, this myriad of EPL provisions introduce differentiated firing costs along several dimensions (age, gender, skill, education, unemployment duration, etc.). Typically, the result is that, in those countries with more prevalence of “atypical” employment contracts, EPL entails lower firing costs for low-skilled, low-educated workers in low-productivity jobs. Rather than focusing in each of the dimensions along which firing costs may differ, we take this observation as the main guide for our model of differentiated firing costs and only distinguish between high-productivity and low-productivity workers, regardless of the sources of the productivity differentials across workers.

2.2 Empirical Evidence on targeted EPL reforms

Regarding the existence of spillover effects of targeted reductions of firing costs, we rely on the empirical literature on the unemployment consequences of labor market institutions. This literature has followed two routes. First, there are cross-country studies that use quantitative or qualitative indicators for the stringency of EPL to explain international differences in labor market outcomes, such as employment and unemployment rates (see, e.g., Nickell and Layard, 1999). Within this literature, a large number of recent studies have looked at the interactions between institutions and shocks, and to the different impact of institutions on the labor market outcomes of different population groups, such as youths and females.¹² Nonetheless, in most studies, targeted employment policies or partial labor market reforms are considered, if anything, in the construction of the overall institutional indexes regarding EPL strength, but not separately as an institutional feature on its own. This approach can be fairly restrictive since, as shown below, a general reduction of firing costs does not have the same effects as a commensurate reduction in the firing costs of a certain group of workers. Nonetheless, despite the fact that the empirical evidence on this type of reform is not totally conclusive, in general there is some support for the existence of spillover effects. Among the studies that estimate the labor market impact of targeted employment policies (e.g., those based on temporary contracts) separately from aggregate indexes of EPL, Jimeno and Rodriguez-Palenzuela (2002) find that, while a less strict regulation of fixed-term employment contracts tends to reduce the youth unemployment rate, it also leads to a small rise in the prime-age male unemployment rate. Likewise, using an unbalanced panel of nine

¹² On interactions, see Blanchard and Wolfers (2000). On the different impact of labor market institutions across population groups, see Bertola, Blau, and Kahn (2003), Jimeno and Rodriguez-Palenzuela (2002), and Neumark and Wascher (2003). On the impact of employment protection legislation on employment adjustment, see Caballero, Engel and Micco (2003).

OECD countries during the late 1980s and first half of the 1990s, Nunziata and Staffolani (2001) also estimate the effects of targeted EPL by distinguishing three types of regulations: EPL regarding dismissals of permanent employees, regulations regarding fixed-term employees, and temporary work agencies (TWAs) regulations. Their findings are similar to those discussed before: less stringent regulations had a significant positive impact on total employment of young workers while some spillover effects on other groups of workers are documented.

The second stream of the empirical literature looks at specific country episodes of targeted reforms by analyzing labor market outcomes before and after the reform, along the lines of the “differences-in-differences” evaluation approach. In the Spanish case, Kugler, Jimeno and Hernanz (2003) find that the reduction of firing costs (and payroll taxes) in 1997 for young, older and long-term unemployed workers had a positive effect on hiring for young workers, with little effect on dismissals, while it increased both dismissals and hiring for older men. Blanchard and Landier (2002), looking at transitions between temporary and permanent employment in France, observe larger turnover since 1983, especially for the younger cohorts of workers whose probability of holding a fixed-term job increased significantly after the reform. Yet, they also document a somewhat larger turnover for prime-age workers as a consequence of cross-effects. Finally, Hopenhayn (2001) also finds that the introduction of fixed-term contracts in Argentina had a very strong impact on labor turnover, inducing an increase in the hiring rate of young/unskilled workers, but also detects some strong substitution of permanent jobs by temporary jobs.

3. The model

Our model draws on Mortensen and Pissarides (1994, 1999) with two extensions. First, we allow for heterogeneity in workers’ productivity. Secondly, we assume that the *initial* productivity of jobs is random. The first extension gets at how reforms aimed at easing layoffs of one type of workers affects unemployment, productivity and wages of *all* workers. The second extension allows for a more detailed analysis of how the hiring of different types of workers depends crucially on the structure of firing costs. These costs, as mentioned earlier, are modeled as pure waste (not as a transfer to the worker) and, hence, do not play any efficiency role.

The model is in continuous time and only steady states are considered. The economy is populated by a continuum of workers of measure one. Workers are risk neutral, infinitely-lived, and are of two types, depending on their productivity (low, L, and high, H). To simplify the analysis, we assume that there are no transitions across workers’ groups. The type of the worker is revealed to the

firm when the two agents meet, so that workers do not have to signal their productivity characteristics.¹³ Firms also know the arrival rate of productivity shocks and the distributions from which productivity is drawn for each worker's type. The mass of workers of L-type workers is α . The income obtained while unemployed is z_i ($i=L,H$), which is interpreted here as home production or leisure and, thus, does not need to be financed.

The number of firms is endogenously determined. Each firm offers one job. The flow cost of keeping a job vacancy unfilled is c . Vacancies are created until the exhaustion of any rents from their creation. When a worker and a firm with a job vacancy meet, they realize the value of the match. The productivity of the match is a random draw from a c.d.f. $F^i(\varepsilon)$ with support $[0, \infty)$, ($i=L,H$), such that $F^L(\varepsilon) > F^H(\varepsilon)$ for all ε . Thus, the distribution of productivity of H-type workers stochastically dominates the distribution of productivity of L-type workers.

Wages are determined by Nash bargaining and can be renegotiated continuously.

Job termination is endogenous. There are *i.i.d.* productivity shocks with Poisson arrival rates λ_i ($i=L,H$). To terminate the job, firms must pay pure-waste dismissal costs K_i ($i=L,H$). Further, we assume that all separations involve dismissal costs. By allowing for different termination costs we aim at capturing the targeted nature of EPL discussed at length in the previous sections. Our insight is that there are direct (first-round) and indirect (second-round) effects of reducing firing costs for just one group of workers, say L-type workers. The direct effects stem from the fact that the productivity threshold at which L-type workers are dismissed (hired) is higher (lower) the lower K_L is. The indirect effects, in turn, arise through the determination of the value of jobs filled by H-type workers which also changes when K_L is reduced.

Matching, hiring, and firing

Job vacancies and unemployed workers meet according to a conventional CRS meetings function $m(v,u)$, where v and u denote, respectively, the masses of job vacancies and of unemployed workers. The meetings function is increasing in both arguments and homogeneous of degree one. Labor market tightness is denoted by $\theta = v/u$. Given this function, firms meet with L-type and H-type workers with probabilities $\delta q(\theta)$ and $(1-\delta)q(\theta)$, respectively, where δ is the proportion of unemployed workers of type L and $q(\theta) = m(1,1/\theta)$, such that $q'(\theta) < 0$. The matching rate of all workers is $\theta q(\theta)$, with $q(\theta) + \theta q'(\theta) > 0$.

¹³ One possibility is that workers' productivity is positively correlated with educational level and firms receive workers' CVs or any other certificate displaying their skill level.

After the match-specific productivity parameter is revealed, employers face a hiring decision. Since the surplus of the match is increasing in productivity, there are two productivity thresholds $(\varepsilon_L^h, \varepsilon_H^h)$, one for each class of workers, above which hiring takes place. Conversely, employers terminate a match if the productivity of the job falls below the firing thresholds $(\varepsilon_L^d, \varepsilon_H^d)$.

Flows

Given the meetings probabilities and the hiring and firing rules, the flow equations are given by:

$$[(1 - F^L(\varepsilon_L^h)]\theta q(\theta)\delta u = \lambda_L F^L(\varepsilon_L^d)e_L, \quad (1)$$

$$[1 - F^H(\varepsilon_H^h)]\theta q(\theta)(1 - \delta)u = \lambda_H F^H(\varepsilon_H^d)e_H, \quad (2)$$

where e_L and e_H are the masses of employed L and H-type workers, respectively. The left-hand-sides of (1) and (2) give the outflows from unemployment while the right-hand-sides give the inflows into unemployment (i.e., outflows from employment) for L and H-type workers, respectively.

Since $\delta u + e_L = \alpha$ and $(1 - \delta)u + e_H = 1 - \alpha$, the steady state unemployment rates of both types of workers (denoted by ur) are given by:

$$ur_L = \frac{\delta u}{\alpha} = \frac{\lambda_L F^L(\varepsilon_L^d)}{[(1 - F^L(\varepsilon_L^h)]\theta q(\theta) + \lambda_L F^L(\varepsilon_L^d)}, \quad (1')$$

$$ur_H = \frac{(1 - \delta)u}{1 - \alpha} = \frac{\lambda_H F^H(\varepsilon_H^d)}{[1 - F^H(\varepsilon_H^h)]\theta q(\theta) + \lambda_H F^H(\varepsilon_H^d)}. \quad (2')$$

Bellman equations

Let U_i and $W_i(\varepsilon)$ denote, respectively, the value of unemployment and the value of employment with productivity ε , for workers of type i ($=L, H$). Then, the corresponding Bellman equations are as follows:

$$rU_i = z_i + \theta q(\theta) \max \left\{ \int_{\varepsilon_i^h}^{\infty} (W_i(x) - U_i) dF^i(x), 0 \right\} \quad (3)$$

$$rW_i(\varepsilon) = w_i(\varepsilon) + \lambda_i F^i(\varepsilon_i^d) [U_i - W_i(\varepsilon)] + \lambda_i \max \left\{ \int_{\varepsilon_i^d}^{\infty} (W_i(x) - W_i(\varepsilon)) dF^i(x), 0 \right\} \quad (4)$$

where r is the real interest rate, z is the flow utility while unemployed, and w is the wage. Notice that, since there is continuous renegotiation, wages depend on productivity and change instantly every time a productivity shock occurs (see the discussion on wage determination below).

As regards the employers, the value functions of an unfilled vacancy (V) and the value functions of filled vacancies with worker of type i (J_i) are given by the following Bellman equations:

$$rV = -c + \delta q(\theta) \max \left\{ \int_{\varepsilon_L^d}^{\infty} (J_L(x) - V) dF^L(x), 0 \right\} + (1 - \delta) q(\theta) \max \left\{ \int_{\varepsilon_H^d}^{\infty} (J_H(x) - V) dF^H(x), 0 \right\} \quad (5)$$

$$rJ_i(\varepsilon) = \varepsilon - w_i(\varepsilon) + \lambda_i F^i(\varepsilon_i^d) [V - J_i(\varepsilon) - K_i] + \lambda_i \int_{\varepsilon_i^d}^{\infty} [J_i(x) - J_i(\varepsilon)] dF^i(x) \quad (6)$$

Wage determination

As shown by Ljungqvist (2002), the way wage determination is modeled is crucial for the analysis of the employment effects of firing costs. On the one hand, when firing costs are assumed to reduce the firm's threat point in the initial match, they have a significant impact on hiring and tend to increase equilibrium unemployment. On the other, when the worker's relative share of match surplus is assumed to remain invariant as the severance pay changes, they tend to increase employment. Here we choose the first modeling strategy route. In particular, we assume that: i) wages are determined by *symmetric* Nash bargaining, so that the bargaining power for each party is equal to 0.5, ii) workers cannot post a bond and iii) renegotiation takes place as soon as the vacancy is filled out. Instantaneous renegotiation implies that workers get insider power and extract the rents from firing costs since the beginning of the match. In other words, the possibility of undoing the detrimental effect of firing costs on firm's profits by the worker accepting a wage cut from the outset of the match is excluded. Under this assumption, the firm's threat point is the value of the unfilled vacancy net of firing costs. Therefore, wages are given by the following condition:

$$J_i(\varepsilon) - V + K_i = W_i(\varepsilon) - U_i \quad (7)$$

which, in turn, implies that

$$w_i(\varepsilon) = \frac{1}{2}[\varepsilon + r(U_i + K_i)] \quad (7')$$

Hence, workers get their bargaining share of productivity, inclusive of the return from the value of being unemployed and the corresponding firing costs. As explained before, due to the assumption of instantaneous renegotiation, condition (7') applies both to the initial negotiations with a candidate worker and to bargains in continuing relationships that experience a productivity shock.¹⁴

Equilibrium

The productivity thresholds at which the hiring process starts to take place are those at which the value of a filled vacancy is equal to the value of an unfilled vacancy. Since there is free entry, $V=0$ in the steady-state equilibrium. Likewise, jobs are terminated when the value of the job is equal to the value of an unfilled vacancy minus termination costs. Thus,

$$J_i(\varepsilon_i^h) = V = 0 \quad (8)$$

$$J_i(\varepsilon_i^d) + K_i = V = 0 \quad (8')$$

Solving the model

The surplus of a job with productivity ε filled by a worker of type i is given by $S_i(\varepsilon) = J_i(\varepsilon) - V + K_i + W_i(\varepsilon) - U_i$, where $S_i'(\varepsilon) > 0$. Since

$$W_i(\varepsilon_i^d) = U_i \text{ and } J(\varepsilon_i^h) = 0, i = L, H,$$

equations (4) and (6) can be rewritten as follows:

¹⁴ In section 4.2, we show that this assumption yields realistic predictions for the effects of the 1997 targeted reform in Spain. However, as already mentioned, there could be alternative specifications of the bargaining process in which the worker extract rents from firing costs in continuing matches but not in the first match. Ljungqvist (2002) shows that this kind of a two-tier wage system is formally equivalent to assuming that the relative split of the match surplus is unaffected by firing costs throughout the employment relationship. This equivalence arises by imposing a wage profile under the Mortensen and Pissarides (1999) setup in which new workers post a bond equal to their share of any future expected firing costs. A version of the model, where the outside option of the firm for newly created jobs is simply V , and not $V+K$, has also been simulated yielding similar qualitative results.

$$(r + \lambda_i)[W_i(\varepsilon) - U_i] = w_i(\varepsilon) - z_i + \lambda_i \int_{\varepsilon_i^d}^{\infty} [W_i(x) - U_i] dF^i(x) - \theta q(\theta) \int_{\varepsilon_i^h}^{\infty} [W_i(x) - U_i] dF^i(x) \quad (4')$$

$$(r + \lambda_i)[J_i(\varepsilon) - V + K_i] = \varepsilon - w_i(\varepsilon) + \lambda_i \int_{\varepsilon_i^d}^{\infty} [J_i(x) - V + K_i] dF^i(x) - r(V - K_i). \quad (6')$$

Hence, adding up those two equations and using (7) yields:

$$(r + \lambda_i)S_i(\varepsilon) = \varepsilon - z_i + \lambda_i \int_{\varepsilon_i^d}^{\infty} S_i(x) dF^i(x) - \frac{\theta q(\theta)}{2} \int_{\varepsilon_i^h}^{\infty} S_i(x) dF^i(x) - r(V - K_i) \quad (9)$$

Further, noting that $S_i'(\varepsilon) = \frac{1}{r + \lambda_i}$ and integrating by parts implies that:

$$\int_{\varepsilon}^{\infty} S_i(x) dF^i(x) = [1 - F^i(\varepsilon)]S_i(\varepsilon) + \frac{1}{r + \lambda_i} \int_{\varepsilon}^{\infty} [1 - F^i(x)] dx \quad \text{for all } \varepsilon$$

Thus,

$$(r + \lambda_i)S_i(\varepsilon) = \varepsilon - z_i + \frac{\lambda_i}{r + \lambda_i} \int_{\varepsilon_i^d}^{\infty} [1 - F^i(x)] dx - \frac{\theta q(\theta)}{2(r + \lambda_i)} \int_{\varepsilon_i^h}^{\infty} [1 - F^i(x)] dx - \frac{\theta q(\theta)}{2} [1 - F^i(\varepsilon)]S_i(\varepsilon) - r(V - K_i) \quad (10)$$

This equation gives the productivity thresholds values for the firms' hiring and firing decisions. Given that $S_i(\varepsilon_i^d) = 0$, $S_i(\varepsilon_i^h) = 2K$, and $V=0$ in equilibrium, we get:

$$\varepsilon_i^d = z_i - \frac{\lambda_i}{r + \lambda_i} \int_{\varepsilon_i^d}^{\infty} [1 - F^i(x)] dx + \frac{\theta q(\theta)}{2(r + \lambda_i)} \int_{\varepsilon_i^h}^{\infty} [1 - F^i(x)] dx + [\theta q(\theta)[1 - F^i(\varepsilon_i^h)] - r] K_i \quad (11)$$

$$\varepsilon_i^h = z_i - \frac{\lambda_i}{r + \lambda_i} \int_{\varepsilon_i^d}^{\infty} [1 - F^i(x)] dx + \frac{\theta q(\theta)}{2(r + \lambda_i)} \int_{\varepsilon_i^h}^{\infty} [1 - F^i(x)] dx + [\theta q(\theta)[1 - F^i(\varepsilon_i^h)] + r + 2\lambda_i] K_i \quad (12)$$

so that $\varepsilon_i^h - \varepsilon_i^d = 2(r + \lambda_i)K_i$. Equations (11) and (12) give the job destruction and job creation rules, respectively. Notice that both rules depend on labor market tightness which, in turn, is determined by the job flows implied by the hiring and firing rules.

Finally, in equilibrium, the supply of vacancies is determined by the free-entry condition $V=0$, which can be written as follows:

$$\begin{aligned} \frac{c}{q(\theta)} &= \delta \int_{\varepsilon_L^h}^{\infty} \left[\frac{1}{2} S_L(x) - K_L \right] dF^L(x) + (1-\delta) \int_{\varepsilon_H^h}^{\infty} \left[\frac{1}{2} S_H(x) - K_H \right] dF^H(x) = \\ &= \frac{\delta}{2(r + \lambda_L)} \int_{\varepsilon_L^h}^{\infty} [1 - F^L(x)] dx + \frac{1-\delta}{2(r + \lambda_H)} \int_{\varepsilon_H^h}^{\infty} [1 - F^H(x)] dx \end{aligned} \quad (13)$$

To solve the model we must find a vector of variables $(\delta, u, \theta, \varepsilon_L^h, \varepsilon_L^d, \varepsilon_H^h, \varepsilon_H^d)$ satisfying equations (1'), (2'), (11), (12) and (13). Note that equations (11) and (12) come in pairs, leading to seven equations in seven unknowns. However, since the thresholds are related by a simple expression, $\varepsilon_i^h - \varepsilon_i^d = 2(r + \lambda_i)K_i$, and equations (1') and (2') can be combined to eliminate the unemployment rate, u , the full system can be easily reduced to four equations in four unknowns $(\delta, \theta, \varepsilon_L^h, \varepsilon_H^h)$.

4. Quantitative analysis

In order to obtain tractable analytical results, we assume that the productivity of the workers, ε_i , is exponentially distributed. Thus, $F^i(x) = 1 - \exp(-\mu_i x)$, $i = L, H, \mu_H < \mu_L$.

Under this assumption, the integrals (which represent the option values of future productivity shocks) can be easily solved yielding the following system of four equations:

(JH_H & JH_L)

$$\varepsilon_H^h = z_H + (r + 2\lambda_H)K_H + \left[\theta q(\theta) \left(\frac{1}{2\mu_H(r + \lambda_H)} + K_H \right) - \frac{\lambda_H \exp[2\mu_H(r + \lambda_H)K_H]}{\mu_H(r + \lambda_H)} \right] \exp(-\mu_H \varepsilon_H^h)$$

$$\varepsilon_L^h = z_L + (r + 2\lambda_L)K_L + \left[\theta q(\theta) \left(\frac{1}{2\mu_L(r + \lambda_L)} + K_L \right) - \frac{\lambda_L \exp[2\mu_L(r + \lambda_L)K_L]}{\mu_L(r + \lambda_L)} \right] \exp(-\mu_L \varepsilon_L^h)$$

$$(JC) \quad \frac{2c}{q(\theta)} = \frac{\delta \exp(-\mu_L \varepsilon_L^h)}{\mu_L(r + \lambda_L)} + \frac{(1 - \delta) \exp(-\mu_H \varepsilon_H^h)}{\mu_H(r + \lambda_H)}$$

$$(BC) \quad \delta = \alpha \frac{1 + \frac{\theta q(\theta)}{\Theta_H}}{1 + \frac{\theta q(\theta)}{\Theta_H} \left[\alpha + (1 - \alpha) \frac{\Theta_H}{\Theta_L} \right]}$$

where $\Theta_i = \lambda_i [\exp(\mu_i \varepsilon_i^h) - \exp[2\mu_i(r + \lambda_i)K_i]]$, for $i=L,H$.

The first two equations define the two job hiring thresholds (JH's) as a function of labor market tightness. As shown in Appendix A, for plausible parameter values, higher tightness implies higher hiring thresholds. In effect, as tightness rises, it takes more time to fill a job vacancy and firms will raise the minimum levels of productivity at which L-type and H-type workers are hired to compensate for the higher wage of applicants. The job creation equation (JC) makes the expected cost of filling a vacancy equal to the expected flow of benefits. They depend on the skill composition of the unemployed (δ), as the vacancy can be filled by either type of worker, and on the hiring thresholds (ε_H^h and ε_L^h), as they determine expected surplus during the duration of the match. For a given value of δ , it establishes a negative relationship between tightness and the hiring thresholds. The intuition for this relationship is simple: the higher the hiring thresholds are, the lower the expected value of filled vacancy is. Thus, for the marginal job vacancy to be created, tightness needs to be lower. Finally the fourth equation – a combination of the Beveridge curves (BC) for each type of workers in (1') and (2') – implies that the skill composition of the unemployed (δ) differs from that of the population (α) by a term that depends both on relative job creation rates and job destruction by skills which, in turn, depend upon tightness, the arrival rates of productivity shocks and relative productivities.

4.1. Calibration

In the rest of this section, we perform some numerical simulations of the model in order to gain some further insights on the effects of targeted EPL. In view of our discussion in section 2, we take the Spanish labor market as a guide for the

calibration of the parameters. The period is one quarter and, following Ljungqvist (2002) and Mortensen and Pissarides (1994), we set the quarterly interest rate $r=0.01$. The rest of the parameters are chosen to match some stylized of the Spanish labor market in 1997 when a major targeted EPL reform was approved. Before the reform, firing costs (that in our model refer only to the costs implied by dismissal procedures) are set equal to a quarter's wage ($K_L = w_L$, $K_H = w_H$).¹⁵

Next, we set the share of L-type workers, α , equal to 0.46 so as to match the proportion of the workforce that was eligible under the 1997 reform, namely, individuals aged 16-30 and 45-65, typically without a college degree. Since age and education are highly correlated with productivity and, in fact, young and low-educated workers are very much overrepresented in the stock of "atypical" employment contracts, this seems a reasonable choice as a counterpart of the L-group. Notice that we implicitly assume that there are no transitions between the L and H-groups given the characteristics of the Spanish high-education system.¹⁶ Therefore, the distribution of workers by educational levels is exogenously given and the age distribution of the workforce is assumed to be constant across steady states.

Regarding productivity differentials, we aim at matching the wage differential between the two groups of workers (computed as the ratio of the mean wages of H-type and L-type workers) observed in the pre-reform period, i.e., 1.22 in 1995.¹⁷ In terms of the parameters of the exponential distributions assumed above for the productivity levels, this leads to normalizing $\mu_L=1$ and setting $\mu_H=0.925$. The flow cost of posting a vacancy is set at the average productivity of the L-type workers ($c=1$). Taking into account the existing replacement ratio (60%) –identical for all workers– and coverage rate (62.5%) in the pre-reform period, the flow utility of being unemployed is set at 37.5% of wages for both types of workers. The arrival rates of productivity shocks are chosen to be $\lambda_L = 0.0535$ and $\lambda_H = 0.02$, namely about 2.5 larger for L-type workers. Given the rest of the parameter values, these values of the arrival rates are the ones which allow us to match both the aggregate firing rate (3.3%) and the unemployment rates of L-type and H-type workers (25.6% and 16.3%, respectively) observed in the data for 1997. We use a standard Cobb-Douglas specification $m(u, v) = h u^{0.5} v^{0.5}$ for the

¹⁵ In Spain there is an advanced notice period and dismissals have to go through a labor court, in case of individual dismissals, or through administrative approval, in case of collective dismissals. Although the process is quite complex, firing costs equivalent to a quarter's wages is a good guess.

¹⁶ Tuition fees in Spanish public universities are very low (about € 600 per year in 2005). Thus, it seems reasonable to assume that some people have the skills to graduate from college at no cost while others cannot graduate no matter what their effort is.

¹⁷ The wage data are taken from the Wage Structure Survey. This survey is the unique source of data on wages by age and educational attainment in Spain. It is available for 1995 and 2002. The rest of the observations in this section are taken from the Spanish Labor Force Survey for 1997.

meetings function, with the bargaining power of workers being equal to 0.5.¹⁸ Notice that the combined assumptions of a constant matching elasticity of 0.5 and symmetric Nash bargaining is widely used in the literature and receives some support in the data (see Petrongolo and Pissarides, 2001). Finally, the shift parameter h is set equal to 4.5 to yield an aggregate exit rate from unemployment equal to 12.8%, similar to the one observed in 1997. The complete list of parameter values is reported in Table 1.

Table 1

Baseline parameters

Interest rate	$r = 0.01$
Share of L-type workers	$\alpha = 0.46$
Firing costs	$K_L = w_L$ $K_H = w_H$
Exponents of productivity distribution	$\mu_L = 1$ $\mu_H = 0.925$
Flow utility of unemployed	$z_L = 0.375w_L$ $z_H = 0.375w_H$
Flow cost vacancies	$c = 1$
Arrival rates of productivity shocks	$\lambda_L = 0.0535$ $\lambda_H = 0.02$
Shift parameter of matching function	$h = 4.5$

4.2. Results

Table 2 describes the initial labor market outcomes under the assumption that the firing costs are equal to a quarter's wages. Inspection of the results reveals that

¹⁸ In a previous version of this paper we discussed the role of the matching elasticity. The value of this parameter is an important determinant of the differences in the steady state distribution with segmented and un-segmented markets but the qualitative predictions for the effects of EPL reforms are not sensitive to this choice.

our baseline calibration replicates almost perfectly with the pre-reform situation in Spain. Thus, departing from this initial setup, we proceed in the sequel to simulate the effects of three different EPL reforms: i) a reduction of firing costs targeted on L-type workers ($K_L=0$, $K_H=w_H$), ii) a reduction of firing costs targeted on H-type workers ($K_L=w_L$, $K_H=0$), and iii) a proportional reduction of firing costs for all workers ($K_L=\tau'w_L$, $K_H=\tau'w_H$, $0<\tau'<1$). In the case of the latter reform the value of parameter τ' is set to obtain an identical reduction in firing costs as under the first reform. Both reforms are therefore commensurate. The results for these three alternative cases are reported in Table 3.

Table 2

Benchmark calibration

	Model			Data		
	L	H	Aggregate	L	H	Aggregate
Labor market tightness θ	--	--	1.44			
Unemployment rates (%)	25.6	16.3	20.6	25.6	16.4	20.6
Threshold levels						
Destruction, ε^d	3.10	4.02	--			
Hiring, ε^h	3.60	4.31	--			
Exit rate from unemployment (%) –quarterly	14.82	10.05	12.78			12.82
Firing rate (%) –quarterly	5.11	1.95	3.31			3.35
Average productivity	4.57	5.38	5.03			
Average wage	3.91	4.76	4.39			
Wage differential (H/L)			1.218			1.214
Total firing costs	0.068	0.0420	0.1103			
	3					

As shown in the first panel of Table 3, when a targeted reform at L-type workers is implemented ($K_L=0$), the reduction in the unemployment rate of the L-group is rather large (8.1 p.p.) whilst it is lower for the H-group (0.7 p.p.), resulting in a fall in the aggregate unemployment rate of 4.1 p.p. The proportion

of L-type workers in the unemployment pool falls from 57.3% to 48.7%.¹⁹ While the firing rate of the H-type workers is not significantly affected by this type of reform, exit rates from unemployment for both groups increase, particularly in the case of workers in the L-group whose firing costs are now zero. Finally, although the average wage hardly changes, the between-group wage inequality increases substantially, as reflected by the rise in the ratio between the wages of H-type and L-type workers (w_H / w_L) from 1.22 to 1.28. Lastly, total firing costs fall from 0.1103 (about 3.2% of the wage bill) to 0.0424 (about 1.2% of the wage bill).

Table 3

The effects of targeted and comprehensive EPL reforms (random matching)

	Targeted EPL reforms						Comprehensive EPL reform		
	$K_L=0, K_H=4.76$			$K_L=3.91, K_H=0$			$K_L=0.3625*3.91$ $K_H=0.3625*4.76$		
	L	H	Aggregate	L	H	Aggregate	L	H	Aggregate
Tightness, θ	--	--	1.90	--	--	1.63	--	--	1.86
Unemployment rates (%)	17.5	15.7	16.5	25.1	13.2	18.7	20.1	14.0	16.8
Threshold levels									
Destruction, ε^d	3.24	4.13	--	3.13	4.10	--	3.22	4.15	--
Hiring, ε^h	3.24	4.41	--	3.63	4.10	--	3.40	4.25	--
Exit rate from unemployment (%) –quarterly	24.24	10.49	17.18	15.24	12.88	14.34	20.40	12.05	16.64
Firing rate (%) –quarterly	5.14	1.96	3.40	5.12	1.96	3.29	5.14	1.96	3.36
Average productivity	4.24	5.49	4.92	4.61	5.19	4.94	4.40	5.33	4.92
Average wage	3.81	4.86	4.38	3.95	4.65	4.36	3.88	4.76	4.37
Total firing costs	0	0.0424	0.0424	0.0689	0	0.0689	0.0268	0.0157	0.0424

By way of illustration, it is useful to confront the above-mentioned results with the post-reform situation in the Spanish labor market. In 2002, i.e., five years after the reform, the corresponding unemployment rates of L-type and H-type

¹⁹ These figures are not reported in the Tables since they can be easily computed from the value of α and the unemployment rates. The average productivity level has been computed using the ergodic distribution of productivity whose derivation can be found in the working paper version of this article (see Dolado et al., 2005).

workers had fallen to 13.2% and 11.2%, respectively, resulting in an average unemployment rate of 11.5%. Similarly, between 1997 and 2002, the wage differential (w_H / w_L) went up from 1.22 to 1.27. Hence, in line with the predictions of our calibrated model, the unemployment differential between L and H-type workers narrowed substantially and the reform seems to have induced an increase in the between-group wage inequality. Finally, by comparing the absolute figures of the predicted and realized unemployment rates, we can conclude that a targeted EPL reform can account for roughly one half of the total fall in unemployment during this period.

Hence, the accuracy of our predictions for the 1997 reform suggests that our calibrated model provides an adequate framework to evaluate the effects the other two above-mentioned EPL reforms. In the second panel of Table 3 we report the effects of a targeted reform that only eliminates the firing costs for H-type workers ($K_H=0$). In this case, as expected, there is a smaller reduction in the unemployment rates for the aggregate (1.9 p.p.) and for L-type workers (0.5 p.p.), and a larger one for H-type workers (2.5 p.p.) than under the first reform, relative to the pre-reform situation displayed in Table 2. The between-group inequality decreases from 1.22 to 1.08, reflecting the higher (lower) wage of L-type (H-type) workers after the reform. Total firing costs, in turn, fall from 3.2% of the wage bill to 1.9%, implying a smaller reduction than under the first reform. Thus, for each percentage point of a reduction in total firing costs, the fall in aggregate unemployment due to EPL reform targeted at L-type workers is much higher (about 2.8 times) than under an EPL reform targeted at H-type workers.

The basic explanation for this last result has to do with the role played by the relatively low arrival rate of shocks for H-type workers in the working of the matching spillovers. In effect, in each of these reforms, there are two reasons why the targeted reduction of firing costs for one group of workers makes more profitable the creation of vacancies by firms: i) the reduction in the waste of resources when a bad productivity shocks occur and ii) the weaker bargaining position of the particular group of workers whose firing costs have been reduced. In a single market, as firms create more vacancies, both groups of workers exit unemployment at a faster rate. However, the effect is substantially stronger for the group whose firing costs are eliminated since the reform eliminates the gap between the hiring and firing margin, leading to lower wages. Likewise, for the non-targeted group, the exit rate out of unemployment goes up because the increase in the meeting rate is only partially offset by the increase in their wages resulting from higher labor market tightness. The higher is the workers' turnover of the targeted group, the more will benefit the non-targeted group through the spillover effects. Hence, with a much lower arrival rate of productivity shocks to H-type workers, a reduction in their firing costs produces a smaller change in workers' flows than in the first reform. This intuition help to explain our main

result in this paper, namely that targeting a reduction of firing costs at workers with low and volatile productivity is most effective at cutting aggregate unemployment. In unreported simulations, however, we also found that a similar result in favor of targeting the firing costs of L-type workers obtains when the share of these workers in the population (α) is chosen to be much larger than in Table 1, in exchange for more similar arrival rates of shocks. In this case, as before, a reduction of firing costs for H-type workers is not so effective in reducing the aggregate unemployment rate as a reform targeted at L-type workers since the beneficial effects of increased tightness in the labor market spread across too many non-targeted workers.

The previous insight also holds when we last compare the targeted reduction of EPL for L-type workers with a comprehensive reform, designed to be commensurate in the sense of generating an identical reduction in firing costs. This reduction amounts to 36.25% of a quarter's wages, i.e., $\tau' = 0.3625$.

The last panel of Table 3 displays the labor market outcomes for this reform. A comparison with the first panel of Table 3 shows that a comprehensive reform leads to a lower increase in the labor market tightness and a smaller reduction in the aggregate unemployment rate (3.8 p.p.) than under the first reform (4.1 p.p.). Moreover, both the composition of the pool of unemployment (55.0% of L-type workers) and the average wage ratio of wages (81.6%) are similar to the pre-reform values (57.3% and 82.2%, respectively).

In sum, the above results suggest that, in order to achieve the largest fall in aggregate unemployment, the Spanish policy makers did well in reducing the firing costs of workers with relatively low levels of productivity and high rates of job destruction, relative to the other alternative reforms.

A last issue that deserves some attention is the magnitude of the matching spillover effects stemming from targeted EPL reforms. As explained above, these reforms stimulate job creation in our benchmark economy because they reduce both the deadweight losses from firing costs and the wage of the targeted workers. However, given that the matching process is completely random, some of these additional jobs may end up in the hands of the group of workers whose firing costs are unchanged. To estimate how relevant are these spillover effects, we next compute the outcomes of the three reforms for the case of a perfectly segmented labor market and compare them to those obtaining in a single market. The results for the former case are reported in Table 4, whereas Table B.1 in Appendix B presents the choice of the calibrated parameters in the pre-reform situation.

A comparison of the results in Table 4 with those in Table 3 suggests that the spillover effects are somewhat small in absolute size. Yet, their contribution to the reduction in equilibrium unemployment is far from being negligible. For example, considering the reform targeted at L-type workers under segmented markets, the unemployment rate of L-type and the aggregate unemployment rate

fall, respectively, by 6.9 and 3.3 p.p., whilst the corresponding reductions under random matching were 8.1 and 4.1 p.p. Thus, in terms of percentage points of aggregate unemployment, the spillover effects only accounts for 0.8 p.p. However, this contribution represents almost 20% of the 4.1 p.p. reduction in unemployment due to the targeted EPL reform. Hence, even though this proportion ought to be interpreted as an upper bound on the true magnitude of the spillover effects, it leads out to conclude that they should not be neglected in the analysis of targeted reforms.

Table 4

The effects of targeted and comprehensive EPL reforms (segmented markets).

	Targeted reforms						Comprehensive reform		
	$K_L=0, K_H=4.76$			$K_L=3.91, K_H=0$			$K_L=0.3625*3.91$ $K_H=0.3625*4.76$		
	L	H	Aggregate	L	H	Aggregate	L	H	Aggregate
Tightness, θ	1.83	1.89	1.86	1.10	2.46	1.83	1.50	2.23	1.94
Unemployment rates (%)	18.8	16.4	17.5	25.7	12.5	18.6	21.2	13.7	17.2
Threshold levels									
Destruction, ε_L^d	3.26	4.12	--	3.02	4.26	--	3.18	4.21	--
Hiring, ε_L^h	3.26	4.41	--	3.52	4.26	--	3.36	4.32	--
Exit rate from unemployment (%) –quarterly	23.29	10.48	16.83	13.94	13.74	13.87	19.06	12.39	16.18
Firing rate (%) –quarterly	5.15	1.96	3.40	5.09	1.96	3.26	5.13	1.96	3.35
Average productivity	4.26	5.48	4.93	4.50	5.34	4.99	4.36	5.40	4.95
Average wage	3.78	4.86	4.37	3.82	4.81	4.40	3.80	4.83	4.38
Total firing costs	0	0.0429	0.0429	0.0607	0	0.0607	0.0263	0.0148	0.0421

5. Concluding remarks

A relevant feature of some EPL reforms in several countries is that they are targeted at changing the firing costs of some groups of workers facing more difficulties in finding jobs, while the firing regulations of prime-age workers are left unaffected. Empirical studies trying to estimate the effects of these policies have found evidence that targeted EPL reforms affect not only the targeted groups but also the other types of workers.

In this paper we have presented a simple extension of Mortensen and Pissarides' (1994, 1999) search equilibrium model, with heterogeneous workers competing for the same jobs, which helps to understand how the effects of targeted EPL reforms differ from comprehensive reforms. We also show that the impact of reductions of firing costs on unemployment of different groups of workers is qualitatively different depending on which type of workers those reductions are targeted upon. In our simulations for the Spanish labor market following a major targeted EPL reform in 1997, we found that targeting those reductions on low productivity workers and in jobs subject to frequent productivity shocks turns out to be most effective in reducing aggregate unemployment. Although we have centered our analysis on the reduction of firing costs for different types of workers, it is plausible that the effects of other targeted employment policies (like targeted reductions of non-wage costs or differentiated minimum wages) could vary depending on the structural characteristics of the labor market being analyzed.

There are, however, some limitations in our analysis that should be highlighted before drawing strong policy implications. We have abstracted in the analysis from efficiency and equity considerations. Firing costs may have additional positive and negative effects on labor market variables than the ones considered here. For instance, firing costs are detrimental to output and productivity in a model with productivity growth in which higher turnover improves the reallocation of production factors and the adoption of new technologies. And, on the contrary, firing costs may improve welfare if workers are risk-averse and there are not insurance mechanisms against losing jobs. These issues are in our future research agenda.

Appendix A: Some comparative-static results of the model

a) The hiring and the firing rules

Differentiating the (JH) equations yields:

$$\frac{d\varepsilon_i^h}{d\theta} = \frac{1 - [1 + 2\mu_i(r + \lambda_i)K_i] \exp(-\mu_i\varepsilon_i^h)}{\theta + \theta q'(\theta) [2\mu_i(r + \lambda_i)K_i] [1 + \mu_i(\varepsilon_i^h - z_i - (r + 2\lambda_i)K_i)]}$$

$i=L,H$

which is positive as long as:

$$\varepsilon_i^h + \frac{1}{\mu_i} - z_i - (r + 2\lambda_i)K_i > 0, \quad i = L, H$$

Thus, a sufficient condition for the hiring thresholds being increasing in labor market tightness is that the average productivity is higher than the benefit from being unemployed augmented by the discounted value of firing costs to be accrued in the future. Notice that this inequality is a requisite for the existence of an equilibrium.

b) The job creation condition

Differentiation of the (JC) equation yields:

$$\frac{\delta \exp(-\mu_L\varepsilon_L^h)}{r + \lambda_L} \frac{d\varepsilon_L^h}{d\theta} + \frac{(1 - \delta) \exp(-\mu_H\varepsilon_H^h)}{r + \lambda_H} \frac{d\varepsilon_H^h}{d\theta} = \frac{2cq'(\theta)}{q(\theta)^2} + \left[\frac{\exp(-\mu_L\varepsilon_L^h)}{\mu_L(r + \lambda_L)} - \frac{\exp(-\mu_H\varepsilon_H^h)}{\mu_H(r + \lambda_H)} \right] \frac{d\delta}{d\theta}$$

The second term of the right-hand-side in the equation above is likely to be positive as

$$\frac{\exp(-\mu_L\varepsilon_L^h)}{\mu_L(r + \lambda_L)} < \frac{\exp(-\mu_H\varepsilon_H^h)}{\mu_H(r + \lambda_H)} \quad \text{and} \quad \frac{d\delta}{d\theta} < 0$$

for most plausible parameter values. However, if the two types of workers are not too dissimilar (in terms of the rate of arrival of productivity shocks, average productivity) and the difference of firing costs is not too large, this term is also

likely to be small, as both factors would be close to zero (see below for the reason why the response of the skill composition of the labor force to labor market tightness is also small). Hence, whenever this term can be discarded, the JC condition establishes a negative relationship between the hiring thresholds and labor market tightness, since $\frac{2cq'(\theta)}{q(\theta)^2} < 0$.

c) The skill composition of the unemployment pool

From the (BC) equation we get:

$$\ln \delta = \ln \alpha + \ln \left[1 + \frac{\theta q(\theta)}{\Theta_H} \right] - \ln \left[1 + \frac{\theta q(\theta)}{\Theta_H} \left[\alpha + (1 - \alpha) \frac{\Theta_H}{\Theta_L} \right] \right].$$

Hence,

$$\ln \delta \approx \ln \alpha + \frac{\theta q(\theta)}{\Theta_H} (1 - \alpha) \left[1 - \frac{\Theta_H}{\Theta_L} \right]$$

so that δ will be a decreasing function of θ as long as $\Theta_H > \Theta_L$, a result which always holds in our simulations. Moreover, as long as the difference $(\Theta_H - \Theta_L)$ is sufficiently close to unity - which, as mentioned in b), is the case where the two types of workers are not too dissimilar (in terms of the rate of arrival of productivity shocks and average productivity) and the difference of firing costs is not too large- δ will barely change when θ changes, implying that the second-round effects of δ on θ will be dominated by the first-round effects as the firing costs are reduced.

In the simulations presented in the text we have confirmed that the conditions for the existence of a unique equilibrium heuristically discussed above are satisfied.

Appendix B: Results under segmented markets

This Appendix reports the results of the calibration exercise presented in Section 4 under the assumption of segmented markets. They are obtained by solving equations (JH) and (JC) in the text after imposing $\delta=\alpha=1$. The corresponding parameter values for each group of workers in order to match the pre-reform situation (1997) are shown in Table B.1.

Table B.1

Benchmark calibration (segmented markets)

	$K_L=3.91; K_H=4.76$		
	L	H	Aggregate
Tightness, θ	1.14	1.89	1.45
Unemployment rates (%)	25.7	16.4	20.8
Threshold levels			
Destruction, ε_L^d	3.02	4.12	--
Hiring, ε_L^h	3.52	4.41	--
Exit rate unemployment (%) –quarterly	13.94	10.48	12.53
Firing rate (%) –quarterly	5.09	1.96	3.29
Average productivity	4.50	5.48	5.06
Average wage	3.82	4.86	4.42
Total firing costs	0.0620	0.0451	0.1071

Notes: Steady state values for simulations with the following set of parameter values: $r=0.01$, $c=1$, $\alpha=0.46$, $z_L=1.4625$, $z_H=1.8$, $\lambda_L=0.0535$, $\lambda_H=0.02$, $\mu_L=1$, $\mu_H=0.925$, $h=4.5$,

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