



Partial disability and labor market adjustment: The case of Spain[☆]



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ABSTRACT

Although partially disabled individuals in Spain are allowed to combine disability benefits with a job, the empirical evidence shows that the employment rate of this group of individuals is very low because they have much lower job finding and higher job separation rates than nondisabled workers. Moreover, a decomposition analysis of the equilibrium employment rate shows that the differences in the job finding rates explain 85 percent of the disabled employment gap. To explain these facts, we construct a labor market model with search intensity and matching frictions to identify the incentives and disincentives to work in Spain from the point of view of both disabled workers and employers. According to the model, the high employment rate gap observed between nondisabled and disabled individuals can be partly explained by the presence of a lower level of productivity among disabled individuals that discourages them from looking for jobs. In terms of policy interventions, sensitivity analysis shows that, since the disability condition is permanent, one-off subsidies in new hired positions have a much lower impact on the employment rate and welfare of disabled individuals than long-term policies.

1. Introduction

Disability policies have recently attracted attention, particularly in OECD countries, because they represent an important share of public spending and also because societies are increasingly concerned about the need to promote the integration of people with disabilities. For these reasons, the possibility of increasing the number of disabled individuals who work is regarded as a good strategy to decrease pressure on the financial stability of social security systems as well as to achieve the social integration of people with disabilities (OECD, 2007).

The impact of disability regulations on the employment of disabled individuals has been documented in a recent book by Burkhauser and Daly (2011) and in several papers for the case of the U.S. (Autor and Duggan 2006, 2007, 2008; Autor et al. 2011; Benítez-Silva and Heiland, 2007, 2008). With regard to the U.S. Social Security Disability Insurance (SSDI) program, researchers seem to agree that the disability program rules and, in particular, its work-contingent

basis, have been the main explanation for the reported decline in the employment rates of individuals with disabilities. That is, individuals stop working to qualify for disability benefits even though they maintain some capacity to work. In line with this, the promotion of the employment of disabled individuals is particularly relevant for the Spanish case because, unlike other disability systems in developed economies, the Spanish system is not contingent on working status and, therefore, allows partially disabled individuals to work while they receive disability benefits. The puzzle is, however, that employment rates for this group of disabled individuals are very low: the country reported an average employment rate of just 13.6 percent for people with partial disability from 2001 to 2011, which contrasts with the observed rate for nondisabled employees (75.3 percent)¹. This suggests that, even in non-working contingent programs, hiring and fiscal regulations regarding disabled workers can generate disincentives to work.

Therefore, in this paper we analyze the incentives and disincentives to work in Spain from the point of view of both disabled individuals and

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¹ Independently of the disability benefits system, in the majority of developed countries there is a similar employment gap between nondisabled workers and those that self-report as disabled. While the average employment rate for self-reported disabled individuals was 45% in the U.K., 40% in the U.S. and 37% in Spain, the employment rate for nondisabled individuals was 81% in the U.K., 84% in the U.S. and 70% in Spain in the same period (late 2000s) (OECD, 2010).

employers. The central goal of the study is twofold: (i) identify how differences in workers' characteristics explain the low employment rates of partially disabled individuals vis-à-vis their nondisabled counterparts; (ii) analyze the sensitivity of the employment rates to changes in the parameters of the Spanish disability system. The final aim is to reach some conclusions about the types of policy initiatives that might be more effective in increasing both individual incentives to work as well as employers' incentives to hire disabled workers.

To do this, we consider a search and matching model of individuals with disabilities and their interaction with nondisabled individuals in the search for jobs. We also include in the model the hiring decisions made by companies and the incentives available in the legislation to hire disabled workers. We assume that, due to their disabling condition, disabled workers are, on average, less productive and incur in higher job-search costs than nondisabled individuals. The presence of a productivity gap between disabled and nondisabled workers has been documented in Malo and Pagan (2012).² These authors demonstrate that between 68 and 74 percent of the Spanish wage differential between nondisabled and disabled workers is due to differences in worker characteristics.³

We calibrate and simulate the model to match a number of stylized facts observed in the administrative data provided by the Spanish Social Security Administration (the Continuous Sample of Working Lives). Our simulated model helps to understand the differences between disabled and nondisabled workers. Specifically, it simulates an employment rate of 22.2 percent among disabled workers, which is much lower than the observed rate for nondisabled individuals (75.3 percent). The model also shows that, for disabled workers, the job finding rate is much lower and the job separation rate is higher than for nondisabled workers. All these results are in line with the Spanish data.

According to the model, the high employment rate gap observed between nondisabled and disabled workers can be partially explained by the presence of a lower level of productivity among disabled individuals that discourages them from looking for jobs, generating a search intensity gap of 31 percentage points between disabled and nondisabled individuals.

In terms of policy interventions, the sensitivity analysis shows that the employment rate gap between disabled and nondisabled workers can be considerably reduced by decreasing the disability benefits for unemployed workers, by increasing the disability benefits for disabled employees, by increasing the deduction to Social Security contributions paid by the employer, or by increasing the tax deduction for disabled workers. In contrast, the model shows that lump-sum hiring subsidies have a much lower impact on the employment rate and welfare of disabled individuals. This is important because it suggests that, since the disability condition is permanent, these policies should be more focused on introducing subsidies to keep the disabled workers in the firm rather than to hire them.

As far as we know, no papers in the literature have used structural models to analyze the matching problems in the labor market for individuals with disabilities.⁴ However, two studies analyze the labor supply behavior of individuals with disabilities using life-cycle models in the United States: Benitez-Silva et al. (2010) and Yin and Benitez-Silva (2009). Both studies focus on the U.S. economy, where the disability system does not allow disabled individuals to combine benefits with a job, which is very different from the Spanish system.

² This paper uses the Oaxaca-Blinder wage decomposition method for Spain and other European countries.

³ Because the authors use data from the European Community Household Panel survey, they define disabled workers as "individuals that are hampered in their daily activities."

⁴ A paper by Silva and Vall-Castello (2012a) estimates a structural labor supply job search model to reproduce the behavior of disabled individuals. However, the paper does not include the interactions between disabled and nondisabled individuals and it also neglects the role of employers.

Furthermore, these studies do not consider interactions with nondisabled workers or the role of employers. In our model, we include search intensity and matching frictions because we think they play a central role in determining employment outcomes of disabled individuals. With respect to the empirical evidence on the labor market behavior of disabled individuals, the literature analyzing the U.S. system is extensive (see Autor and Duggan (2006, 2007, 2008); Autor et al. (2011); Burkhauser and Daly (2011), among others), but still rather limited for the Spanish case (Cervini-Plá et al., 2015; Malo and Pagan 2012; Marie and Vall-Castello 2012; Vall-Castello 2012; Malo et al. 2011).

In the next section, we present the main policies of the Spanish Disability System that have been included in our model. Section 3 describes the database, shows the evolution of labor market variables, and presents the decomposition analysis of the equilibrium employment rate. Section 4 shows the theoretical model and describes the timing of the events. Then, in Section 5 we calibrate the model in the steady state at annual frequency to be consistent with certain empirical Spanish labor market facts. The benchmark simulated results are presented in Section 6, while Section 7 shows the sensitivity analysis with respect to the workers characteristics and policy parameters. Section 8 presents conclusions.

2. Main features of the Spanish system of disability benefits

As shown in Table 1, there are currently three main economic incentives for employers to hire disabled workers in Spain. First, there is a lump-sum subsidy of 3,906.58 euros for each disabled worker hired (this amount is adjusted proportionally for part-time contracts). Second, employers can benefit from deductions to Social Security contributions. These deductions are linked to the worker's gender and the intensity of the disability. In general, they are 4500 euros per year. The third element is another subsidy aimed at adapting the working space to any special needs the disabled worker may have. The maximum amount of this subsidy is 902 euros and it is only paid once for each contract.

With respect to the economic incentives for disabled workers, the Spanish Social Security Administration defines permanent contributive disability insurance as the economic benefits to compensate individuals for losing a certain amount of wages or professional earnings when affected by a permanent reduction or complete loss of their working ability due to the effects of a pathologic or a traumatic process derived from an illness or an accident.

To capture the different situations in which a person might be after experiencing a disabling condition, the Spanish Social Security Administration uses a classification of three main degrees of disability that depend on the working capacity lost.⁵

- 1) Partial disability (57 percent of claimants): individuals are unable to develop all or the fundamental tasks of their usual job or professional activity, but they are still capable of developing a different job or professional activity.
- 2) Total disability (40 percent of claimants): individuals are unable to develop any kind of job or professional activity.
- 3) Severe disability (3 percent of claimants): individuals who, as a result of anatomic or functional losses, need the assistance of a third person to develop essential activities of daily living, such as eating or moving.

As the aim of the paper is to analyze the incentives and disincentives to work provided by the disability system in Spain, we focus

⁵ There was a fourth degree of disability benefits (permanent limited disability), but this type of benefit has been discontinued and it only consisted of a one-time lump-sum payment.

Table 1
Summary of the Economic Incentives for Employers.

| Lump-sum subsidy (one for each contract) | Deductions to Social Security contributions | Other subsidies |
|--|---|---|
| 3,906.58 (open to part-time contracts; proportional) | 4,500 euros/year | INEM subsidies to adapt working spaces(maximum 902 euros) |

only on the group of partially disabled individuals because the Social Security medical team has determined that they retain a certain capacity to work (in a professional activity that is different from the one developed before the onset of the disability). We do not include in our sample individuals with a total or a severe disability because they are unable to develop any kind of job or professional activity.

The benefits received vary according to the individual’s degree of disability. In general, individuals in the partial disability scheme receive 55% of the regulatory base (which is an average of the last salaries) because it is assumed that they receive some income from work that would allow them to reach a similar amount of the money earned before becoming disabled. This 55% can be increased to 75% for individuals aged 55 or more, but only if the individual has difficulties finding a job. On the contrary, total disability benefits provide 100% of the regulatory base because individuals are considered to have lost all their ability to work and, thus, are unable to earn any extra income from work.

Regarding the taxes that disabled individuals have to pay, Table 2 indicates that individuals with a total disability benefit are exempt from paying income taxes. On the other hand, partially disabled workers are required to pay income taxes (they are only exempt if they reside in the Basque Country and do not have a job). However, there is a reduction in the employment income that is used to calculate the income tax for partially disabled workers. This reduction is 2800 euros per year if the disability level is between 33 and 65 percent.

Finally, Spanish legislation does not provide a different subsidy for disabled and nondisabled workers when converting contracts from temporary to permanent status. More specifically, the subsidy for converting a temporary apprenticeship contract into a permanent one is 500 euros for males and 700 euros for females, but there is no distinction in the amount of the subsidy between disabled and nondisabled workers.

3. Database, employment and transition rates in the Spanish labor market for disabled and nondisabled workers

3.1. Database

The study uses the Continuous Sample of Working Lives (*Muestra Continua de Vidas Laborales*, MCVL), which is a microeconomic dataset based on administrative records provided by the Spanish

Table 2
Summary of the fiscal measures for individuals receiving disability benefits.

| | Partially disabled individuals | Totally disabled individuals |
|---|--|------------------------------|
| Income taxes | Pay income taxes. Exempt if in the Basque ^a Country and without a job. | Exempt from income tax |
| Reduction in employment income used to calculate the income tax | 2800 euros/year (if disability level falls between 33 and 65 percent and the individual is working). | |

^a Disabled individuals in the provinces of Vizcaya and Guipúzcoa (in the Basque Country) are exempted from paying income tax on partial disability pensions if they don’t work.

Social Security Administration. Each wave contains a random sample of 4 percent of all the individuals who had contributed to the Social Security system (either by working or by being on an unemployment scheme) or had received a contributory benefit during at least one day in the year the sample was selected (over 1 million people). Thus, the sample does not include those individuals without any contact with the Social Security in such a year. In order to minimize the sample selection risk, we combine the database for four years, from 2008 to 2011, and therefore include everybody that had a relationship with the Social Security administration of at least one day during this four-year period. For those individuals, we can reconstruct the complete employment and pension history.

The available information includes the exact duration of employment, unemployment, and disability pension spells, and for each spell, several variables that describe the characteristics of the job or the unemployment/disability benefits. There is also information on personal characteristics such as age, gender, nationality, and level of education.

For the sample of disabled workers, we select an inflow sample of all individuals that started receiving partial disability benefits between 2001 and 2011, and we follow their labor market transitions until 2011 or until they reach the age of 65 and are automatically transferred to the old-age pension system. For the sample of nondisabled individuals, we selected individuals who have never received (and will never receive) a disability benefit and we followed their transitions in the labor market from 2001 to 2011. For both samples, we consider individuals to be employed if they are observed as working on December 15th.⁶ Thus, the sample is not fully representative of the respective population as it does not include individuals that die or that leave the country between 2001 and 2008 or those that do not contribute to the Social Security administration or receive a pension (disability, old age, unemployment) for at least one day during 2008–2011. In any case, we estimate that only around 0.25% of individuals cannot be followed for the above-mentioned reasons.

3.2. Employment and transition rates

In this section we present a set of indicators that compare the Spanish labor market behavior for partially disabled (*d*) and nondisabled (*n*) individuals from 2001 until 2011. Fig. 1 shows the annual employment rates of these two types of individuals, as a proportion of the working-age population. The first noteworthy result is the presence of a significant employment gap between nondisabled and partially disabled workers during the whole period. More specifically, while the employment rate of nondisabled employees fluctuates between 70.2 percent and 78.5 percent, the corresponding rate of partially disabled employees moves between 11.4 percent and 15.4 percent. Both employment rates show a somewhat similar trend, increasing between 2001 and 2007 and decreasing during the last downturn.

Fig. 1 also shows that the employment rate of nondisabled workers decreased by much more during the economic downturn (2008–2011). These data suggest that the employment rate of nondisabled workers seems to be more volatile than the disabled rate during labor market fluctuations. This result can be explained by the higher incidence of nondisabled workers in the construction sector, the most affected sector after the burst of the Spanish housing bubble.

We also analyze the ins and outs of employment by considering measures of separation and job finding rates derived from the MCVL. Let eu_t^i and ue_t^i denote the gross flows from employment to none-employment and from nonemployment to employment with $i=d,n$, respectively, and let e_{t-1}^i and u_{t-1}^i indicate the measured stocks of

⁶ We have also worked with a different definition of employment and the results do not change substantially. We have decided to use the December 15th definition because it proved to be the definition with a lower irregular component.

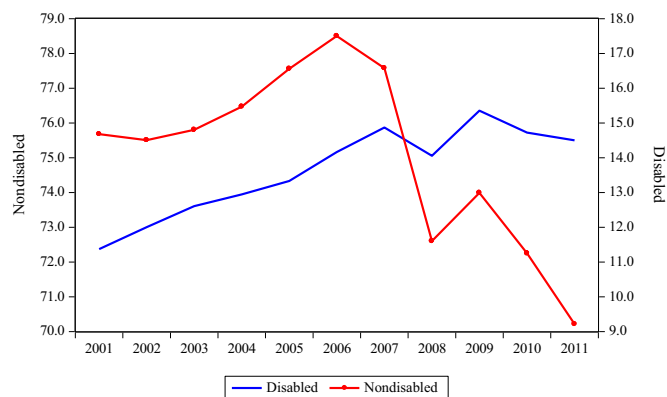


Fig. 1. Spanish Employment Rates for Disabled and Nondisabled Workers (2001–2011).

Source: Authors' elaboration from the MCVL.

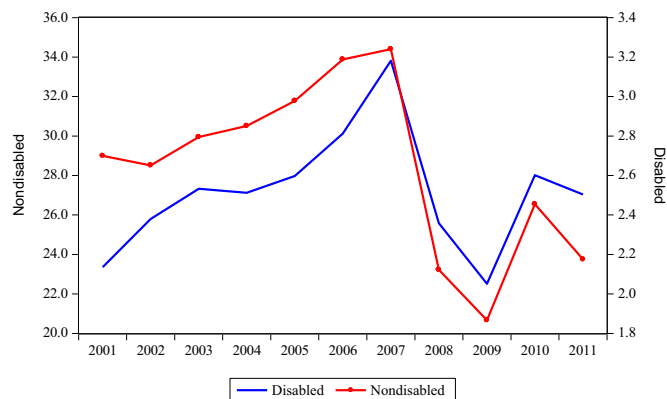


Fig. 2. Job Finding Rates for Disabled and Nondisabled Workers (2001–2011).

Source: Authors' elaboration from the MCVL.

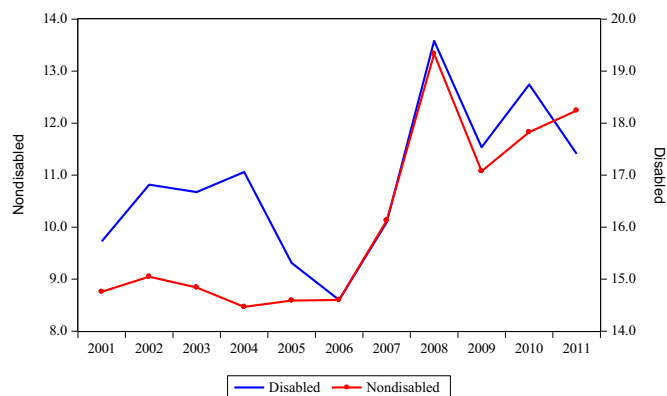


Fig. 3. Job Separation Rates for Disabled and Nondisabled Workers (2001–2011).

Source: Authors' elaboration from the MCVL.

employed and nonemployed workers in year $t-1$, respectively. Then, the annual separation and job finding rates are determined by $\psi_t^i = \frac{eu_t^i}{e_{t-1}^i}$ and $f_t^i = \frac{ue_t^i}{u_{t-1}^i}$. Figs. 2 and 3 show the evolution of the job finding and job separation rates for both disabled and nondisabled workers.

As can be observed in Fig. 2, the job finding rate for nondisabled workers is much higher than that for disabled people. On average, the job finding rate for the former is 11.4 times higher (0.284 and 0.025, respectively). In addition, both rates display similar behavior during the period, showing a correlation coefficient of 0.73. In turn, Fig. 3

shows that the job separation rate of disabled workers is only 1.7 times higher than that for nondisabled workers (0.169 vs. 0.101, on average). Moreover, both rates are positively correlated, displaying a correlation coefficient of 0.83.

In summary, we find that the job finding rate is much lower for disabled workers than it is for nondisabled workers, while the job separation rate is somewhat higher. These results imply that non-employment spells for the disabled are much longer while, at the same time, these workers lose or are dismissed from their jobs with higher frequency.

3.3. Employment rate decomposition

It is possible to obtain the contribution of each transition rate to the employment rate gap by using the equilibrium employment rate equation as a function of the job finding and job separation rates. More specifically, if the dynamics of employment is given by the following expression,

$$e_t^i = e_{t-1}^i + f_t^i(1 - e_{t-1}^i) - \psi_t^i e_{t-1}^i,$$

then, by setting $e_t^i = e_{t-1}^i$, the equilibrium employment rate is $e_t^i = \frac{f_t^i}{f_t^i + \psi_t^i}$. Next, we can calculate the contribution of each transition rate to the employment gap by substituting one of the nondisabled transition rates into the equilibrium employment rate of disabled employees. For example, the disability employment rate with equal job finding rate between disabled and nondisabled workers is $e_t^d = \frac{f_t^n}{f_t^n + \psi_t^d}$. Then, the difference between the observed and the modified equilibrium employment rates captures the contribution of each transition rate to the employment rate gap. Fig. 4 presents the adjusted disabled employment rates calculated using the nondisabled job finding (red line) and job separation (green line) rates. As it can be seen, the employment gap is considerably reduced in the former case. Thus, the job finding rate explains 85% of the employment gap. In other words, with the same job finding rate as nondisabled workers, the average disabled employment rate would be 62.4% (red line), which is nearly as high as the nondisabled equilibrium employment rate of 73.1% (black line).

Therefore, with transition rates empirically obtained from the Spanish Social Security database, in the next sections we present and simulate a model with matching frictions and search intensity that includes the main aspects of the Spanish Disability System in order to explain the labor market differences between disabled and nondisabled workers.

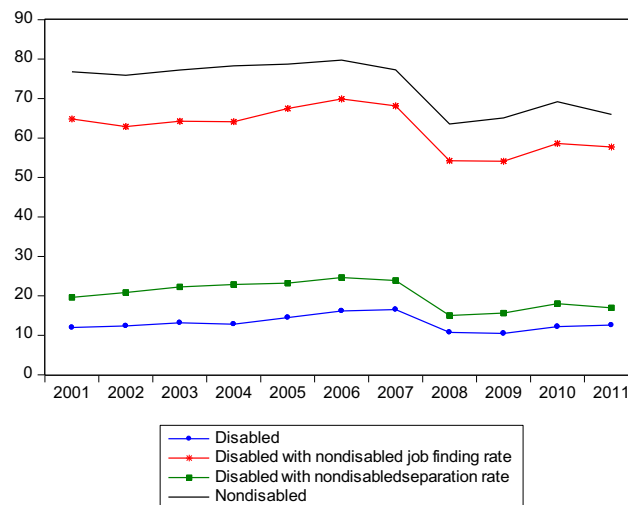


Fig. 4. Equilibrium Employment Rates (2001–2011).

Source: Authors' elaboration from the MCVL.

4. The theoretical model

4.1. Main features of the model

The economy consists of a continuum of risk-neutral, infinitely lived firms, and individuals who discount future payoffs at a common rate, β . We normalize the population to 1. Moreover, capital markets are perfect and time is discrete. Individuals may be either nondisabled (n) or partially disabled (d). A nondisabled individual can be converted into partially disabled with exogenous probability, π (the health shock). In turn, a partially disabled individual exits from the labor market with exogenous probability, ρ , due, for example, to retirement or a transition to total disability.

Both partially disabled and nondisabled individuals can either be employed or unemployed. All workers compete in the labor market for the same jobs and the process to match firms and workers is random. There are two reasons why we assume this. First, partially disabled workers represent 3 percent of the working-age population in Spain. Thus, it is reasonable to assume that it is costly for a representative firm to create a vacancy specifically for them. Second, disabled workers do not have specific job centers; they only have access to the same job centers with the same vacancy positions as nondisabled individuals.

Unemployed individuals enjoy an instantaneous utility, b , each period. This employment opportunity cost has to be given up when the worker finds a job. According to Pissarides (2000), unemployed workers have search intensity. Let s_j^j with $j = n, d$ be a variable measuring the search intensity for each type of unemployed worker. Unemployed workers incur in convex job search costs, $b(s_j^j)^\sigma$, expressed in terms of the employment opportunity costs, b . It is more difficult for a person with a partial disability to look for a job than it is for a nondisabled person. Thus, we assume that the search costs for disabled individuals are proportional to the level of disability, dis . The presence of higher job search costs has been documented in the findings derived from the Spanish Survey on Disability (*Encuesta de Discapacidad, Autonomía Personal y Situaciones de Dependencia*, EDAD). For example, according to that survey, 40 percent of disabled individuals have difficulties finding jobs due to their disability. Moreover, according to survey information provided by Loprest and Maag (2001), half of nonworking adults with disability in the U.S. have difficulty finding jobs. The lack of appropriate jobs, transportation, and information about jobs are the most cited difficulties.

Since the Spanish Disability System is a non-work contingent system, partially disabled workers receive disability benefits, $\alpha_{e,u} w_0^d$, regardless of their labor market status. However, the disability scheme for an unemployed worker, α_u , can be different with respect to the one for the employment status, α_e . More specifically, according to the Spanish Disability System, the pension received varies according to the individual's degree of disability. Individuals in the partial disability scheme receive, in general, 55 percent of the regulatory base (which is an average of the last salaries). This 55 percent can be increased to 75 percent for individuals aged 55 conditionally on having difficulties to find a job.

There are three different types of disabled employees: 1) those employed when nondisabled who then receive a negative health shock and are reallocated to another job within the same firm; 2) disabled workers hired from unemployment; and, finally, 3) disabled workers in continuing jobs.⁷ We differentiate between the first two types of disabled individuals because, according to the Spanish Disability System, the firm receives a different subsidy for each type of worker. Thus, the employers receive a one-time, lump-sum subsidy, ζ_e , when they retain a newly disabled individual in the firm just after a disability shock, or ζ_u if they hire a disabled worker from among the unemployed.

⁷ We use the super-index $j=n,d$ for disabled (d) and nondisabled (n) and the sub-index $i=u,r,c$ for new employed individuals coming from unemployment (u), job reallocation of new disabled workers in the same firm (r) and workers in continuing jobs (c).

In turn, the main difference between the newly and the previously disabled employee is that the second one has higher productivity due to the presence of a job learning process in the new job position. This assumption is important because the Spanish Disability System does not allow the newly disabled individuals to keep the same job or professional activity they had before becoming disabled. Thus, we assume that newly disabled employees have a productivity gap with two components: (i) a permanent component, which is proportional to the degree of disability, dis ; and (ii) a transitory component, dis_t , related to the presence of assimilation costs for working in a different job or professional activity. This second component disappears after one year spent working in the new job position.⁸

The presence of both temporary and permanent productivity gaps in our model is also consistent with recent empirical evidence on wages presented by Cervini-Plá et al. (2016). More specifically, the authors found that around 40 percent of the initial wage gap between a nondisabled and a newly disabled individual is reversed after two years in the new job position. However, the authors also show that the other 60 percent of the wage gap remains over time and corresponds to a permanent fall in productivity.

Each firm consists of one job that is either filled or vacant and uses only labor as input. Before a position is filled, the firm has to create a job vacancy with cost κ per period. A firm's output depends on aggregate productivity, A_t , a match-specific term, z_t , and the worker's type. In particular, nondisabled workers on a job filled produce, $A_t z_t$, whereas workers with a partial disability in new and continuing jobs produce $(1 - dis - dis_t) A_t z_t$ and $(1 - dis) A_t z_t$, respectively.

The match-specific productivity term, z_t , is assumed to be independent and identically distributed across firms and time, with a cumulative distribution function, $G(z)$, and support, $[0, \bar{z}]$. We also assume that the idiosyncratic productivity, z , is assumed to be log-normally distributed with normalized mean, μ , and standard deviation, σ . Thus, in each period, any job position may be endogenously terminated. In this case, firms will incur in firing tax costs γ_j^j for each type of position. In line with the duality observed in the Spanish Labour Market, we assume that the new and continuing job positions are related with temporary and permanent contracts, respectively. Additionally, and following Sala et al. (2012), we also assume no effective firing tax on temporary positions due to the short duration of these types of contracts. Thus, we set $\gamma_u^d = \gamma_r^d = \gamma_u^n = 0$. Workers can also exogenously quit the firm with probability φ for any type of worker. In this case, the firm does not incur in firing costs. When an employment relationship is broken, the worker becomes unemployed.

Consistent with the Spanish Disability System, firms receive an annual deduction of ξ from Social Security contributions for each disabled worker and, finally, disabled workers receive a net income tax deduction, p , when they are working.

Employed individuals earn wages net of taxes, w_{it}^j , which are the result of bilateral Nash bargaining between workers and firms. This assumption implies that, if all workers have the same bargaining power, the differences in wages that the model generates between nondisabled and disabled workers are explained by the presence of different worker characteristics (productivity and searching costs) as well as the design of the Spanish Disability System, which has different types and amount of subsidies for each group of workers. Thus, the Nash bargaining assumption in our model is not incompatible with the presence of anti-discrimination laws.

⁸ The parameter dis_t can also be linked to firms incurring extra hiring costs when they hire a newly disabled worker. For example, they need to adapt the working space so that workers with disabilities can properly do their jobs, and they have to take into account the extra time supervisors or co-workers will need to assist workers with disabilities. Therefore, these costs can be expressed in terms of forgone productivity while the disabled worker is adapting to the new job position.

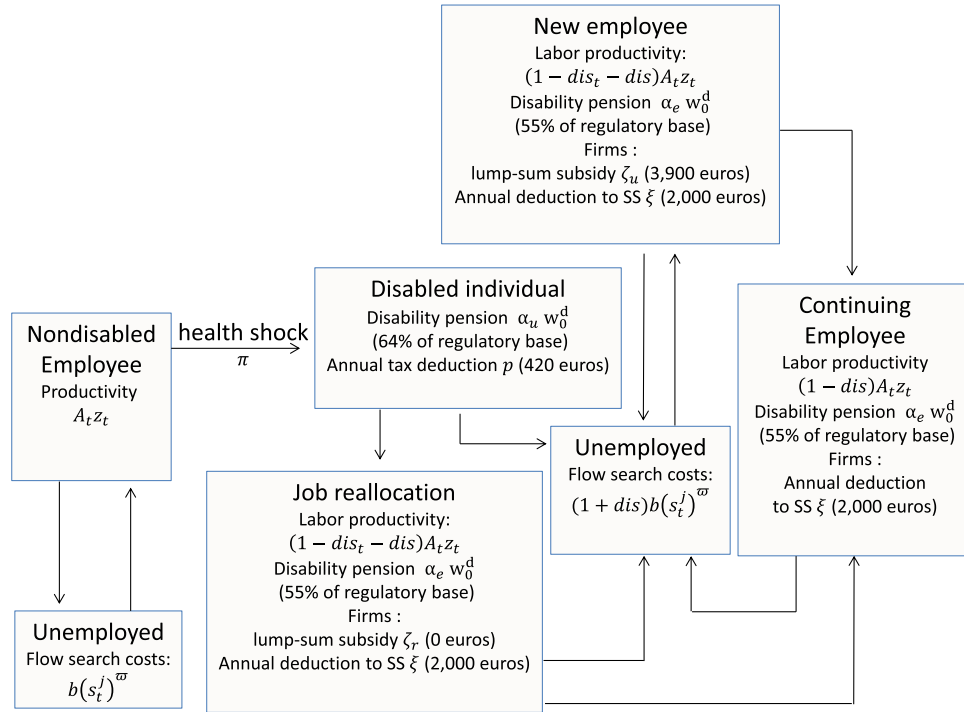


Fig. 5. The events of the model.

4.2. The events of the model

The events of the model are summarized in Fig. 5 and can be described as follows. At the beginning of each period a nondisabled employee receives a health shock, π , becomes partially disabled, and receives an annual tax deduction of p if he works. He also receives disability benefits, $\alpha_e w_0^d$, if he is employed or, $\alpha_u w_0^d$, if he is unemployed. The newly disabled employee faces the possibility of being reallocated to a different job position inside the firm. This will happen if the worker's productivity is sufficiently high and, consequently, the job position generates a positive surplus. If the firm reallocates the worker, it receives the lump-sum subsidy, ζ_r , and an annual social security deduction, ξ . In contrast, if the worker is not reallocated in the firm, he becomes unemployed. All newly disabled positions have an aggregate productivity gap, $(1 - dis - dis_s)$, with respect to nondisabled positions. In case of disagreement, the firm opens a new vacancy that may be filled by either a disabled or a nondisabled worker. In turn, a partially disabled unemployed worker incurs job search costs that increase linearly with the degree of disability, dis . Then, this unemployed worker will meet with a firm and a new employment relationship will be created if the worker's net productivity generates a positive surplus. The job meeting process between firms and disabled workers depends on both the relative number of disabled workers looking for jobs and their search intensity level. If an unemployed disabled worker fills the new vacancy, the firm will receive a lump-sum subsidy, ζ_u , and an annual social security deduction, ξ . One period after the match, the newly disabled workers become incumbents. In this case, firms only receive, ξ , and, due to a job-learning process, the temporary component of the productivity gap disappears, $dis_s = 0$.

Finally, at the beginning of each period, an idiosyncratic productivity is drawn from an accumulative distribution $G(z)$, implying that a job will be endogenously destroyed if the idiosyncratic productivity is not high enough to generate a positive surplus. When this happens in permanent or continuing positions, the firm incur in firing tax costs γ_c^j .

4.3. The equations of the model

In this section, we present the equations that characterize the

model. There is a time-consuming and costly random matching process between unemployed workers and job vacancies. As in Den Haan et al. (2000), we assume that the meeting function takes the following form:

$$m(s_t u_t, v_t) = \frac{s_t u_t v_t}{(s_t u_t^{\theta} + v_t^{\theta})^{1/\theta}}, \quad (1)$$

where u_t denotes the unemployment rate, v_t are vacancies, and s_t defines the average job search intensity. Each period an unemployed individual meets a firm with probability, $\lambda_t^j = s_t^j \frac{m(s_t u_t, v_t)}{s_t u_t}$. Since there is no search intensity for firms, they meet an unemployed worker with probability $q_t = \frac{m(s_t u_t, v_t)}{v_t}$.

We assume that there is free entry for firms. Hence, firms create vacancies until the expected value of doing so becomes zero. Therefore, in equilibrium the value of a vacancy, V_t , is equal to zero:

$$V_t = 0. \quad (2)$$

The Bellman equations characterizing the firms' behavior are: the value of the filled new and continuing positions with a nondisabled worker, $J_{u,t}^n(z_t)$ and $J_{c,t}^n(z_t)$, the new job position with the disabled worker remaining in the same firm, $J_{r,t}^d(z_t)$, the new disabled position with a worker coming from the unemployed, $J_{u,t}^d(z_t)$, and the position with a disabled employee in a continuing job, $J_{c,t}^d(z_t)$.

$$J_{u,t}^n(z_t) = A_t z_t - w_{u,t}^n(z_t) + (1 - \varphi)\beta E_t \left\{ (1 - \pi) \left[\int_{z_{c,t+1}^n}^z J_{c,t+1}^n(z) dG(z) \right] + \pi \int_{z_{r,t+1}^d}^z J_{r,t+1}^d(z) dG(z) \right\}, \quad (3)$$

$$J_{c,t}^n(z_t) = A_t z_t - w_{c,t}^n(z_t) + (1 - \varphi)\beta E_t \left\{ (1 - \pi) \left[\int_{z_{c,t+1}^n}^z J_{c,t+1}^n(z) dG(z) - G(z_{c,t+1}^n) \gamma_c^n \right] + \pi \int_{z_{r,t+1}^d}^z J_{r,t+1}^d(z) dG(z) \right\}, \quad (4)$$

$$J_{u,t}^d(z_t) = (1 - dis - dis_r)A_t z_t - w_{u,t}^d(z_t) + \zeta_u + \xi + (1 - \varphi)(1 - \rho)\beta E_t \left[\int_{z_{c,t+1}^d}^z J_{c,t+1}^d(z) dG(z) \right], \quad (5)$$

$$J_{r,t}^d(z_t) = (1 - dis - dis_r)A_t z_t - w_{r,t}^d(z_t) + \zeta_r + \xi + (1 - \varphi)(1 - \rho)\beta E_t \left[\int_{z_{c,t+1}^d}^z J_{c,t+1}^d(z) dG(z) \right], \quad (6)$$

$$J_{c,t}^d(z_t) = (1 - dis)A_t z_t - w_{c,t}^d(z_t) + \xi + (1 - \varphi)(1 - \rho)\beta E_t \times \left[\int_{z_{c,t+1}^d}^z J_{c,t+1}^d(z) dG(z) - G(z_{c,t+1}^d) \gamma_c^d \right], \quad (7)$$

where E_t is the expectation operator and $\tilde{z}_c^n, \tilde{z}_r^d$ and \tilde{z}_c^d are productivity thresholds defined such that nonprofitable matches (i.e., with negative surplus) are severed.

New hires are determined according to the expected value of a contact with an unemployed worker. This value is the average of the expected hiring values of disabled and nondisabled unemployed workers. Thus, it depends on the effective job search share of disabled and nondisabled individuals, $\delta_t^j = \frac{s_t^j u_t^j}{s_t^n u_t^n + s_t^d u_t^d}$. The average expected value of a new filled position is equal to

$$\frac{\kappa}{q_t} = \beta E_t \left\{ \delta_t^n \int_{z_{u,t+1}^n}^z J_{u,t+1}^n(z) dG(z) + \delta_t^d \int_{z_{u,t+1}^d}^z J_{u,t+1}^d(z) dG(z) \right\}. \quad (8)$$

According to Eq. (8), in equilibrium, the average expected value of a new filled position is equal to the hiring costs, $\frac{\kappa}{q_t}$. The conditions defining the thresholds for job creation and destruction are

$$J_{u,t}^n(\tilde{z}_{u,t}^n) = 0, \quad (9)$$

$$J_{c,t}^n(\tilde{z}_{c,t}^n) + \gamma_c^n = 0, \quad (10)$$

$$J_{r,t}^d(\tilde{z}_{r,t}^d) = 0, \quad (11)$$

$$J_{u,t}^d(\tilde{z}_{u,t}^d) = 0, \quad (12)$$

$$J_{c,t}^d(\tilde{z}_{c,t}^d) + \gamma_c^d = 0. \quad (13)$$

The first two expressions, (9) and (10), captures the job creation and job destruction condition for a nondisabled individual, respectively. Expression (11) is the job reallocation condition for the disabled worker that remains in the same firm. In turn, expression (12) is the job creation condition for a disabled worker coming from among the unemployed. Finally, expression (13) is the job destruction condition for each disabled employee in a continuing job position. The job destruction conditions in continuing positions (10) and (13) include firing costs for both nondisabled, γ_c^n , and disabled workers, γ_c^d . Finally, and according to the Spanish Disability System, if a new disabled individual is not reallocated in a different job position, the firm does not have to pay firing costs because the status of the worker has changed from nondisabled to permanent disabled.

From the worker's perspective, the values of being unemployed, U_t^j , and employed, $W_{i,t}^j(z_t)$, are

$$U_t^n = b - b(s_t^n)^{\bar{m}} + \pi\beta E_t U_{t+1}^n + (1 - \pi) \beta E_t \left\{ \lambda_t^n \left[\int_{z_{u,t+1}^n}^z W_{u,t+1}^n(z) dG(z) + G(z_{u,t+1}^n) U_{t+1}^n \right] + (1 - \lambda_t^n) U_{t+1}^n \right\}, \quad (14)$$

$$U_t^d = b - b(1 + dis)(s_t^d)^{\bar{m}} + \alpha_u w_0^d + (1 - \rho) \beta E_t \left\{ \lambda_t^d \left[\int_{z_{u,t+1}^d}^z W_{u,t+1}^d(z) dG(z) + G(z_{u,t+1}^d) U_{t+1}^d \right] + (1 - \lambda_t^d) U_{t+1}^d \right\}, \quad (15)$$

$$W_{u,t}^n(z_t) = w_{u,t}^n(z_t) + (1 - \pi)\beta E_t \left\{ (1 - \varphi) \left(\int_{z_{c,t+1}^n}^z W_{c,t+1}^n(z) dG(z) + G(z_{c,t+1}^n) U_{t+1}^n \right) + \varphi U_{t+1}^n \right\} + \pi\beta E_t \left[\left(\int_{z_{r,t+1}^d}^z W_{r,t+1}^d(z) dG(z) \right) + G(z_{r,t+1}^d) U_{t+1}^d \right], \quad (16)$$

$$W_{c,t}^n(z_t) = w_{c,t}^n(z_t) + (1 - \pi)\beta E_t \left\{ (1 - \varphi) \left(\int_{z_{c,t+1}^n}^z W_{c,t+1}^n(z) dG(z) + G(z_{c,t+1}^n) U_{t+1}^n \right) + \varphi U_{t+1}^n \right\} + \pi\beta E_t \left[\left(\int_{z_{r,t+1}^d}^z W_{r,t+1}^d(z) dG(z) \right) + G(z_{r,t+1}^d) U_{t+1}^d \right], \quad (17)$$

$$W_{u,t}^d(z_t) = \alpha_e w_0^d + w_{u,t}^d(z_t) + p + (1 - \rho)\beta E_t \left\{ (1 - \varphi) \left(\int_{z_{c,t+1}^d}^z W_{c,t+1}^d(z) dG(z) + G(z_{c,t+1}^d) U_{t+1}^d \right) + \varphi U_{t+1}^d \right\}, \quad (18)$$

$$W_{r,t}^d(z_t) = \alpha_e w_0^d + w_{r,t}^d(z_t) + p + (1 - \rho)\beta E_t \left\{ (1 - \varphi) \left(\int_{z_{c,t+1}^d}^z W_{c,t+1}^d(z) dG(z) + G(z_{c,t+1}^d) U_{t+1}^d \right) + \varphi U_{t+1}^d \right\}, \quad (19)$$

$$W_{c,t}^d(z_t) = \alpha_e w_0^d + w_{c,t}^d(z_t) + p + (1 - \rho)\beta E_t \left\{ (1 - \varphi) \left(\int_{z_{c,t+1}^d}^z W_{c,t+1}^d(z) dG(z) + G(z_{c,t+1}^d) U_{t+1}^d \right) + \varphi U_{t+1}^d \right\} \quad (20)$$

Unemployed nondisabled and disabled workers find jobs with the following probabilities:

$$f_t^n = (1 - \pi)\lambda_t^n [1 - G(\tilde{z}_{u,t+1}^n)], \quad (21)$$

$$f_t^d = (1 - \rho)\lambda_t^d [1 - G(\tilde{z}_{u,t+1}^d)]. \quad (22)$$

Moreover, it follows that nondisabled and disabled workers shift from employment to unemployment with probabilities

$$\psi_t^n = (1 - \pi)[\varphi + (1 - \varphi)G(\tilde{z}_{c,t+1}^n)], \quad (23)$$

$$\psi_t^d = (1 - \rho)[\varphi + (1 - \varphi)G(\tilde{z}_{c,t+1}^d)]. \quad (24)$$

In turn, the reallocation and non-reallocation rates for newly disabled employees are

$$\chi_{r,t}^d = (1 - \rho)\pi [1 - G(\tilde{z}_{r,t+1}^d)], \quad (25)$$

$$\chi_{u,t}^d = (1 - \rho)\pi G(\tilde{z}_{r,t+1}^d). \quad (26)$$

Notice that the survival rate inside the firm for newly disabled workers is just $q_{r,t}^d = [1 - G(\tilde{z}_{r,t+1}^d)]$.

Neither workers nor employers can instantaneously find an alternative match partner in the labor market. Because hiring and firing decisions are costly, a match surplus exists. To divide this surplus we assume wages to be the result of bilateral Nash bargaining between workers and firms. They are revised periodically when new shocks occur, and the Nash solution is the wage that maximizes the weighted product of the workers' and the firms' net return from the job matches. The first-order conditions for the disabled and nondisabled employees yield the following four equations:

$$(1 - \eta)[W_{u,t}^n(z_t) - U_t^n] = \eta J_{u,t}^n(z_t), \tag{27}$$

$$(1 - \eta)[W_{c,t}^n(z_t) - U_t^n] = \eta [J_{c,t}^n(z_t) + \gamma_c^n], \tag{28}$$

$$(1 - \eta)[W_{u,t}^d(z_t) - U_t^d] = \eta J_{u,t}^d(z_t), \tag{29}$$

$$(1 - \eta)[W_{r,t}^d(z_t) - U_t^d] = \eta J_{r,t}^d(z_t), \tag{30}$$

$$(1 - \eta)[W_{c,t}^d(z_t) - U_t^d] = \eta [J_{c,t}^d(z_t) + \gamma_c^d], \tag{31}$$

where $\eta \in (0, 1)$ denotes workers' bargaining power relative to firms. The Nash condition for continuing positions display an extra term depending on γ_c^d or γ_c^n . Since firing costs are only operational in continuing job positions, they are explicitly considered in the wage negotiation conditions (28) and (31).

Finally, each type of unemployed worker chooses search intensity, s_t^j , to maximize the present-discounted value of their expected income, U_t^j , during the search process, taking the other market variables as given. Each optimal, s_t^j , satisfies

$$(1 - \pi) \frac{m(s_t u_t, v_t)}{s_t u_t} \beta E_t \left[\int_{z_{u,t+1}^n}^{\bar{z}} W_{u,t+1}^n(z) dG(z) - (1 - G(z_{u,t+1}^n)) U_{t+1}^n \right] = b \varpi (s_t^n)^{\varpi-1}, \tag{32}$$

$$(1 - \rho) \frac{m(s_t u_t, v_t)}{s_t u_t} \beta E_t \left[\int_{z_{u,t+1}^d}^{\bar{z}} W_{u,t+1}^d(z) dG(z) - (1 - G(z_{u,t+1}^d)) U_{t+1}^d \right] = b \varpi (1 + dis) (s_t^d)^{\varpi-1}. \tag{33}$$

To fully characterize the dynamics of this economy, we need to define the law of motion for unemployed and employed workers (u_t^j and e_t^j). These evolve according to the following differential equations:

$$e_t^n = e_{t-1}^n + f_t^n u_{t-1}^n - \psi_t^n e_{t-1}^n - \chi_{r,t}^d e_{t-1}^n - \chi_{u,t}^d e_{t-1}^n, \tag{34}$$

$$e_t^d = e_{t-1}^d + f_t^d u_{t-1}^d - \psi_t^d e_{t-1}^d + \chi_{r,t}^d e_{t-1}^n - \rho e_{t-1}^d, \tag{35}$$

$$u_t^n = u_{t-1}^n - f_t^n u_{t-1}^n + \psi_t^n e_{t-1}^n - \pi u_{t-1}^n, \tag{36}$$

$$u_t^d = u_{t-1}^d - f_t^d u_{t-1}^d + \psi_t^d e_{t-1}^d + \pi u_{t-1}^n + \chi_{u,t}^d e_{t-1}^n - \rho u_{t-1}^d, \tag{37}$$

$$e_t^n + e_t^d + u_t^n + u_t^d = 1, \tag{38}$$

$$u_t^n + u_t^d = u_t, \tag{39}$$

$$e_t^n + e_t^d = e_t. \tag{40}$$

5. Calibration

We calibrate the model in the steady state at annual frequency to be consistent with certain empirical Spanish labor market facts. In particular, the parameterization must match the average values of the main labor market characteristics of nondisabled individuals between 2001 and 2011. More specifically, and according to Section 3, we target an employment rate of 75.3 percent and a job separation rate of 10.1 percent. Thus, we set $e_t^{rate} = \frac{e_t^n}{e_t^n + u_t^n} = 0.753$ and $\psi^n = 0.101$. We also set the average proportion of nondisabled workers in the labor force at 97 percent. Following Silva and Vázquez-Grenno (2011), the hiring cost parameter is calibrated to match a quarterly hiring cost equivalent to 3 percent of nondisabled wages, $\frac{c}{w_c^n} = \frac{0.12}{4}$. In turn, Cervini-Plá, et al. (2016) estimate an initial wage gap of 19 percent between a new disabled and nondisabled individual, $\frac{w_c^n}{w_u^d} = 1.19$, which is similar to the 20 percent wage gap estimated by Malo and Pagan (2012). Cervini-Plá et al. (2016) also estimate a permanent wage gap of 11.4 percent, $\frac{w_c^n}{w_c^d} = 1.114$. Based on Castillo et al. (1998), the calibration also must match our target elasticity, ϵ_u , of 0.80 in the matching function with respect to unemployment. Finally, we set the sum of the effective job searching shares of disabled and nondisabled individuals to one, $\delta^n + \delta^d = 1$.

We normalize the aggregate labor productivity to one, $A = 1$. We fix the discount factor at $\beta = 0.96$, which implies a reasonable interest rate of nearly 4 percent. From the Spanish administrative database, the transition rate from nondisability to partial disability is set at 0.14 percent per year, $\pi = 0.0014$, while the exit rate for disabled individuals from disability to retirement or to total disability is 4.4 percent per year, $\rho = 0.044$.

Our next target pins down firing tax costs for the firms. We use the World Bank's Doing Business survey and its detailed study of EPL in many countries, to set average severance pay for redundancy dismissal for a worker with permanent contracts and the notice period for redundancy dismissal in Spain is equal to 15.2 and 2.1 weeks of weekly wages, respectively. Cervini-Plá et al. (2014) calculate that the firing tax component amounts to near 51.5% of severance payments. Thus, the annual firing tax component of permanent or continuing jobs amounts to $\gamma_c^j = \frac{17.3 \text{ weeks}}{52 \text{ weeks}} \times 0.515 \times w_c^j$. We do not consider a different firing tax component for disabled and nondisabled workers because, according to the Spanish EPL System, there is no distinction in the amount of the severance payments paid by the firm between disabled and nondisabled workers.

We now target the policy parameters associated with the Spanish Disability System. Fig. 5 above shows the scheme of the policy events. Individuals above 55 years of age in the partial disability scheme receive 75 percent of the regulatory base if they have difficulties find a job and 55 percent otherwise. Since around 45 percent of partially disabled individuals are older than 55, we set the average regulatory base of unemployed individuals at $\alpha_u = 0.55 \times (1 - 0.45) + 0.75 \times 0.45 = 0.64$. In contrast, the same regulatory base of 55 percent applies to all partially disabled employees. Thus, we set $\alpha_e = 0.55$.

The average wage net of tax for a partially disabled worker is 14,168 euros/year.⁹ If the individual works, he receives an income deduction net of taxes of 420 euros/year in employment income if the disability level is between 33 and 65 percent.¹⁰ This amount represents around 3 percent of the average wage for disabled workers. In turn, the average regulatory base (previous wage before becoming disabled) is set at the average wage of a nondisabled worker. Thus, we calibrate w_0^d and p to match these two targets.

In turn, firms receive a lump-sum subsidy of 3900 euros when hiring an unemployed disabled individual, which represents around 28 percent of the average annual net wage of a disabled worker. Thus, we set, ζ_u , to match this target. Since 2001, this subsidy cannot be applied to workers that have worked in the firm in the past 24 months or to workers that had ended a contract during the last 3 months. We assume that, $\zeta_r = 0$.

Firms also receive 4500 euros/year of deduction in Social Security contributions. This represents 32 percent of the net wage for a disabled individual. As before, we set, ξ , to match this target. The logarithm of the idiosyncratic productivity z is assumed to have normal distribution with mean, $\mu = 0$, and standard deviation, $\sigma = 0.2$.

Finally, the workers' bargaining power, η , the parameter of the searching costs, ϖ , the matching function parameter, ϑ , the exogenous separation probability, ϕ , the transitory disability gap, dis_t , the employment opportunity cost, b , the vacancy costs parameter, c , the income deduction, p , the permanent disability gap, dis , the lump-sum subsidy for hiring a disabled worker ζ_u , the firm's deduction to the Social Security contributions, ξ , and the regulatory base parameter, w_0^d , are calibrated to match our 12 targets, simultaneously. Table 3 summarizes the targets and the calibrated parameters in the economy.

⁹ According to Cervini-Plá et al. (2016), the gross average wage is 16,668 (1389×12). Using the OECD Tax Database, we calculate an average income tax of 15 percent.

¹⁰ Multiplying the income tax deduction of 2800 by the tax rate of 0.15 we obtain 420 euros/year.

Table 3
Annual calibrated parameters for the average spanish labor market, 2001–2011.

| Parameters | Value | Definition and Source |
|---------------------------|----------------------|---|
| A | 1.000 | Normalization of aggregate labor productivity |
| β | 0.960 | Discount factor |
| σ_w | 0.200 | Standard deviation for the distribution of $\log(z)$ |
| μ | 0.000 | Mean of the distribution of $\log(z)$ |
| b | 0.762 | The employment opportunity cost |
| θ | 0.5556 | Matching function elasticity |
| φ | 0.101 | Exogenous job exit probability |
| ρ | 0.044 | Exit rate from the labor market for disabled individuals |
| κ | 0.028 | Vacancy costs |
| p | 0.025 | The income deduction for disabled workers |
| ζ_u | 0.234 | The firm's lump-sum subsidy for hiring an unemployed worker with disability |
| ζ_r | 0.000 | The firm's lump-sum subsidy for hiring an employed worker with disability |
| α_u | 0.640 | Partial disability scheme for unemployment |
| α_e | 0.550 | Partial disability scheme for employment |
| w_0^d | 0.836 | Regulatory base for disability |
| dis | 0.476 | Permanent productivity gap |
| dis_t | 0.247 | Transitory productivity gap |
| π | 3.600 | Searching costs |
| η | 0.498 | Workers' bargaining power |
| π | 0.0014 | Transition from nondisability to partial disability |
| ξ | 0.268 | Firm's deduction to Social Security contribution |
| γ_c^j | $0.173 \times w_c^j$ | Firm's firing tax for continuing positions where $j=n,d$ |
| Targets | | |
| $\frac{e^n}{e^n + u^n}$ | 0.753 | Employment rate of nondisabled |
| ψ_t^n | 0.101 | Nondisabled job separation rate |
| $\delta^d + \delta^n$ | 1.000 | Sum of the effective job searching shares of unemployed workers |
| $\frac{e^n + u^n}{u + e}$ | 0.970 | Average proportion of nondisabled workers in the labor force |
| $\frac{c}{w_c^n}$ | 0.030 | Vacancy costs ratio |
| $\frac{w_c^n}{w_c^d}$ | 1.114 | Permanent wage gap between disabled and nondisabled workers |
| $\frac{p}{w_c^d}$ | 0.030 | Worker's subsidy ratio for disabled individuals |
| $\frac{w_0^d}{w_c^d}$ | 1.000 | Regulatory base ratio for disabled individuals |
| $\frac{\zeta_u}{w_c^d}$ | 0.280 | The firm's lump-sum subsidy ratio |
| $\frac{\xi}{w_c^d}$ | 0.320 | Firm's ratio of deduction to Social Security contribution |
| ϵ_u | 0.800 | Elasticity of the matching function |
| $\frac{w_c^n}{w_u^d}$ | 1.190 | Initial disability wage gap |

6. Steady state simulated results

Table 4 shows the benchmark simulation of the model in a steady state and compares it to average values observed in the Spanish labor market between 2001 and 2011. Since we have targeted the employment and transition rates of nondisabled employees, the simulated values are equal to the ones observed in the data. With respect to disabled workers, the benchmark simulation shows an employment rate of 22.2 percent, which is much lower than that observed for nondisabled individuals (75.3 percent). It also shows that the job finding rate for disabled workers (0.079) is significantly lower than the one observed for nondisabled individuals (0.308). The lower average job finding rate of disabled workers is due to their job search intensity rate of 0.141, which is much lower than the rate of nondisabled workers (0.463). This search intensity gap is related to the presence of both a productivity gap and higher job search costs that discourage disabled workers from looking for jobs.

The simulation also shows that when the firm and the unemployed disabled worker meet (87.7 percent of the time), a new employment

Table 4
Steady state simulated results for the spanish labor market average (2001–2011).

| Simulated results | | Simulated results | Data |
|---|----------------|-------------------|-------|
| Nondisabled employment rate | e_{rate}^n | 0.753 | 0.753 |
| Disabled employment rate | e_{rate}^d | 0.222 | 0.136 |
| Nondisabled job separation rate | ψ^n | 0.101 | 0.101 |
| Disabled job separation rate | ψ^d | 0.232 | 0.169 |
| Unsuccessful job meeting rate | $G(\zeta_u^d)$ | 0.123 | — |
| Nondisabled job finding rate | f^n | 0.308 | 0.284 |
| Disabled job finding rate | f^d | 0.079 | 0.025 |
| Employment survival rate for newly disabled | q_r^d | 0.010 | 0.048 |
| Job search intensity for nondisabled | s^n | 0.463 | — |
| Job search intensity for disabled | s^d | 0.141 | — |

relationship is created [$G(\zeta_{u,t+1}^d) = 0.123$]. Moreover, Table 4 shows that the simulated job destruction rate for continuing job disability contracts, ψ^d , amounts to 0.232, which is higher than the job destruction rate of nondisabled employees (0.101). In other words, the model suggests that although firms are willing to hire disabled unemployed individuals, the incentive to keep them in the firms falls in the following periods. This result can be explained by the presence of the lump-sum subsidy received by the firm when a new job position for the disabled is created, ζ_u .

In contrast to the firm's incentive to hire an unemployed disabled worker, the model shows that only one percent of the employees who become disabled are retained in the same firm after the disabling condition. That is, the employment survival rate for newly disabled employees is $q_{r,t}^d = 0.01$, which is lower than the one observed in the data (0.048). This low survival rate can be explained by the fact that firms do not receive a lump-sum subsidy if they decide to keep the newly disabled employee working in the firm.

Finally, although the model can help to explain the differences between disabled and nondisabled workers, notice that it slightly overestimates most of the average transition rates for the latest group of workers observed in the data, except for the case of the job survival rate for newly disabled individuals, which is lower to the observed one, q_r^d .

7. Sensitivity analysis for the level of disability and policy parameters

In this section, we present the results of a sensitivity analysis with respect to workers' characteristics and the parameters related to the Spanish Disability System. We modify some of the relevant parameters and compare the simulated results with the benchmark simulation in Table 4. In each exercise, we only modify one of the model's parameters and keep the rest unchanged. We believe that this exercise allows us to compare the sensitivity of each of the parameters included in the model and to assess the relative importance of each of them in explaining the labor market behavior of disabled workers.

7.1. Workers' characteristics

The first row of Table 5 shows that when the permanent disability gap, dis , decreases one percentage point (from 0.476 percent to 0.466 percent), the employment rate increases from 22.2 percent to 32.3 percent. According to the model, a lower level of disability increases the worker's productivity and decreases the job search costs for disabled individuals. As a result, the job destruction rate decreases from 0.232 to 0.169, while the job finding rate increases from 0.079 to 0.101. In the latest case, the increase in f^d is due to a higher job search intensity of disabled workers (from 0.141 to 0.163). Moreover, the model shows that only 3.0 percent of the meetings between the firm and the worker do not end with a new employment relationship. This simulated

Table 5
Sensitivity analysis to worker characteristics.

| Scenario | e_{rate}^d | $e_{rate}^n - e_{rate}^d$ gap | Employment | f^d | s^d | ψ^d | q_r^d | $G(\bar{z}_u^d)$ |
|------------------------------------|--------------|----------------------------------|------------|-------|-------|----------|---------|------------------|
| Benchmark scenario: | 0.222 | 0.531 | | 0.079 | 0.141 | 0.232 | 0.010 | 0.123 |
| Perm. disability ($dis = 0.466$) | 0.323 | 0.431 | | 0.101 | 0.163 | 0.169 | 0.020 | 0.030 |
| Temp. disability ($dis = 0.237$) | 0.235 | 0.519 | | 0.085 | 0.148 | 0.235 | 0.011 | 0.095 |
| No extra search costs for disabled | 0.236 | 0.518 | | 0.085 | 0.153 | 0.233 | 0.007 | 0.126 |

Table 6
Modifying the disability system (to target $e_{rate}^d = 0.322$).

| Scenario | e_{rate}^d | f^d | s^d | ψ^d | q_r^d | Total Cost | Value function | Value function | Weighted |
|---------------------|--------------|-------|-------|----------|---------|------------|----------------|----------------|----------------------------|
| | | | | | | (% y) | \bar{W}^d | U^d | Welfare ($Welfare^d$) |
| Benchmark scenario: | 0.222 | 0.079 | 0.141 | 0.232 | 0.010 | 3.03 | 100.0 | 100.0 | 100.0 |
| Workers policy | | | | | | | | | |
| $\alpha_u = 0.628$ | 0.322 | 0.100 | 0.162 | 0.169 | 0.024 | 3.07 | 100.9 | 99.3 | 100.1 |
| $\alpha_e = 0.562$ | 0.322 | 0.100 | 0.162 | 0.169 | 0.024 | 3.12 | 100.8 | 100.1 | 100.9 |
| $p = 0.0351$ | 0.322 | 0.100 | 0.162 | 0.169 | 0.024 | 3.14 | 100.8 | 100.7 | 100.9 |
| Firms policy | | | | | | | | | |
| $\xi = 0.277$ | 0.322 | 0.099 | 0.161 | 0.170 | 0.016 | 3.11 | 100.8 | 100.1 | 100.9 |
| $\zeta_r = 0.290$ | 0.314 | 0.079 | 0.141 | 0.232 | 1.000 | 3.12 | 100.0 | 100.0 | 100.5 |
| $\zeta_u = 0.414$ | 0.293 | 0.142 | 0.223 | 0.300 | 0.003 | 3.19 | 100.2 | 100.7 | 100.9 |

scenario also shows that the job survival rate in the firm for newly disabled individuals increases from 1.0 percent to 2.0 percent (Table 6).

The second row presents a scenario with a reduction of one percentage point in the temporary productivity gap, dis . In this case, the employment rate increases, but only from 22.2 to 23.5. The lower sensitivity of the employment rate with respect to the temporary gap is due to the fact that it only has a direct effect on new entry positions. Thus, when dis falls, it becomes more attractive to hire newly disabled workers than it is to keep them in the firm. As a result, the job finding rate increases in both cases but the job destruction rate only falls when the permanent disability gap is reduced.

The third row shows the scenario without extra job search costs on disabled workers with respect to nondisabled individuals. In this case, the employment rate increases from 22.2 to 23.6 percent. As in the case of a reduction in the temporary productivity gap, the employment rate of disabled employees does not show too much sensitivity to the presence of lower job search costs for this group of workers. Lower search costs increase the worker search intensity and, therefore, the job finding rate. However, it doesn't reduce the job separation rate because it doesn't improve the firm's incentive to maintain the worker in his job.

To summarize, the sensitivity analysis shows that the permanent component of the productivity gap is the most important worker characteristic to explain the employment rate gap between nondisabled and disabled employees. This result takes place because the parameter, dis , has a direct effect on both new entry and continuing job positions.

7.2. The Spanish disability system

Next, we perform a simulation to compare different policy changes that would have the same impact on the employment rate of disabled individuals. More specifically, maintaining the rest of the parameters constant, we modified each policy parameter with the objective of increasing, if possible, the employment rate of disabled workers by 10 percentage points (from 22.2 percent to around 32.2 percent). We also

compute the total cost of the policy change in terms of total income and its effects on the welfare of disabled workers. In the context of our model, the welfare of disabled individuals is given by the weighted sum of the average value functions of the employed and unemployed disabled workers.¹¹

With respect to the policy parameters that involve the worker's side of the model, we observe that the disability benefits for unemployed workers, α_u , would need to be reduced from 64.0 percent to 62.8 percent of the regulatory base in order to increase the employment rate of disabled individuals by 10 percentage points. The simulated scenario reduced the employment opportunity cost of disabled workers, increasing their job search intensity, which in turn increases their job finding rate from 0.079 to 0.100. Moreover, with lower employment opportunity costs, individuals are willing to work for a lower wage and, therefore, firms have more incentives to maintain these workers, so the job destruction rate falls from 0.232 to 0.169. With respect to the welfare implications of this policy, the welfare of disabled unemployed workers falls by 0.67 percent (from 100 to 99.3) due to a reduction in the disability benefits, $\alpha_u w_o^d$. In contrast, the welfare of employed workers, \bar{W}^d , increases by 0.09 percent because disabled employees have more job stability. Overall, total welfare increases by 0.10 percent (from 100 to 100.1). This policy change generates an increase in the total cost of the Disability System from 3.03 to 3.07 percent of total income. The increment in the total cost takes place because, although the government pays less in disability benefits per unemployed worker, the increase in the number of new and continuing employees implies that the government has to spend more money in job related policies such as the lump-sum hiring subsidies as well as the annual deduction in Social Security contributions.

A similar result in terms of employment is obtained if we increase

¹¹ Total income is equal to $y = A(1 - dis)\bar{z}^d e^d + A\bar{z}^n e^n - cv$, where $\bar{z}^j = E[z^j | z \geq \bar{z}^j]$. In turn, the weighted welfare of disabled workers is equal to $Welfare^d = \frac{e^d}{e^d + u^d} \bar{W}^d + \frac{u^d}{e^d + u^d} U^d$, where $\bar{W}^d = E[W^d | z \geq \bar{z}^d]$ is the average value function of disabled employees and U^d the value function of disabled workers looking for jobs.

the disability pensions of employed workers, α_e , from 55.0 to 56.2 percent of the regulatory base. The weighted welfare is higher in this case, with an increase of 0.9 percent with respect to the benchmark scenario. This happens because the welfare of unemployed workers does not fall. In this case, the policy change generates an extra cost of around 0.09 percentage points of total income, which is higher than the cost generated through the reduction of disability benefits of unemployed workers.

The last workers' policy parameter corresponds to the income deduction for disabled workers, p . In this case e_{rate}^d increases by 10 percentage points if we include an effective tax deduction of 588 euros/year instead of the current 420 euros/year ($\frac{p}{w_e^d}$ increases from 0.03 to 0.042). In this case, the effects and cost of this policy are similar to the one observed when α_w was increased.

From the firms' side, we first simulate the effects of increasing the firm's deduction to Social Security contribution, ξ , from 4500 to 4640 euros in order to target the new e_{rate}^d ($\frac{\xi}{w_e^d}$ increases from 0.32 to 0.33). The results are almost the same as those obtained when modifying the policy parameters from the worker's side.

We next ask what would happen if the lump-sum subsidy becomes operative not only when a firm hires a newly disabled worker but also when it reallocates an employee who becomes partially disabled, ζ_r . In this case, the maximum achievable employment rate, e_{rate}^d , is 31.4 percent. Notice that this policy only affects the job reallocation rate, q_r^d . This policy parameter will increase the employment rate until q_r^d converges to one. This happens when the subsidy reaches 34.7 percent of the disabled wage, $\zeta_r = 0.290$. Additional increments in this subsidy will have no effect on e_{rate}^d .

Finally, we simulate the effects of an increase in the government's lump-sum subsidy for newly hired disabled workers, ζ_u , from 3900 to 6825 euros ($\frac{\zeta_u}{w_e^d}$ increases from 0.28 percent to 0.49). In this case, the employment rate only increases from 22.2 percent to 29.3 percent. The relatively small impact of this policy parameter is due to the fact that the job finding and job separation rates increase in a similar magnitude. Moreover, once the probability of being hiring from unemployment becomes equal to one, additional increments in ζ_u will not affect e_{rate}^d .

Notice that the two lump-sum subsidies, ζ_u and ζ_r , generate a relatively much lower impact on the employment rate than the Social Security contribution, ξ , implying that firms are much more sensitive to hiring incentives with a permanent duration than they are to those with transitory ones. This result suggests that the two one-off policies introduce a distortion because the main objective of the firm is now to receive the subsidies as many times as possible and not to maintain the employment relationship. As a result, these policies have a much lower impact on the welfare of disabled individuals.

Overall, the simulated results show that both workers and firms are sensitive to the main policy parameters, especially when they remain operative under the different employment or job conditions. Therefore, policies should be more focused on introducing subsidies to keep disabled workers in the firm rather than to hire them. Even more important, our model shows that it is possible to increase the employment rate of disabled workers by 10 percentage points with relatively low extra cost for the system (between 0.04 and 0.16 percentage points of the total income, depending on the policy scenario). In all these scenarios, the welfare of disabled workers increases between 0.1 and 0.9 percent.

The high sensitivity of the Spanish employment rate of disabled individuals with respect to policy changes has also been pointed out by Marie and Vall-Castello (2012) and Silva and Vall-Castello (2012a). Both papers analyze what happens when the Spanish system allows partially disabled individuals to receive an increase in benefits from 55% to 75% of the regulatory base when they become older than 55 years old and do not have a job. More in detail, Marie and Vall-Castello

(2012) use a regression discontinuity approach and estimate a drop of 8 percentage points in the probability of being employed for disabled individuals who receive the increase in the benefit. In turn, Silva and Vall-Castello (2012a) estimate a complementary log-log duration model with Spanish administrative data and use age as an instrumental variable for receiving this increase in benefits and predict a large decrease in the annual hazard rate of finding a job from 0.154 to 0.019. In our model, the same policy reduces the job finding probability from 0.079 to almost zero.

8. Conclusions

In Spain there are approximately 1 million disabled individuals receiving disability benefits; around half of them are partially disabled individuals who are allowed to combine the receipt of disability benefits with a job. The country reports, however, an average employment rate of just 13.6 percent for this group of people from 2001 to 2011, which is much lower than the employment rate of 75.3 percent observed for nondisabled employees in the same period.

In this paper we analyze the incentives and disincentives to work experienced by disabled individuals in Spain. We first present a set of indicators that compare Spanish labor market behavior for partially disabled and nondisabled individuals from 2001 to 2011. We find that the job finding rate for disabled workers is much lower than the rate for nondisabled workers, while the job separation rate is higher. Moreover, the decomposition analysis of the equilibrium employment rate shows that the job finding rate explains 85 percent of the disabled employment gap. We also find that only 4.8 percent of the employees who become partially disabled continue working in the same firm after the disabling condition.

In order to understand the labor market differences observed in the data, we construct a labor market model with search intensity and matching frictions where disabled and nondisabled individuals compete for the same jobs. We also include in the model the hiring decisions made by companies and the incentives available in the legislation to hire disabled workers. We calibrate the model to match a number of stylized facts observed in the Spanish labor market.

In line with the data, our benchmark simulation shows the presence of an employment rate gap of 53.1 percentage points between nondisabled and disabled workers. The model also shows that the job finding rate for disabled workers is much lower while the job separation rate is higher than for nondisabled workers. Part of the employment rate gap observed between nondisabled and disabled workers can be explained by the presence of a job search intensity gap of 32 percentage points. These differences in search intensity are due to the presence of a productivity gap that discourages disabled workers from looking for jobs. Our benchmark scenario also shows that 87.7 percent of the times that firms and disabled workers meet, new employment relationships are created. This is due to the presence of policy incentives for employers to hire disabled workers. In other words, the model suggests that firms are willing to hire disabled individuals coming from the ranks of the unemployed. However, since disabled workers have a relatively high adjusted employment opportunity cost (due to both a lower level of productivity and the receipt of the disability benefits), they look for jobs with much less intensity and are separated from job positions with higher frequency than nondisabled individuals.

In contrast to the strong motivation to hire disabled individuals from among the unemployed, the model shows a much lower employer incentive to maintain workers in the firm when they become disabled. According to the benchmark simulation, only 1.0 percent of the employees who suffer a disabling condition are retained in the same firm because firms that decide to keep the newly disabled employee do not receive the lump-sum subsidy.

With respect to the type of policy initiatives that could be more

effective in increasing both individual incentives to work as well as an employer's incentives to hire disabled workers, the sensitivity analysis shows that the employment rate of disabled individuals can be increased by 10 percentage points (from 22.2 percent to around 32.2 percent) when employing the following policy parameter modifications: 1) reducing the disability benefits of unemployed individuals (from 64 to 62.8 percent); 2) increasing the disability benefits of employed individuals (from 55 to 56.2 percent); 3) increasing the deductions to the Social Security contributions paid by the employer (by an extra deduction of 168 euros/year); or 4) increasing the tax deductions for disabled workers (by 140 euros/year). However, the first of these policies, although relatively cheaper for the government than the other three, implies a welfare loss for unemployed disabled workers.

In contrast, the model shows that one-time lump-sum subsidies have a much lower impact on increasing the employment rate of disabled individuals. This result is important because it suggests that, since the disability condition is permanent, policies should be more focused on introducing subsidies to keep disabled workers in the firm rather than on hiring them. In fact, our simulated scenarios show that the one-off policies are distortionary because they increase the firm's incentive to generate a high job turnover rate among disabled workers in order to receive these subsidies as many times as possible.

We believe our results to be important because, to the best of our knowledge, they are the first to provide a quantitative analysis of the causes of the observed employment gap between disabled and non-disabled workers as well as an estimation of the potential costs and welfare effects that would be needed to reduce this employment gap.

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