Evaluating the effect of regulated severance payments on employment, wages and productivity

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Abstract

This paper presents an equilibrium model of the labor market where it is possible to evaluate different effects of regulated severance payments. The model takes into account two important features of this regulation in most countries, i.e., they are transfers from firms two workers, and depend on worker's tenure. We show that Lazear's (1990) result on the neutrality of severance payments with respect to productivity, employment and job turnover holds in this equilibrium context. However, we also show that the existence of downward wage rigidity eliminates this neutrality. We estimate this model using micro data on labor market transitions and wages for Spain.

1 Introduction

During the 1980s and 1990s some European and Latin-American countries implemented labor market reforms which reduced their regulated severance payments. For most of these countries OECD has included this type of reforms in their recommendations of structural policies. This apparent consensus of policy makers contrasts with the scarce empirical evidence on the effects of severance payments on employment, productivity and welfare. Most of the theoretical and empirical literature on

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the effects of job security regulations has concentrated in the case of firing costs or taxes on job destruction, but not specifically on severance payments (see Bentolila and Bertola, 1990, Hopenhayn and Rogerson, 1993, Cabrales and Hopenhayn, 1997, and Alvarez and Veracierto, 1999). In these models, firing costs are taxes collected by the government or, alternatively, transaction costs. Taxes on firing are very uncommon in most countries, and the effects of this regulation can be different to the ones associated with mandated severance payments. As it has been pointed out by Lazear (1990), severance payments are pure transfers from firms to workers and therefore they might be offset by an equivalent voluntary transfer from workers to employers, or by a lower initial wage.

In this context, one of the objectives of this paper is to present a framework in which it is possible to evaluate empirically the effects of regulated severance payments on employment, productivity and wages. In the construction and specification of this model we have taken into account several aspects of the problem that we consider particularly important. First, policy parameters in this model represent the actual policy parameters in most countries. Severance payments are transfers which depend on the worker's tenure and wage. In contrast to other applications, policy parameters should not be estimated from the data but they are data. Second, the predictions of the model on the tenure profiles of wages and job turnover play a crucial role in the identification of the effects of this regulation. Therefore, it is relevant to incorporate in the model other factors that may affect these profiles in a flexible way. In our model workers' productivity increases with seniority, and firms and workers have uncertainty on future aggregate and idiosyncratic shocks. These shocks make wages and job turnover depend on tenure through a selection mechanism as the one in Bull and Jovanovic (1990). Finally, the model incorporates regulated minimum wages and unions. We show that it is this downward wage rigidity what can make severance payments not neutral with respect to employment and output.

Our model builds on Mortensen and Pissarides (1994). We extend that model to incorporate general experience and tenure as state variables, idiosyncratic shocks, and individual heterogeneity in preferences and productivity. The structural parameters of this model are the productivity function, the transition probability distributions of shocks and matching qualities, firms' hiring costs and operating costs, individuals' preferences, and the relative bargaining power. We discuss in section 3 the econometric problems associated with the identification and estimation of these structural parameters using panel data on individuals labor market transitions and wages. These problems are related with two main previous literatures: the estimation of the wage and productivity effects of firm-specific experience (see Lazear and Moore, 1984, Abraham and Farber, 1987, Altonji and Shakotko, 1987, Rosen, 1988, and Topel, 1991, among others); and the large literature on the estimation of equilibrium search and matching models (see Flinn and Heckman, 1982, Miller, 1984, Jovanovic and Moffit, 1990, Eckstein and Wolpin, 1990, van der Berg 1997, 1998, among others).

In our model, wage-tenure profiles are the result of four different factors: (1) productivity effect, i.e., productivity may increase with tenure; (2) severance payments effect, i.e., these payments, which increase with tenure, can be partly or totally transmitted to wages; (3) selection effect, i.e., high quality matches tend to survive longer than low quality matches; and (4) reversion to the mean effect, i.e., workers tend to be hired when a firm has a positive idiosyncratic shock, but this shock tends to return to its mean value. Using only information on wages and individual characteristics it is not possible to identify separately these effects, unless strong and not plausible restrictions are imposed. Instead, our estimation method exploits information on individuals' labor market transitions and wages.

We estimate the model using Spanish micro data on labor market transitions and wages. High unemployment rates, strong regulation on workers' dismissal, and significant reforms on severance payments during the eighties and nineties have made the Spanish case a particularly interesting one.

The rest of this paper is organized as follows. Section 2 presents the model. In Section 3 we discuss several econometric issues and describe our estimation method. Section 4 describes the data. Preliminary empirical results are presented in Section 5. We summarize our results and conclude in Section 6.

2 Model

In this section we present a labor market equilibrium model that combines features of matching models like Jovanovic (1979) and Bull and Jovanovic (1988), and equilibrium models with job turnover as Hopenhayn (1992), Hopenhayn and Rogerson (1993), and Mortensen and Pissarides (1994). The structure of the model is similar to the one in Mortensen and Pissarides, but we extend that model to incorporate returns to general and firm-specific experience and individual heterogeneity. These extensions are motivated by our objective to bring the model to actual data and to study regulated severance payments (which depend on workers' seniority). The model provides a theoretical framework where it is possible to evaluate different effects of severance payments in equilibrium. The results in this section extend the ones in Lazear (1990) to an equilibrium context where there is not commitment between workers and firms. Furthermore, the solution of the model provides probability distributions of wages and labor market transitions conditional to experience and individual characteristics which can be used to estimate the primitives of the model. We study the identification of the structural parameters in section 3.

2.1 Laissez faire economy

We start describing the economy without mandated severance payments, minimum wages and unions. There is a continuum of risk neutral individuals and firms that operate in the same labor market. Time is discrete. In principle, firms can live infinitely, but they may endogenously decide to liquidate. Individuals retire at age R and have a constant probability of dying after retirement. Every period a new cohort of individuals is born, such that the population is constant. The model is not of general equilibrium. For instance, the interest rate is exogenous and therefore consumption decisions of retirees do not have any incidence on our labor market equilibrium. We start with a version of the model where all individuals are ex-ante identical and there are not aggregate shocks. The economy is always in a steady-state equilibrium, but there is job creation and destruction, and workers accumulate specific and general experience.

Individuals: They maximize their expected lifetime utility, that depends on earnings and leisure (non market time):

$$E\left[\sum_{t=0}^{R-a} \beta^t u(y_t, h_t)\right] = E\left[\sum_{t=0}^{R-a} \beta^t (y_t + h_t)\right] \quad (1)$$

where a is age; β is the discount rate; y represents earnings and h is leisure. If working, the individual's earnings are equal to her wage and leisure is zero. If the individual is unemployed $y + h = b$. An unemployed individual receives a job offer with probability $q_u \equiv M/U$, where M represents total new matches in the economy and U is the number of unemployed workers. This probability is endogenous at the aggregate level. Employed individuals receive a job offer from her current firm, but there is not on-the-job search. A job offer is characterized by a vector (w, θ, ε), where w is the wage rate, θ is the quality of the match, and ε is a time-variant job specific shock. Match qualities are drawn from a cumulative distribution $G(\theta)$, with support $[1, \infty)$, and they are $i.i.d$ over matches and constant over the duration of the match. Idiosyncratic shocks follow a first order Markov process with transition distribution function $F(\varepsilon'; \varepsilon)$ where ε' is next period shock. There are no aggregate shocks, and F^* is the steady-state distribution of shocks.

Firms and jobs: The notion of a firm in this model is very simple. Firms produce a homogeneous good using a constant returns to scale technology. The productivity shock ε is job specific. Therefore, a firm is just a set of jobs, each one with its own productivity shock and match quality.[1] In a job with shock ε, a worker produces output

$$\theta \; \varepsilon \; \mu(x_g, x_s), \quad (2)$$

where x_g is worker's general experience; x_s represents firm specific experience; and the function $\mu(.)$ is monotonically increasing in both arguments. A worker needs equipment to be productive. The firm rents this equipment and pays a renting price c_f. To create a new job a firm has to place a vacancy. The cost per period of placing a vacancy (in units of output) is c_H. Firms decide to place vacancies at the

[1] It would be equivalent to assume that each firm employs only one worker. However, we have preferred to distinguish between a *job* and a *firm* because we do not want to identify job creation and destruction with firms' entry and exit.

beginning of the period, before they know the job specific shock. Placing a vacancy and paying the corresponding cost does not guarantee to find a worker. For any firm, the (endogenous) probability of finding a worker is $q_v \equiv M/V$, where V represents the total number of vacancies in the economy.

Wages: Wage offers are the result of a Nash bargaining process between the individual and the firm. That is, wages are convex linear combinations of the reservation wage of the individual and the willingness to pay of the firm. For the moment, we consider that a wage offer is a function of match quality, productivity shock, workers experience and age:

$$Wage\ offer = w(\theta, \varepsilon, x_g, x_s, a) \tag{3}$$

Matching technology: New matches depend on unemployment and vacancies according to the matching technology $M = M(V, U)$. This matching function is homogeneous of degree one, monotonically increasing in both arguments, and $M(V, U) \leq \min\{V, U\}$. According to this function, the probability that an unemployed worker finds a firm is $q_u = M(V/U, 1)$. For a firm that placed a vacancy, the probability of finding a worker is $q_v = M(1, U/V)$. Therefore, the matching technology implies a relationship between the probabilities q_u and q_v:

$$q_v = Q(q_u) \tag{4}$$

where $Q'(q_u) < 0$. We show below that the function $Q(.)$ contains all the information in the matching technology that is necessary to obtain the equilibrium of the model.

For the sake of notational simplicity, we omit in this section the quality of the match θ as an argument.

2.1.1 Individuals' problem

Consider an individual, employed or unemployed, who receives a job offer (w, ε) and decides to work or not. The value function of that individual is::

$$U(w, \varepsilon, x_g, x_s, a) = \max\{b + \beta\ EU^u(x_g, a+1)\ ;\ w + \beta\ EU^e(\varepsilon, x_g+1, x_s+1, a+1)\} \tag{5}$$

where $EU^u(x_g, a)$ is the expected future value of an unemployed worker with age a and general experience x_g; and $EU^e(\varepsilon, x_g, x_s, a)$ is the expected future value of an employed worker. The optimal decision has a reservation wage structure where the reservation wage is:

$$r(\varepsilon, x_g, x_s, a) = b + \beta \left[EU^u(x_g, a+1) - EU^e(\varepsilon, x_g+1, x_s+1, a+1) \right] \tag{6}$$

Given this reservation wage and the definitions of EU^u and EU^e, we can derive the following expressions: for $a = R$, $EU^u = EU^e = 0$; and for $a < R$,

$$\begin{aligned} EU^u(x_g, a) &= b + \beta \; EU^u(x_g, a+1) \\ &\quad + q_u \int \max\{0 \; ; \; w(\varepsilon', x_g, 0, a) - r(\varepsilon', x_g, 0, a)\} \; dF^*(\varepsilon'), \end{aligned} \tag{7}$$

and

$$\begin{aligned} EU^e(\varepsilon, x_g, x_s, a) &= b + \beta \; EU^u(x_g, a+1) \\ &\quad + \int \max\{0 \; ; \; w(\varepsilon', x_g, x_s, a) - r(\varepsilon', x_g, x_s, a)\} \; dF(\varepsilon'; \varepsilon) \end{aligned} \tag{8}$$

Notice that theses values depend on the wage offers function, $w(.)$, that is endogenous and results from the equilibrium of the model.

2.1.2 Firms' problem

A firm decides to continue or not its current matches, and wether to place vacancies. Consider first the decision of continuation of an existing match with characteristics $(\varepsilon, x_g, x_s, a)$. The value of this match for the firm is:

$$V(w, \varepsilon, x_g, x_s, a) = \max\{0 \; ; \; \varepsilon \; \mu(x_g, x_s) - w - c_f + \beta \; EV(\varepsilon, x_g+1, x_s+1, a+1)\} \tag{9}$$

where the value of a vacant job is zero (see below); and $EV(\varepsilon, x_g, x_s, a)$ is the expected future value of the match for the firm. Therefore, the willingness to pay of a firm is:

$$v(\varepsilon, x_g, x_s, a) = \varepsilon \; \mu(x_g, x_s) - c_f + \beta \; EV(\varepsilon, x_g+1, x_s+1, a+1) \tag{10}$$

Taking in to account this willingness to pay and the definition of $EV(.)$, we can obtain that, for $a = R$ $EV = 0$, and for $a < R$

$$EV(\varepsilon, x_g, x_s, a) = \int \max\{0 \; ; \; v(\varepsilon', x_g, x_s, a) - w(\varepsilon', x_g, x_s, a)\} \; dF(\varepsilon'; \varepsilon) \tag{11}$$

Now, we consider the decision of placing a vacancy. Firms place new vacancies until the expected discounted profit of a vacancy is zero, i.e., until all rents are exhausted.

$$q_v V^e - c_H = 0 \tag{12}$$

where:

$$V^e = \sum_{x_g} \sum_{a} \left(\int V(w[\varepsilon, x_g, 0, a], \varepsilon, x_g, 0, a) \; dF^*(\varepsilon) \right) \pi^u_{aX_g}(a, x_g) \tag{13}$$

where $\pi^u_{aX_g}(.,.)$ is the joint probability distribution of age and general experience in the population of unemployed workers, which is endogenous. Notice that a firm knows the job specific shock, quality of the match, age and experience only when he meets the worker, but not when placing a vacancy. Furthermore, placing a vacancy does not guarantee job creation. There is a probability $1 - q_v > 0$ of not finding a worker.

2.1.3 Wage setting and optimal decisions of job creation and job destruction

Wages are the result of a Nash bargaining process between the individual and the firm. That is, wages are convex linear combinations of the reservation wage of the individual and the willingness to pay of the firm.

$$w(\varepsilon, x_g, x_s, a) = \alpha \; v(\varepsilon, x_g, x_s, a) + (1 - \alpha) \; r(\varepsilon, x_g, x_s, a) \tag{14}$$

where $\alpha \in (0, 1)$ represents the worker's bargaining power. The condition for the continuation of a match, and for the creation of a new match, is that the reservation wage is lower or equal than the willingness to pay. Define the *total surplus of a match*, $s(.)$, as the difference between the willingness to pay of the firm and the reservation wage of the individual. Therefore, a new job is created or an existing job is not destroyed if:

$$s(\varepsilon, x_g, x_s, a) \equiv v(\varepsilon, x_g, x_s, a) - r(\varepsilon, x_g, x_s, a) \geq 0 \tag{15}$$

2.1.4 Equilibrium

Definition: An equilibrium in this model is a scalar $q_u^* \in [0, 1]$ and functions $\{EU^u$, EU^e, EV, v, r, w, s, $\pi^u_{aX_g}\}$ such that the following conditions hold:

(i) the functional equations that characterize the optimal behavior of individuals: equations [6], [7] and [8];

(ii) the functional equations that characterize the optimal behavior of firms: equations [10], [11] and [13];

(iii) the equilibrium condition for the amount of vacancies: equation [12];

(iv) the wage bargaining solution: equation [14];

(v) the job creation/destruction condition: equation [15];

(vi) the system of equations that defines the steady state distribution of age and general experience for unemployed workers, $\pi^u_{aX_g}$ (see Appendix);

(vii) the relationship between the probabilities q_u and q_v implied by the matching technology: equation [4].

However, all these conditions can be summarized in three mappings. First, the expected value functions, reservation wage, willingness to pay and wage offer function can be written in terms of the surplus function.[2] If we combine these expressions we obtain the following functional equation that defines implicitly the surplus function: for $a = R$, $s = 0$, and for $a < R$,

$$\begin{aligned} s(\varepsilon, x_g, x_s, a) &= \varepsilon\ \mu(x_g, x_s) - c_f - b \\ &+ \beta \int \max\{0\ ;\ s(\varepsilon', x_g + 1, x_s + 1, a + 1)\}\ dF(\varepsilon'; \varepsilon) \\ &- \beta\alpha q_u \int \max\{0\ ;\ s(\varepsilon', x_g, 0, a + 1)\}\ dF^*(\varepsilon') \end{aligned} \tag{16}$$

Notice that this mapping depends on the endogenous probability q_u. In order to emphasize this dependence we incorporate the probability q_u as an argument in the surplus function, i.e., $s(\varepsilon, x_g, x_s, a; q_u)$.

Second, we show in Appendix A that given the surplus function, it is possible to obtain the steady-state distribution of age and general experience over unemployed workers, $\pi^u_{aX_g}$. We denote this mapping by:

$$\pi^u_{aX_g}(q_u) = \Pi[S(q_u); q_u] \tag{17}$$

[2] Notice that $w - r = \alpha s$ and $v - w = (1 - \alpha)s$. Therefore, EU^u, EU^e and EV can be written in terms of the surplus function. The reservation wage and the willingness to pay are functions of these expected values, and therefore they can be also obtained once we know the surplus. Finally, by the Nash bargaining solution, we can obtain the wage offer function in terms of the surplus.

where $S(q_u) = \{s(\varepsilon, x_g, x_s, a; q_u) : \textit{for any } (\varepsilon, x_g, x_s, a)\}$. Finally, the equilibrium entry condition is:

$$Q(q_u) = \frac{c_H}{V^e(q_u)} \tag{18}$$

where taking into account the definition of V^e it is simple to verify that

$$V^e(q_u) = (1-\alpha) \sum_{x_g} \sum_a \left(\int \max\{0; s(\varepsilon, x_g, 0, a; q_u)\} \, dF^*(\varepsilon) \right) \pi^u_{aX_g}(a, x_g; q_u) \tag{19}$$

Proposition 1 defines the equilibrium taking into account the previous results. Proposition 2 establishes the existence and uniqueness of this equilibrium. The proofs are in Appendix A.

Proposition 1:
An equilibrium in the laisez-faire economy is a value $q_u^* \in [0,1]$ *such that equations (16), (17) and (18) hold.*

Proposition 2:
The equilibrium defined by equations (16) to (18) exits and is unique.

2.1.5 Time-invariant individual characteristics

It is straightforward to extend the model to allow for time-invariant individual characteristics that affect productivity or/and the utility of being unemployed. Let z be a vector of time-invariant characteristics, such that both b and μ depend on z. Therefore, the social surplus is now a function $s(\varepsilon, x_g, x_s, a, z)$. The fixed point problem for the surplus does not change, except for the fact that now we have a different surplus for each value of z. The equilibrium entry condition is still (18), where now we have the probabilities $\pi^u_{aX_gZ}(a, x_g, z; q_u)$ which represent the steady state distribution of age, experience and time invariant characteristics over unemployed workers.

2.2 Model with severance payments

The terms *dismissal* and *voluntary quit* are based on the premise that only one of the parts, the worker or the firm, is willing to break the match. The implicit assumption behind these definitions is that the wage of an individual worker (or other forms of compensation) cannot be adjusted above or below certain levels. In other words, the concepts *dismissal* and *voluntary quit* do not have any content in an economy with perfect wage flexibility at the individual level. That is the case in the previous model for a *laissez faire* economy. In subsection 2.2.1 we study the effects of severance payments in an economy with perfect wage flexibility. This analysis should be understood just as a theoretical exercise. Regulated severances are paid only upon dismissal, but not upon voluntary quits. In the model without wage rigidity there is not distinction between these two types of separations, and therefore we consider that severances are paid under separation. The introduction of downward wage rigidity in subsection 2.2.2 allows us to distinguish between dismissals and voluntary quits. It is in that version of the model where we consider that severance payments are paid only upon dismissal.

2.2.1 Severance payments with wage flexibility

Consider that if there is a separation the firm should pay the worker a mandated severance payment which depends on worker's tenure. The typical regulation establishes that severance payments should be a certain amount of the annual salary per year worked. For instance, in Spain it is 45 days of salary per year worked, which is a very similar magnitude to the ones in France, Italy and Portugal. The "salary" that should be used to calculate the severance payment is sometimes the worker's current salary, but in other cases it can be the salary determined in a collective wage negotiation at the industry or firm level. Here, we consider that the severance payment schedule has the following form:

$$SP(x_s) = w_0 \; \tau \; \max\{0, x_s - x_{s0}\}$$

where w_0, τ, and x_{s0} are policy parameters.

Proposition 3:

In this model, mandated severance payments do not have any effect on employment, job turnover and output. However, severance payments are transmitted to wages, such *that:*

$$\begin{aligned} For\ a &= R : w_{SP}(\varepsilon, x_g, x_s, R) = \tau(x_s) + w_{NSP}(\varepsilon, x_g, x_s, R) \\ For\ a &< R : w_{SP}(\varepsilon, x_g, x_s, a) = \tau(x_s) - \beta\tau(x_s+1) + w_{NSP}(\varepsilon, x_g, x_s, a) \end{aligned} \tag{20}$$

where $w_{SP}(.)$ *and* $w_{NSP}(.)$ *are the wage functions with and without severance payments, respectively.*

Proposition 3 shows that, in the absence of any form of wage rigidity, severance payments increase by the same amount individuals' reservation wage and firms' willingness to pay, such that the surplus does not change. Since, in this model without wage rigidities, the condition for the continuation of a match only depends on the surplus, we have that job turnover, employment, and output are not affected by severance payments. This idea was previously pointed out by Lazear (1990) in the context of a two period partial equilibrium model, where there was commitment between workers and firms to implement an optimal contract. Proposition 3 extends this result to a dynamic equilibrium context, and shows that this optimal contract can be decentralized.

In Figure 1 we present the probability of job continuation, distribution of tenure, unemployment, and tenure wage profile from a numerical solution of this model. We can see how the severance payment increases the slope of the tenure wage profile and generates a discontinuity at the level of tenure for which a worker starts to be entitled to severance payments.

An issue that we do not incorporate explicitly in our model is how firms accumulate funds to pay future severances. Here we discuss this briefly. Assume that, under regulated severance payments firms distribute only part of their profits. More specifically, for a surviving match with characteristics $\{\varepsilon, x_g, x_s, a\}$ the firm accumulates funds by an amount $p_D(\varepsilon, x_g+1, x_s+1, a+1)\{\tau(x_s+1) - \tau(x_s)\}$, where p_D is the probability of dismissal at next period. If firms are large enough, we can apply the law of large numbers to show that this rule of thumb guarantees that a firm will always have enough funds to pay severances. Notice that the reduction in distributed profits does not have any effect on individuals labor market decisions due to the linearity of the utility function.

2.2.2 Severance payments with downward wage rigidity

Wages are not always the result of wage bargaining at the level of individual workers. Collective wage bargaining at the firm, industry or regional level is a common labor market institution in many countries. These collective agreements impose minimum thresholds for the wage negotiations at the individual level. A regulated minimum wage is another example of this type of downward wage rigidity. In the context of our model, the existence of a minimum threshold for accepted wages will have effects on job turnover and on the rest of endogenous variables. Now, there may be separations even if the total surplus of a match is positive.

Consider that there is a minimum wage m that is imposed to the firm from a regulation or a collective wage agreement. The value of m is exogenous in our model. We define a *dismissal* as a separation with a severance payment, and a *voluntary quit* as a separation without severances. Now, the reservation wage of the individual and the willingness to pay of the firm are different if the alternative to the continuation of a match is a dismissal or a quit. Let $r(.)$ and $v(.)$ be these functions in the case of a quit. It is simple to verify that these functions in the case of a dismissal are $r(.) + SP(x_s)$ and $v(.) + SP(x_s)$, respectively. Notice that in both cases the surplus of the match is the same, i.e., $s = v - r$. If the surplus is negative there is no possibility of continuation of the match, i.e., any wage offer makes one of the parts worse off than in the case of separation, both if the separation is a quit or a dismissal.

The relationship between the firm's willingness to pay $v + SP$ and the minimum wage m determines wether the alternative to the continuation of the match is a voluntary quit or a dismissal.. If $v + SP \geq m$ the firm prefers to continue the match and pay the minimum wage to a dismissal (i.e., $v - m \geq -SP$). The worker cannot claim that the firm is not willing to pay m, and therefore the alternative to no separation is a voluntary quit. On the contrary, if $v + SP < m$ the firm prefers a dismissal and the consequent severance payment to continue the match and pay the minimum wage (i.e., $v - m < -SP$). The worker can claim that the firm is not willing to pay the minimum wage and the separation will be considered a dismissal.

Taking into account the previous considerations, we have four cases for the solution of the bargaining process. Figure 2 represents these possible solutions in the space (v, r).

(i) $s < 0$ *and* $v + SP < m$ *(Dismissal):* The surplus is negative and therefore there is no agreement between the two parts. Furthermore, the firm is better off with a dismissal than paying the minimum wage.

(ii) $s < 0$ *and* $v + SP \geq m$ *(Quit):* Again, there is no agreement because the surplus is negative. But now the firm is willing to pay the minimum wage to avoid a dismissal.

(iii) $s \geq 0$ *and* $v + SP < m$ *(Dismissal):* In principle, there might be an agreement because the surplus is positive. Given that $v + SP < m$ the alternative to no separation is dismissal. Therefore, the wage is the result of maximizing the Nash criterion:

$$\max_w \ln(v + SP - w) + \frac{\alpha}{1-\alpha} \ln(w - r - SP)$$

This implies a wage $w = \tau + (1 - \alpha)r + \alpha v$, that is lower than m. The firm is not willing to pay m and prefers to dismiss the worker.

(iv) $s \geq 0$ *and* $v + SP \geq m$ *(No separation):* Now, the alternative to no separation is voluntary quit. The wage bargaining problem is:

$$\max_w \ln(v - w) + \frac{\alpha}{1-\alpha} \ln(w - r)$$

that results into a wage $w = (1 - \alpha)r + \alpha v$. This is the accepted wage if it is larger than m. Otherwise the wage will be m because both the firm and the worker prefer no separation with $w = m$ than a quit.

$$w(\varepsilon, x_g, x_s, a) = \max\{m \ ; \ \alpha \ v(\varepsilon, x_g, x_s, a) + (1-\alpha) \ r(\varepsilon, x_g, x_s, a) \qquad (21)$$

The condition for the continuation of a match (or the creation of a new match) still can be represented as, $\{r(.) \leq w(.) \leq v(.)\}$. However, this condition is no longer equivalent to $s(.) \geq 0$. In fact, we have that now the condition is:

$$s(\varepsilon, x_g, x_s, a) \geq 0 \qquad \textit{and} \qquad v(\varepsilon, x_g, x_s, a) - m \geq 0 \qquad (22)$$

Now, it is possible to have a separation when the total surplus of the match is positive but the minimum wage is greater than the firm's willingness to pay. Severance payments increase firms' willingness to pay and therefore they reduce the probability of job destruction (and job creation). However, the effect on unemployment is ambiguous. We see also that the minimum wage increases job turnover, and severance payments tend to reduce it. Bertola and Rogerson (1997) have pointed out that this opposite effect of the two regulations might explain why job turnover rates in European and Northamerican countries are so similar despite the differences in job security rules in these countries.

3 Data and preliminary evidence

We estimate the previous model using micro data from the Spanish economy. High unemployment rates, strong regulation on workers' dismissal, and significant reforms on regulated severance payments during the last fifteen years, have made the Spanish case a particularly interesting one (see Bentolila and Saint-Paul, 1994, Cabrales and Hopenhayn, 1997, and Aguirregabiria and Alonso, 1999, among others). Unfortunately, there is not a panel data survey for the Spanish economy combining information on wages and labor market transitions. In contrast to the US CPS, most European labor force surveys do not have information on wages. For this reason, we combine data on labor market transitions from the Spanish Labor Force Survey (*Encuesta de Poblacion Activa,* EPA) with wage information from the recently available 1995 Spanish Wage Structure Survey (*Encuesta de Estructura Salarial*, EES). Both surveys are carried out by the Spanish National Statistical Institute, INE.

The EES-1995 is the most comprehensive survey of individual wages in the Spanish economy. It contains individual hourly wages for more than $177,000$ salaried workers from approximately $18,000$ establishments in the manufacturing, construction and services industries.[3] The sampling design proceeded in two stages. In a first stage establishments were randomly chosen from the Social Security Census. In the second stage, for each selected establishment, approximately 5% of the workers were interviewed. Data on wages, hours of work, and type of labor contract come from

[3] Government officials, agricultural workers and non salaried workers (e.g., CEO's and other top managers) are not included. Furthermore, establishments with less than 10 workers were not considered.

establishments' payroll files. The survey contains also information on workers' characteristics like education, age, gender, years of tenure in the firm, and occupation. Another interesting feature of this dataset is that it reports some characteristics of the establishment, e.g., total number of workers, industry and whether wages were negotiated at the level of the firm or the industry. Our working sample consists of those salaried workers between 20 and 55 years of age. Since we do not incorporate in our model the retirement decision and Social Security pensions, we have preferred to remove from our sample those individuals who are relatively close to retirement age.[4]

The Spanish Labor Force Survey (EPA) is a rotating quarterly panel. Every new rotation group stays in the survey for six quarters. A cross section consists of approximately $150,000$ adult individuals from six different rotation groups. The survey contains information on socioeconomic characteristics (education, gender, age, etc) labor force status, occupation, industry, labor contract and duration in the current job or in unemployment.[5] As in the case of the wage survey, our working sample consists of those individuals between 20 and55 years old.

Figures 3 presents the time series for the unemployment rate, proportion of salaried workers and proportion of temporary workers for the period 1987-1996, obtained from EPA. The most interesting feature in this figure is the behavior of temporary employment. In 1984, a labor market reform (Real Decreto 2104/1984) introduced a new type of labor contract that was called *temporary contract*. The most important features of this type of contract are: (1) the duration should be between three months and one year, and it can be renewed up to three years; and (2) upon termination of the contract the worker is not entitled to severance payments. Before the 1984 reform the use temporary contracts was restricted to seasonal activities in the agriculture and tourism industries. The reform allowed to use these contracts in a much more flexible way. Since 1984 the proportion of salaried workers with

[4]In Spain the regulated retirement age with full benefits is 65 years old. It is possible to retire between ages 60 and 65 with reduced benefits. The proportion of people who retired before age 55 is very small.

[5]For a detailed description of the survey and of the creation of the matching sample see Jimenez and Peracchi (1998).

temporary contracts has increased from less than 5% to more that one third. Figure 3 shows that most of this increase occurred during the expansion period 1987-1989. There process desacelerated during the 1990-1992 recession, and it recovered in 1993 and 1994. Since 1995 the proportion of workers with temporary contracts has been stable around 33%. The slow transition path to the new equilibrium provides indirect evidence of the costs associated with destruction of matches where workers are entitled to severance payments. During this period most of the destruction in permanent employment was the result of worker's retirement and not of dismissals.

The conditional probabilities of job continuation for permanent and temporary jobs provide some preliminary evidence on the role of severance payments in employment decisions. We have estimated these probabilities using probit models for each year and for temporary and permanent jobs separately. The explanatory variables are: industry dummies (57); educational dummies (7); female dummy; age dummies (35), quarterly dummies; and job tenure dummies (3 in the probit for temporary jobs and 23 for permanent jobs). The estimated probabilities are for quarterly transitions. Figure 4 presents these probabilities for different values of tenure, and evaluated at the sample means of the other regressors.[6] There is a significant differential in the probabilities of job continuation for temporary and permanent workers (between 4% and 6%). However, this differential might be partly the result of differences in unobservable characteristics of temporary and permanent workers, and not of severance payments.

More interestingly, we see that, for temporary workers, the probability of job continuation decreases significantly from two years to three years of tenure. At three years of tenure this probability represents the decision of promotion from a temporary job to a permanent job. If severance payments did not affect the decision of job continuation, we would expect the probability not to decrease.

Figure 5 presents estimated tenure wage profiles for temporary and permanent workers with and without controlling for selection, using the EES survey. They

[6]The sample means of the regressors have been obtained using both temporary and permanent workers. Therefore, the reported probabilities of job destruction do not capture differences in the distribution of the regressors for temporary and permanent workers.

have been obtained from a logarithm wage equation with the same regressors as in the probits for job continuation. We have controlled for selection by including a third order polynomial in the propensity score. We can see that wages of temporary workers tend to increases with tenure at least as much as wages of permanent workers. Again, this evidence is at odds with the hypothesis that severance payments are fully transmitted to wages.

Figure 6 presents the estimated wage tenure profiles for permanent workers (controlling for selection) and the theoretical profile. This theoretical profile has been obtained under the assumption that severance payments are fully transmitted to wages and it is the only source for wages increasing with tenure. Furthermore, β has been fixed at 0.95, and the parameter τ is the actual value under the Spanish regulation, 1.5/12. Using this comparison it is not possible to reject the hypothesis of neutrality of severance payments. However, this seems to indicate (as Figure 5 does) that severance payments play a relatively minor role in the tenure wage profile.

4 Estimation of the structural model

Consider a sample of individuals with information on wages, experience, tenure and labor market transitions: $\{w_i, x_{gi}, x_{si}, a_i, D_i : i = 1, 2, ..., n\}$ where D_i is the indicator for the event "individual i is currently working". We know also minimum wages and severance payments in the economy: $\Lambda \equiv \{m; \tau(.)\}$. We are interested in the estimation of the structural parameters of the model: $\Gamma = \{b, c_f, c_H, \beta, Q(.), G(.), F(.), \mu(.), \alpha\}$.

4.1 Econometric approach

The econometric model can be represented by the following equations: (a) the condition for the creation/continuation of a match,

$$D_i = 1 \Leftrightarrow \{s(\theta_i, \varepsilon_i, x_{gi}, x_{si}, a_i; \Gamma, \Lambda) \geq 0\} \qquad \textit{and} \qquad \{v(\theta_i, \varepsilon_i, x_{gi}, x_{si}, a_i; \Gamma, \Lambda) - m \geq 0\}; \tag{23}$$

(b) the equation for the equilibrium wage,

$$w_i = \max\{m \ ; \ \alpha \ v(\theta_i, \varepsilon_i, x_{gi}, x_{si}, a_i; \Gamma, \Lambda) + (1 - \alpha) \ r(\theta_i, \varepsilon_i, x_{gi}, x_{si}, a_i; \Gamma, \Lambda); \tag{24}$$

and (c) the equilibrium conditions which define the functions $s(.)$, $v(.)$, and $r(.)$.

There are three main econometric issues in the estimation of this model: (1) correlation between autocorrelated unobservables and experience variables; (2) identification problems associated with self-selection; and (3) computational issues. We deal with these issues in turn.

The unobservables θ_i and ε_i are autocorrelated. It is well-known that not taking this autocorrelation into account generates spurious state dependence, i.e., inconsistent estimates of the effects of state variables as experience or tenure. In principle, a possible strategy to deal with this problem is to use simulation estimation methods. However, the combination of the high dimensional integration problem (due to autocorrelated unobservables) and the fixed point problem associated with the solution of the model makes this strategy extremely costly in terms of computation. Furthermore, the estimation strategy that we propose does not require one to solve the structural model for different values of the vector of structural parameters, but this strategy requires a conditional independence assumption for the unobservables. Therefore, our approach is to "proxy" autocorrelated unobservables by using observable variables. More specifically, we define different groups of individuals and firms according to certain time-invariant variables firm's and individual's characteristics (e.g., education, occupation, industry, region, size). We make the following simplifying assumption:

$$\theta_i * \varepsilon_i = \xi(z_i) * \tilde{\varepsilon}_i$$

where $\tilde{\varepsilon}_i$ is a pure *iid* shock that is not correlated with previous labor market history.

We discuss the identification of the model in Appendix B. We show that: (1) α is not identified; and (2) given α and a parametric assumption on the productivity function $\mu(.)$, it is possible to identify the rest of parameters, and in particular the distribution of $\tilde{\varepsilon}_i$ is nonparametrically identified.

Define the following probability functions,

$$\begin{aligned} p_D(x_g, x_s, a, z) &= \Pr(D_i = 1 \mid x_{gi} = x_g; x_{si} = x_s; a_i = a; z_i = z) \\ p_w(w, x_g, x_s, a, z) &= p(w_i = w \mid D_i = 1; x_{gi} = x_g; x_{si} = x_s; a_i = a; z_i = z) \end{aligned}$$

Notice that the hazard function $p_D(.)$ and the distribution of accepted wages $p_w(.)$ are nonparametrically identified from the data. Using the recursive expression for the surplus function and the *iid* assumption for $\tilde{\varepsilon}_i$ we can obtain recursive expressions for $p_D(.)$ and $p_w(.)$

$$\begin{aligned} p_D(x_g, x_s, a, z) &= \Psi_D\left[x_g, x_s, a, z;\ p_D(x_g+1, x_s+1, a+1, z),\ p_D(x_g, 0, a+1, z);\ \Gamma, \Lambda\right] \\ p_w(w, x_g, x_s, a, z) &= \Psi_w\left[w, x_g, x_s, a, z;\ p_D(x_g, x_s, a, z),\ p_D(x_g, 0, a+1, z);\ \Gamma, \Lambda\right] \end{aligned}$$

See Appendix C for the analytical expressions of $\Psi_D(.)$ and $\Psi_w(.)$. Based on this result we consider the following two-stage estimator of Γ:

$$\hat{\Gamma} = \arg\max_{\Gamma} \sum_{i=1}^{n} D_i\ \ln \Psi_{Di}(\hat{p}_D, \hat{p}_w; \Gamma, \Lambda) + (1-D_i)\ln(1-\Psi_{Di}(\hat{p}_D, \hat{p}_w; \Gamma, \Lambda)) + \sum_{Di=1} \ln \Psi_{wi}(\hat{p}_D, \hat{p}_w; \Gamma, \Lambda)$$

where $\hat{p}_D$ and $\hat{p}^w$ are nonparametric consistent estimates of $p_D(.)$ and $p_w(.)$, respectively.

5 Summary and preliminary conclusions

This paper presents a theoretical framework to analyze the effects of experience-rated severance payments on the tenure profiles of wages, job turnover and worker turnover. The solution of the model provides tenure profiles for wages, job turnover rates and workers' turnover rates. In principle, the primitives of this model can be estimated combining micro data of wages, flows of workers, and firms' employment decisions. Using Spanish micro data on workers labor market transitions and wages we have presented some preliminary evidence on the effect of severance payments on employment decisions and wages. First, the probability of continuation in a job decreases significantly when the firm has to start to pay severance payments to that worker. Second, the tenure profile of wages for permanent workers (entitled to severance payments) and temporary workers (not entitled to severance payments) is very similar, what is also at odds with the hypothesis that this regulated transfer is fully transmitted to wages and does not affect employment decisions.

Appendix A: Proofs

[A.1] Equilibrium distribution of tenure and experience:

Given the surplus function and the distribution of ε it is possible to obtain the probabilities of job creation/job continuation conditional to tenure, experience and age. These are the hazard rates for the duration of a job conditional to age and general experience. Let $p(x_g, x_s, a; q_u)$ be these hazards. For $x_s > 0$ (i.e., job continuation),

$$p(x_g, x_s, a; q_u) = \frac{\Pr\left(\{s(\varepsilon_j, x_g - j, j, a - j; q_u) \geq 0 : j = 0, 1, ..., x_s\} \mid x_g, x_s, a; q_u\right)}{\Pr\left(\{s(\varepsilon_j, x_g - j, j, a - j; q_u) \geq 0 : j = 0, 1, ..., x_s - 1\} \mid x_g, x_s, a; q_u\right)}$$

and for $x_s = 0$ (i.e., job creation)

$$p(x_g, 0, a; q_u) = q_u \Pr\left(s(\varepsilon, x_g, 0, a; q_u) \geq 0 \mid x_g, a; q_u\right)$$

When ε is *iid* over time and individuals these hazards take a simple form.

Let Π be the steady state distribution of experience and tenure over age groups,

$$\Pi \equiv \{\pi(x_g, x_s, a) : x_g = 0, 1, ...R; x_s = 0, 1, ..., R; a = 0, 1, ..., R\}$$

First, notice that at any age and for any value of (x_g, x_s) there are only two possible transitions for the experience: variables: to $(x_g, 0)$ (i.e., employment to unemployment, or unemployment to unemployment), and to $(x_g + 1, x_s + 1)$ (i.e., employment to employment, or unemployment to employment). Therefore, for $a > 0$, $x_g > 0$ and $x_s > 0$,

$$\pi(x_g, x_s, a) = \pi(x_g - 1, x_s - 1, a - 1)\ p(x_g - 1, x_s - 1, a - 1)$$

And for $a > 0$ and $x_s = 0$ (and any x_g),

$$\pi(x_g, 0, a) = \sum_{k=0}^{a-1} \pi(x_g, k, a - 1)\ [1 - p(x_g, k, a - 1)]$$

Finally, at age $a = 0$ all the individuals have zero experience, and therefore, $\pi(0, 0, 0) = 1/(R + 1)$, and for $x_s > 0$ or $x_g > 0$ $\pi(x_s, x_g, 0) = 0$. Given these initial conditions and the previous difference equations we can obtain the steady state distribution Π from the hazard rates $p(.)$.

Given Π, it is simple to obtain the unemployment rate π_u and the distribution of general experience over unemployed workers, $\pi^u_{aX_g}$.

$$\pi_u = \sum_{a=0}^{R} \sum_{x_g=0}^{R} \pi(x_g, 0, a)$$

And:

$$\pi^u_{aX_g}(x_g, a) = \pi(x_g, 0, a)/\pi_u$$

[A.2] Proof of Proposition 2:

First, for any value $q_u \in [0, 1]$ the mapping that defines the surplus function (equation [16]) is a contraction mapping and therefore $s(.; q_u)$ exists and is unique. Second, by assumption $Q'(q_u) < 0$, $Q(0) = 1$, and $Q(1) = 0$. Therefore, there is an equilibrium and it is unique if: (1) $V^e(q_u)$ is decreasing in q_u; (2) there is a $\bar{q}_u \in (0, 1)$ such that $V^e(\bar{q}_u) < c_H$. We now prove (1) and (2). TO BE WRITTEN.

[A.3] Proof of Proposition 3:

The wage bargaining with severance payments still implies that $w = \alpha v + (1 - \alpha)r$, and therefore $w - r = \alpha s$, and $v - w = (1 - \alpha)s$. Now, the value function of an individual who receives a job offer is:

$$U(w, \varepsilon, x_g, x_s, a) = \max\{b+\tau(x_s)+\beta\ EU^u(x_g, a+1)\ ;\ w+\beta\ EU^e(\varepsilon, x_g+1, x_s+1, a+1)\}$$

And therefore the reservation wage is:

$$r(\varepsilon, x_g, x_s, a) = b + \tau(x_s) + \beta\left[EU^u(x_g, a + 1) - EU^e(\varepsilon, x_g + 1, x_s + 1, a + 1)\right]$$

Taking into account the definitions of EU^u and EU^e, we have that: for $a = R$, $EU^u = EU^e = 0$; and for $a < R$,

$$EU^u(x_g, a) = b + \tau(0) + \beta\ EU^u(x_g, a + 1) + \alpha q_u \int \max\{0\ ;\ s(\varepsilon', x_g, 0, a)\}\ dF^*(\varepsilon'),$$

and

$$EU^e(\varepsilon, x_g, x_s, a) = b+\tau(x_s)+\beta\ EU^u(x_g, a+1)+\alpha \int \max\{0\ ;\ s(\varepsilon', x_g, x_s, a)\}\ dF(\varepsilon'; \varepsilon) \tag{25}$$

Therefore, given that $\tau(0) = 0$, we have that: $r(\varepsilon, x_g, x_s, R) = b + \tau(x_s)$, and for $a < R$,

$$\begin{aligned} r(\varepsilon, x_g, x_s, a) &= b + \tau(x_s) - \beta\tau(x_s + 1) \\ &+\alpha\beta q_u \int \max\{0\ ;\ s(\varepsilon', x_g, 0, a+1)\}\ dF^*(\varepsilon') \\ &-\alpha\beta \int \max\{0\ ;\ s(\varepsilon', x_g + 1, x_s + 1, a+1)\}\ dF(\varepsilon'; \varepsilon) \end{aligned}$$

The value function of a firm that makes a job offer is:

$$V(w, \varepsilon, x_g, x_s, a) = \max\{-\tau(x_s)\ ;\ \varepsilon\ \mu(x_g, x_s) - w - c_f + \beta\ EV(\varepsilon, x_g + 1, x_s + 1, a+1)\}$$

Therefore, the willingness to pay is:

$$v(\varepsilon, x_g, x_s, a) = \tau(x_s) + \varepsilon\ \mu(x_g, x_s) - c_f + \beta\ EV(\varepsilon, x_g + 1, x_s + 1, a+1)$$

Taking into account this willingness to pay we can obtain that: for $a = R$, $EV = 0$, and for $a < R$:

$$EV(\varepsilon, x_g, x_s, a) = -\tau(x_s) + (1 - \alpha) \int \max\{0\ ;\ s(\varepsilon', x_g, x_s, a)\}\ dF(\varepsilon'; \varepsilon)$$

Therefore, for $a = R$, $v = \tau(x_s) + \varepsilon\ \mu(x_g, x_s) - c_f$, and for $a < R$,

$$\begin{aligned} v(\varepsilon, x_g, x_s, a) &= \tau(x_s) - \beta\tau(x_s + 1) + \varepsilon\ \mu(x_g, x_s) - c_f \\ &+\beta(1 - \alpha) \int \max\{0\ ;\ s(\varepsilon', x_g + 1, x_s + 1, a+1)\}\ dF(\varepsilon'; \varepsilon) \end{aligned}$$

Using the previous expressions for the reservation wage and the willingness to pay we can see that the surplus function, $s = v - r$, is not affected by the existence of severance payments. That is, equation (16) still defines the surplus and, for given q_u, this functional equation is unchanged by the introduction of severance payments. Since $s(.; q_u)$ does not depend on severance payments, that is also the case for the equilibrium distribution of general experience and age over unemployed workers (see [A.1]), and for $V^e(q_u)$. Given that the matching function $Q(.)$ is the same, the equilibrium probability q_u^* is not affected by severance payments. Therefore, $s(.; q_u^*)$, the job turnover probabilities, the unemployment rate $\pi_u(q_u^*)$, and the distribution of general and specific experience are not altered by the introduction of a mandated severance payment.

The wage function is equal to $\alpha v+(1-\alpha)r$. Given that q_u^* and $s(.)$ are not affected by severance payments, the previous expressions for $r(.)$ and $v(.)$ imply that: for a $a=R$, $r=\tau(x_s)+r_{NSP}$ and $v=\tau(x_s)+v_{NSP}$, and for $a<R$,

$$\begin{aligned} r(\varepsilon,x_g,x_s,a) &= \tau(x_s)-\beta\tau(x_s+1)+r_{NSP}(\varepsilon,x_g,x_s,a) \\ v(\varepsilon,x_g,x_s,a) &= \tau(x_s)-\beta\tau(x_s+1)+v_{NSP}(\varepsilon,x_g,x_s,a) \end{aligned}$$

where r_{NSP} and v_{NSP} are the reservation wage and the willingness to pay, respectively, without severance payments.. Therefore,

$$\begin{aligned} For\ a &= R: w(\varepsilon,x_g,x_s,a)=\tau(x_s)+w_{NSP}(\varepsilon,x_g,x_s,a) \\ For\ a &< R: w(\varepsilon,x_g,x_s,a)=\tau(x_s)-\beta\tau(x_s+1)+w_{NSP}(\varepsilon,x_g,x_s,a) \end{aligned}$$

Appendix B: Identification

For the sake of simplicity, we consider here the identification of a myopic model (i.e., $\beta = 0$) without minimum wages or severance payments. However, it is possible to show that the identification of this case implies the identification of the more general dynamic model with or without minimum wages and severance payments. Let x_i be the pair (x_{gi}, x_{si}). The econometric model is:

$$\begin{aligned} D_i &= I\{\gamma_0 + \sigma\ \tilde{\varepsilon}_i\ \mu(x_i, z_i) \geq 0\} \\ w_i &= \beta_0 + \alpha\ \sigma\ \tilde{\varepsilon}_i\ \mu(x_i, z_i) \end{aligned}$$

where $\beta_0 = b - \alpha c_f$; $\gamma_0 = -(c_f + b)$; $\tilde{\varepsilon}_i \sim iid(1,1)$ with *cdf* $F(.)$, and σ is the standard deviation of ε_i. Define:

$$\begin{aligned} p(x, z) &= \Pr(D_i = 1 \mid x_i = x; z_i = z) \\ \bar{w}(x, z) &= E(w_i \mid D_i = 1; x_i = x; z_i = z) \end{aligned}$$

Notice that $p(.)$ and $\bar{w}(.)$ are nonparametrically identified from our data. We consider the problem of uniquely recover $\{b, \alpha, c_f, \sigma, F(.), \mu(.)\}$ from $p(.)$ and $\bar{w}(.)$.

According to our model,

$$\begin{aligned} p(x, z) &= 1 - F\left(\frac{-\gamma_0}{\sigma\ \mu(x, z)}\right) \\ \bar{w}(x, z) &= \beta_0 + \alpha\ \sigma\ \mu(x, z)\ h\left(\frac{-\gamma_0}{\sigma\ \mu(x, z)}\right) \end{aligned}$$

where $h(c) \equiv E(\tilde{\varepsilon} | \tilde{\varepsilon}_i \geq c)$. It is straightforward to obtain simple examples showing that, even if we specify $F(.)$ and $\mu(.)$ parametrically, the bargaining power parameter α is not identified. However, given a parametric assumption on $F(.)$, it is possible to identify β_0, $\alpha\gamma_0$, and $\sigma\mu(.)/\gamma_0$: i.e., $\sigma\mu(x, z)/\gamma_0 = \left[-F^{-1}\left(1 - p(x, z)\right)\right]^{-1}$ and

$$\bar{w}(x, z) = \beta_0 + \alpha\ \gamma_0 \left[-F^{-1}\left(1 - p(x, z)\right)\right]^{-1} h\left[F^{-1}\left(1 - p(x, z)\right)\right]$$

But therefore, it is clear that given a fixed value of α and a parametric specification for $F(.)$, we can identify all the structural parameters, and in particular $\sigma\mu(.)$ is nonparametrically identified. It is also simple to show that given α and a parametric specification for $\mu(.)$ the model is identified with a nonparametric specification for $F(.)$.

Appendix C: Estimation

The expressions for the mappings Ψ_D and Ψ_w are:

$$\Psi_D(.) \;=\; F\left(\frac{1}{\sigma}\ln\left\{\frac{\mu(x_g,x_s,z)}{c_f+b-\beta Es[p(x_g+1,x_s+1,a+1,z)]+\beta Es[p(x_g,0,a+1,z)]}\right\}\right)$$

and,

$$\begin{aligned}\Psi_w(.) \;&=\; b+\alpha\left[\mu(x_g,x_s,z)h[p(x_g,x_s,a,z)]-c_f-b\right] \\ &+\;(1-\alpha)\alpha\beta q_u Es[p(x_g,0,a+1,z)]\end{aligned}$$

where $h[p(x_g,x_s,a,z)] = E(\tilde{\varepsilon}|\tilde{\varepsilon} > c)$, and

$$\begin{aligned}Es[p(x_g,x_s,a,z)] \;&=\; p(x_g,x_s,a,z)\ \mu(x_g,x_s,z) \\ &\quad h[p(x_g,x_s,a,z)]\left[1-\exp\left\{-\sigma F^{-1}[p(x_g,x_s,a,z)]\right\}\right]\end{aligned}$$

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Table 1
Descriptive Stattistics: EPA and EES
Subsample: Manufacturing and services; Age 20 to 55

Variable	*EPA-1995*		*EES-1995*
	All indiv.	*Salaried workers*	*Salaried workers*
Number of observations	348,450	145,477	133,941
Female (%)	51.3	35.9	25.0
educ=1 (%)	7.3	3.7	2.1
educ=2 (%)	30.7	25.8	27.5
educ=3 (%)	24.2	25.7	39.2
educ=4 (%)	5.5	6.2	4.8
educ=5 (%)	12.5	11.1	10.3
educ=6 (%)	6.3	8.6	7.3
educ=7 (%)	5.6	9.0	3.2
educ=8 (%)	7.9	10.0	5.7
Age (years)	36.1	36.2	36.1
	(10.3)	(9.5)	(9.3)
Tenure (years)	8.2	8.0	8.5
	(8.8)	(9.0)	(8.0)
% Inactive	29.9	-	-
% Unemployed (over active)	24.6	-	-
% Salaried (over employment)	79.2	-	-
% Self-employed (over employment)	18.3	-	-
% Informal (over unemployed)	2.5	-	-
% Temporary (over salaried workers)	35.3	35.3	26.1

Figure 1

Numerical solution

Model with severance payments and wage flexibility

Model parameters: $\mu(x_s) = 1000(1+x_s)^{0.05}$; $\ln \varepsilon \sim N(0, 0.25)$; $\alpha = 0.5$; $Q(q_u) = 0.5(1-q_u)/(q_u + 0.5(1-q_u))$; $c_H = 10$; $c_f = 50$; $b = 950$; $\beta = 0.95$; $\tau(x_s) = 125 \max\{0, x_s - 3\}$

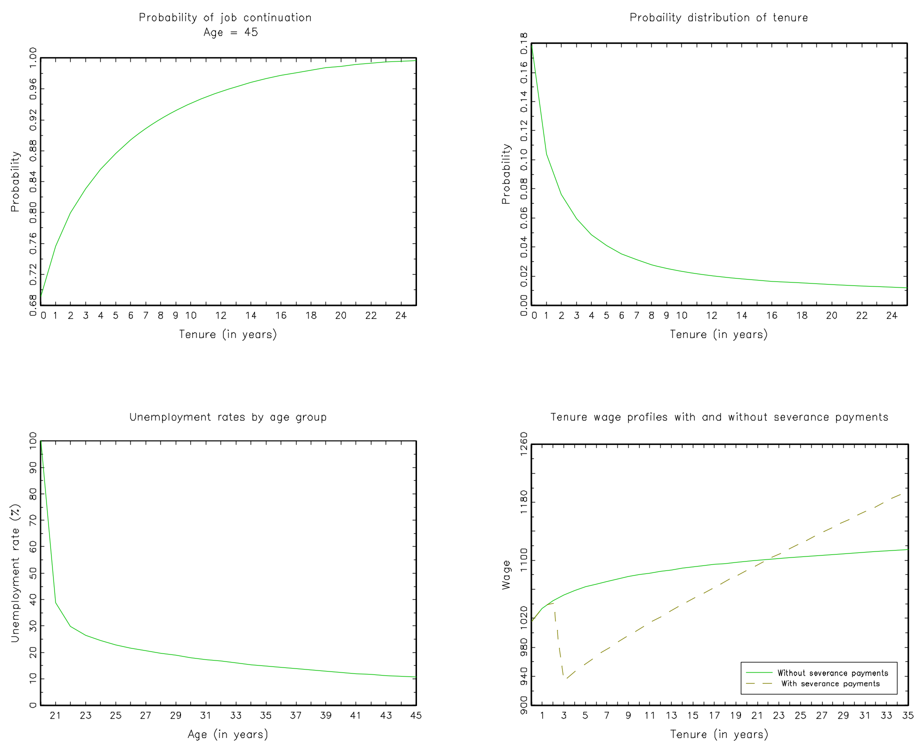


FIGURE 2

Model with severance payments and minimum wages

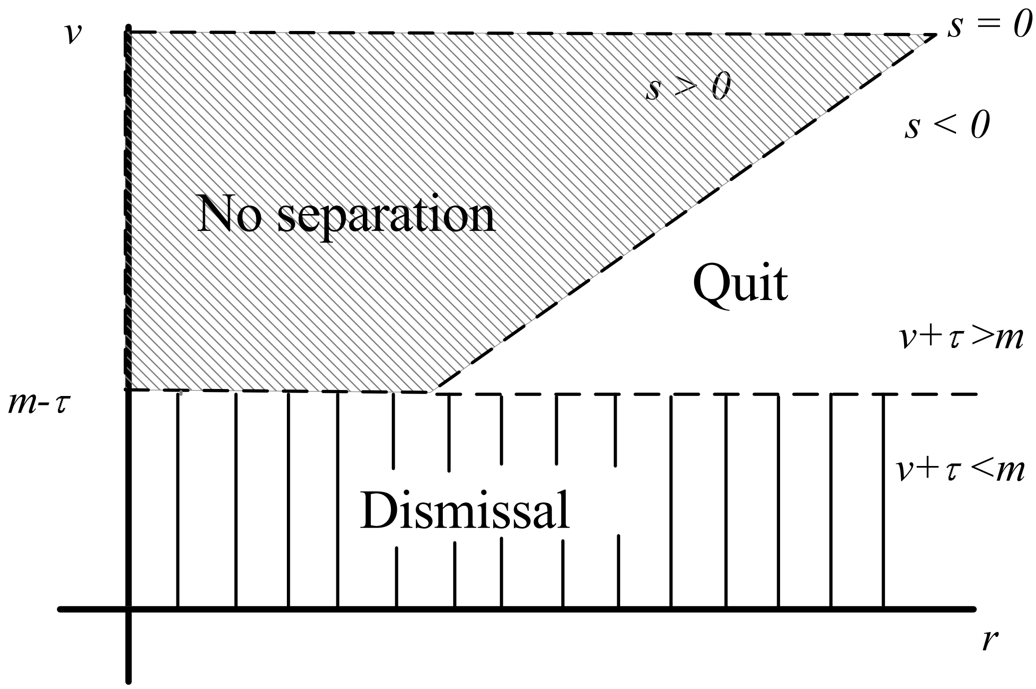


FIGURE 4

CONDITIONAL TRANSITION PROBABILITIES

EMPLOYMENT-TO-EMPLOYMENT (Source EPA 1992-1995)

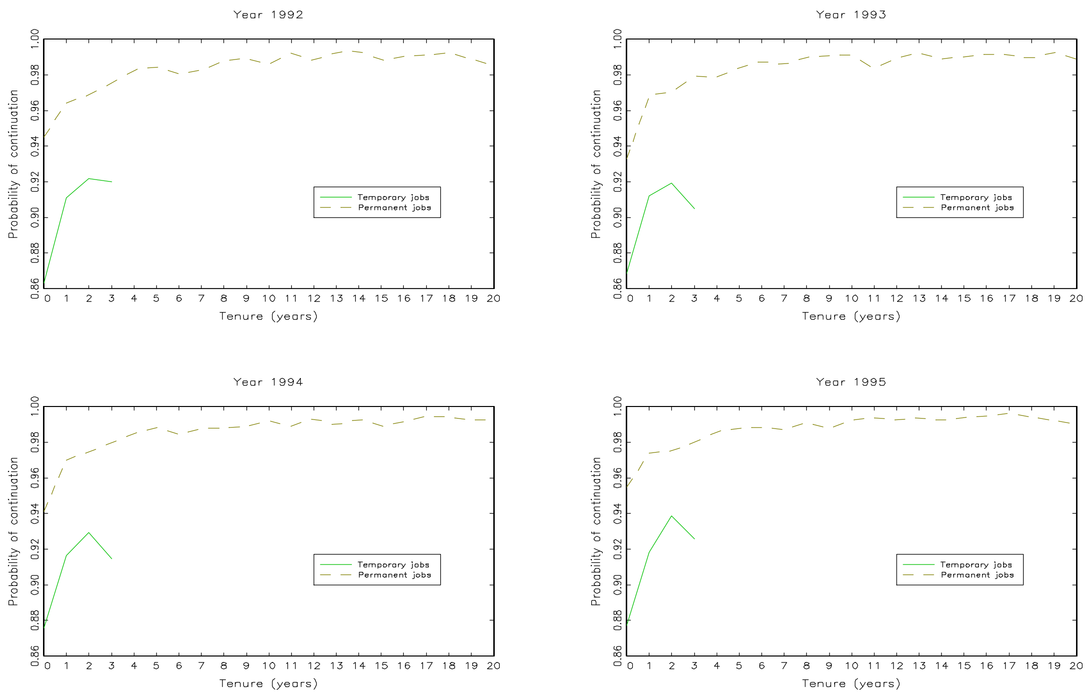
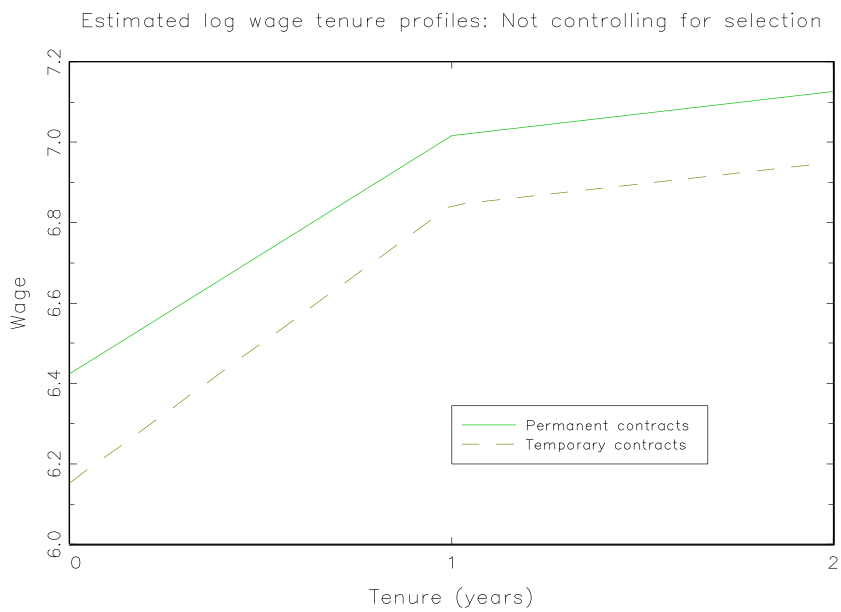


FIGURE 5

ESTIMATED LOG-WAGE TENURE PROFILES (Source EES-1995)



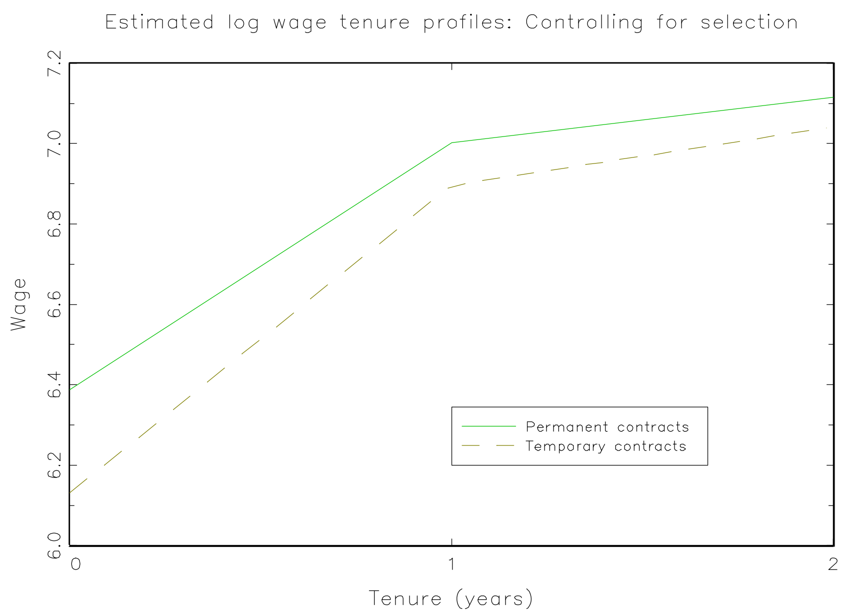


FIGURE 6

ESTIMATED AND THEORETICAL WAGE TENURE PROFILE FOR PERMANENTS (Source EES-1995)

$$\beta = 0.95; SP(x_s) = w_0 \frac{1.5}{12} x_s$$