Structural Aspects of the Labor Markets of Five OECD Countries

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1 Introduction

In the past decades, labor economists have accumulated evidence that is at odds with the hypothesis that the labor market is a standard competitive market. Wage regressions show that employer size, *i.e.* the number of employees of the firm or establishment, has a positive effect on the wage (Brown and Medoff (1989)), and that there are persistent differences between the wages in different industries (Krueger and Summers (1988)). These effects remain, if an extensive list of controls for productive differences between workers is included in the regression. Moreover, these results have been replicated for many countries.

In the same period another literature has emerged that stresses the importance of labor market flows (Mortensen (1986), Blanchard and Diamond (1989)), *e.g.* flows to and from unemployment and job-to-job transitions. The size of these flows is assumed to be affected by the behavior of employers and employees, who make their decisions with incomplete knowledge of the opportunities in the market. The discovery of these opportunities is modelled as the outcome of a random process, *i.e.* random from the point of view of the individual employer or employee. The resulting delays are referred to as search frictions. There are various types of search models, that differ in the search technology of the agents, allowance for aggregate supply and demand effects, and the nature of uncertainty. The standard job search model assumes that (un)employed individuals search randomly among firms, that they take aggregate supply and demand conditions as given, and that they are uncertain on both the location of employment opportunities and on the terms of these opportunities, in particular the wage. The job search model has inspired empirical research on unemployment and job spells. This research focuses on variations in search frictions and the role of choice in transitions between labor market positions (Devine and Kiefer (1991) give a survey).

More recently, attempts have been made to integrate the two strands of research in labor economics. The impetus came from difficulties that arose in obtaining variation in the terms of employment as an equilibrium outcome (Diamond (1971)). The standard job search model is a model of labor supply, and the distribution that describes the uncertainty on the terms of employment is exogenous to this model. Hence, research started to make the determination of the terms of employment endogenous to the model. A number of such models are now available (Albrecht and Axell (1984), Mortensen (1990), Burdett and Mortensen (1996)). We shall refer to these models as equilibrium search models. Equilibrium search models are consistent with the observed anomalies in wage determination. In these models a firm can have a larger workforce by offering wages that are higher than those of other firms. Moreover, search frictions prevent the equalization of wages and profits among industries, and inefficient firms can survive by paying low wages. In explaining the anomalies equilibrium search models do not invoke special behavioral assumptions that are difficult to test directly, as required by *e.g.* efficiency wage models.

Some of the theoretical models have been used in empirical studies (Eckstein and Wolpin (1990), Van den Berg and Ridder (1993)). A partial survey can be found in Ridder and Van den Berg (1996). This research is facilitated by the availability of panel data on labor market histories and the relatively modest computational effort that is needed to solve these theoretical models. Moreover, if we maintain the hypothesis that firms maximize their long-run profit rate, the parameters of the model can be estimated from observed labor market histories. Data on firms are not needed, although they would allow us to test and relax some of the assumptions on employer behavior.

The resulting models have policy implications that sometimes differ from those derived from the standard competitive model. We consider the effect of changes in the level of unemployment benefits and in the level of the minimum wage. The standard job search model predicts that an increase in unemployment benefits raises the reservation wage of the unemployed and as a consequence lengthens unemployment spells and raises the level of unemployment. This argument ignores the fact that employers may change their wage offers in reaction to a change in the reservation wage. If employers set wages, they will make their wage offer equal to some reservation wage. Hence, if firms make positive profits, they may react to an increase in the benefit level by increasing their wage offers leaving unemployment unaffected. Recent proposals to lower the benefit level, or equivalently to lower taxes on wages but not on unemployment benefits, in order to decrease reservation wages, will lower the wage offers, but not the level of unemployment. These results are not robust over all possible models and parameter values, but it seems unwise to ignore the effect of changes in the level of benefits on wage offers.

Because in equilibrium search models frictions confer some monopsony power on employers, the effect of a change in the minimum wage may differ markedly from that in the standard competitive model. In the simplest model a moderate increase of the minimum wage raises the average wage offer, but has no effect on unemployment. In a model where individuals differ in the value that they attach to unemployment income, a increase in the minimum wage may reduce unemployment, because the higher average wage offer makes more individuals willing to work. In a model where jobs have different levels of productivity the minimum wage may destroy jobs, because some activities may become unprofitable. Equilibrium search models are sufficiently rich to allow for all possibilities, and the question which situation applies can be resolved by empirical research. It is hardly surprising that Card and Krueger (1995) in their controversial study of the effect of the minimum wage on employment mention equilibrium search models as a possible explanation for their results.

The simplest equilibrium search models depend on a few parameters that determine the joint distribution of unemployment spells, job spells, and wages. In this study we use aggregate data to estimate these key parameters for five OECD countries: (West-)Germany, The Netherlands, France, the United Kingdom and the USA. We show that in the simple model only information on the marginal distribution of wages and the marginal distributions of unemployment and job spells is needed to estimate the structural parameters. Thus, the methodological contribution of this paper is the demonstration that the model can be calibrated from readily available aggregate data, and that panel data on individuals are not necessary. Our estimation method provides a direct link between types of information and parameters. For example, we shall show that data on job durations allow us to estimate an index of the search frictions, without the need to estimate the other parameters simultaneously. The parameters, the arrival rate of wage offers, the rate of job destruction, the average productivity of jobs, and the variation of job productivities are of interest in their own right. We shall also use the parameter estimates to obtain estimates of structural unemployment due to wage floors, of the average level of monopsony power in the economy, and to make a decomposition of wage variation into variation due to productive differences between jobs and variation due to search frictions.

The estimation results are reported in section 5. In section 2 we introduce the equilibrium search model that we use to obtain these results. The estimation procedure is described in section 3, and section 4 discusses the data. Section 6 contains some conclusions and questions for further research.

2 The Burdett-Mortensen equilibrium search model

As noted, there are several models for search markets (see Ridder and Van den Berg (1996) for a review). Our starting point is the equilibrium search model of Burdett and Mortensen (Burdett and Mortensen (1996), Mortensen (1990)). This model has a dispersed wage offer distribution as an equilibrium outcome, even if all workers and firms are identical. Moreover, it allows for job-to-job transitions, which can not occur in some other equilibrium search models. The model gives explicit solutions for the wage offer distribution and the distribution of wages paid in a cross-section of employees, and it specifies all relevant transition intensities up to a vector of parameters. For our purposes, it is important that the equilibrium solution is such that the parameters of the joint distribution of wages and unemployment and job spells can be identified from the implied marginal distributions of wages and job/unemployment durations. This allows us to use aggregate data on wages and unemployment/job durations that are available for a number of countries, to estimate the parameters of the equilibrium search model.

First, we introduce the Burdett-Mortensen model with identical workers and firms. Next, we extend the basic model by allowing for differences in productivity between workers and firms.

2.1 The basic model: homogeneous workers and firms

We consider a labor market consisting of a continuum of workers and firms. Firms set wages and unemployed and employed workers search among firms. The unemployed are looking for an acceptable job, the employed for a better job. Jobs do not last forever, but terminate at an exogenous rate. Firms compete for employees, and set their wage taking account of the wages offered by other firms and the acceptance strategies of the (un)employed. Workers use the resulting wage offer distribution to determine their acceptance strategies. In such a labor market, there are flows of workers who change jobs, who find a job from unemployment, and who become unemployed. In a steady state the flows to and from the stocks of individuals in a particular labor market position are equal. We assume that the labor market is in this steady state. The model does not consider how this steady state is reached.

We use the following notation:

λ_0	$=$	arrival rate of job offers while unemployed
λ_1	$=$	arrival rate of job offers while employed
δ	$=$	rate at which jobs terminate
w	$=$	wage rate
p	$=$	marginal value product of employee
b	$=$	value of leisure (which, among other things, depends on unemployment benefits
m	$=$	number (measure) of workers
u	$=$	number (measure) of the unemployed
$F(w)$	$=$	distribution function of wage offer distribution
$G(w)$	$=$	distribution function of earnings distribution
r	$=$	reservation wage of unemployed job seekers

The distribution functions F and G have the usual properties: they are right-continuous. The left-hand limit of F at w is denoted by $F(w-)$. Initially, we allow for discontinuities in F, *i.e.* there may be wages with $F(w) - F(w-) > 0$. This is important, because we must entertain the possibility that the wage offer distribution is degenerate. The wage offer distribution is the distribution of the wage offers made to employed and unemployed workers. The earnings distribution is the distribution of wages paid to a cross-section of employees at a particular moment. To derive the equilibrium of the model we must consider the behavior of the suppliers of labor, *i.e.* the unemployed and employed individuals, and of the employers. This behavior, and the constraints imposed by the lags in the arrival of information, determine the flows between labor market positions.

First, we consider the workers. The unemployed obtain wage offers from $F(w)$ at an exogenous rate λ_0. The optimal acceptance strategy maximizes the expected wealth of the unemployed. It is characterized by a reservation wage r (Mortensen and Neumann (1988))

$$r = b + (\lambda_0 - \lambda_1) \int_r^\infty \frac{1 - F(w)}{\delta + \lambda_1(1 - F(w))} \mathrm{d}w \tag{2.1}$$

This reservation wage takes account of search on the accepted job. As a result, it depends on the difference between the arrival rates while unemployed and employed. In particular, the reservation wage is equal to the value of leisure if the arrival rates are equal. The unemployed may accept offers below b if $\lambda_1 > \lambda_0$. Here and in the sequel, we assume that future income is not discounted. A comparison of equation (2.1) with the usual expression for the reservation wage in the infinite horizon case, shows that wage offers are implicitly discounted at a rate $\delta + \lambda_1(1 - F(w))$, which is the job-leaving rate as we shall see shortly.

The acceptance strategy of the employed workers is simple. They accept any wage offer, that exceeds their current wage. We assume that job-to-job transitions are costless.

Next, we consider the flows of workers, that result from these acceptance strategies. The flow from unemployment to employment is $\lambda_0(1 - F(r-))u$, the product of the offer arrival rate, the acceptance probability, and the measure of unemployed workers. The flow from employment to unemployment is $\delta(m - u)$. In a steady state these flows are equal and the resulting measure of unemployed workers is

$$u = \frac{m}{\delta + \lambda_0(1 - F(r-))} \tag{2.2}$$

Let the distribution of wages paid to a cross-section of employees have distribution function G. The wages paid to a cross-section of employees are on average higher than the wages offered, because of the flow of employees to higher paying jobs. Consider the stock of employees with a wage less or equal to w, which has measure $G(w)(m - u)$. In the steady-state the flows into and from this stock are equal, and this equality gives a relation between the wage offer and earnings distributions. The flow into this group consists of the unemployed that accept a wage less than or equal to w, and this flow is equal to $\lambda_0(F(w) - F(r-))u$ if $w \geq r$ and is 0 otherwise. The flow out of this group consists of those who become unemployed, $\delta G(w)(m - u)$ and those who receive a job offer that exceeds w, $\lambda_1(1 - F(w))G(w)(m - u)$. In a steady state the inflow and outflow are equal, and we can express G as a function of F

$$G(w) = \frac{F(w) - F(r-)}{1 - F(r-)} \frac{\delta}{\delta + \lambda_1(1 - F(w))} \tag{2.3}$$

where we have substituted for u from equation (2.2). This equation holds if $w \geq r$, and $G(w) = 0$ otherwise. Note that if jobs last forever, *i.e.* $\delta = 0$, the steady-state unemployment rate is 0, and transitions to higher paying jobs would continue until all workers have a wage equal to p. In the sequel we only consider the case that $\delta > 0$.

From the two wage distributions we derive the supply of labor to an employer that offers wage w. There are $(G(w) - G(w - h))(m - u)$ employees that earn a wage in the interval $(w - h, w]$ and there are $F(w) - F(w - h)$ employers that offer a wage in that interval. Because firms that offer the same wage have the same steady-state employment level, the supply of labor to a firm that offers w is obtained by dividing the number of employees by the number of firms and letting h approach 0. This supply is denoted by $l(w \mid r, F)$ where we explicitly indicate its dependence on the acceptance strategy of the unemployed and the wages offered by other firms that compete for the same workers.

$$\begin{aligned} l(w \mid r, F) &= \lim_{h \to 0} \frac{(G(w) - G(w-h))(m-u)}{F(w) - F(w-h)} \\ &= \frac{\frac{m\delta\lambda_0(\delta+\lambda_1(1-F(r-))}{\delta+\lambda_0(1-F(r-))}}{(\delta+\lambda_1(1-F(w)))(\delta+\lambda_1(1-F(w-)))} \quad , \text{for } w \geq r \\ &= 0 \quad , \text{for } w < r \end{aligned} \tag{2.4}$$

Note that it is allowed that a positive measure of employers offers wage w. It is easily seen that l increases in w. Due to search frictions and competition for workers employers face an upward sloping supply curve for labor with a finite wage elasticity. If F is differentiable at w, this elasticity is proportional to the fraction job leavers, that leave for a higher paying job and the measure of firms that pay a comparable wage. The supply function is discontinuous at points of discontinuity of F.

Finally, we consider optimal wage setting by the employer. We assume that the marginal value product p does not depend on the number of employees, *i.e.* we assume that the production function is linear in employment. In that case the profit flow of the firm that pays wage w is $(p - w)l(w \mid r, F)$. The wage offer of the firm maximizes this profit flow

$$w = \underset{s}{\operatorname{argmax}}[(p-s)l(s \mid r, F)] \tag{2.5}$$

We make the implicit assumption, that the firm is only interested in the steady state profit flow. Hence, in setting its wage the firm does not try to smooth its level of employment in response to short run random fluctuations in the level of employment. Because all workers and all firms are identical, each worker is equally productive at each firm. This completes our description of the search market.

Next, we characterize equilibrium in this search market. Because firms that offer wages that are strictly smaller than r have no employees and 0 profits, while a firm that offers r has strictly positive profits, we have $F(r-) = 0$, *i.e.* there are no wage offers below r. Because firms, that offer a wage equal to p have 0 profits, and again a firm that offers r has strictly positive profits, wage offers are bounded above by p. The fact that the profit per employee $p - w$ is continuous in w, puts restrictions on the equilibrium wage offer distribution. For let w be offered by a positive measure of firms, *i.e* $F(w) - F(w-) > 0$. Then $l(w+) - l(w-) > 0$, *i.e.* there is a positive measure of workers employed at wage w. If one of the firms that offer w increases its wage offer by a small amount, it will eventually attract all the workers employed at firms with wage offer w. Because the profit per employee is continuous in w, the firm increases its profit rate by $[l(w+) - l(w-)]w > 0$. Hence, competition for employees eliminates the discontinuities in the wage offer distribution. An equilibrium wage offer distribution has no mass points, and in particular, it can not be degenerate. We have already noted, that we also need $\delta > 0$ to preclude that the wage offer distribution is degenerate at p.

The wage offers also are a connected set. For firms that offer a wage at the upper bound of a gap in the set of wage offers, can lower their wage to the lower bound of the gap without losing any employees, because l is constant, if F does not change with w. In doing so they increase their profits. Hence, profit maximization eliminates the gaps in the set of wage offers. As a consequence F is strictly increasing for all wage offers. Finally, we derive an expression for F. In equilibrium, firms have no incentive to change their wage offer. This implies, that all wage offers must give the same profit flow π. We already know, that the lowest wage offer is equal to r. Firms that offer r only attract unemployed workers. Their profits are equal to

$$\pi = (p-r)l(r \mid r, F) = \frac{m\delta\lambda_0}{(\delta+\lambda_0)(\delta+\lambda_1)} \frac{p-r}{(\delta+\lambda_1(1-F(w)))^2} \tag{2.6}$$

Hence, this equation expresses the common profit rate as a function of the arrival rates, p and r. All equilibrium wage offers yield the same profit rate π

$$\frac{m\delta\lambda_0(\delta+\lambda_1)}{\delta+\lambda_0} \frac{1}{(\delta+\lambda_1(1-F(w)))^2} \tag{2.7}$$

Substituting for π from equation (2.6) we can solve for F

$$F(w) = \frac{\delta+\lambda_1}{\lambda_1}\left(1-\sqrt{\frac{p-w}{p-r}}\right) \tag{2.8}$$

This expression holds for all equilibrium wage offers. The lowest wage offer is r. By setting F equal to 1 we obtain the highest offer $\overline{w}$

$$\overline{w} = \left(\frac{\delta}{\delta+\lambda_1}\right)^2 r + \left(1-\left(\frac{\delta}{\delta+\lambda_1}\right)^2\right) p \tag{2.9}$$

Of course, $F(w)$ is 0 for $w < r$ and 1 for $w > \overline{w}$. Note that F is differentiable. The density function is

$$\begin{aligned} f(w) &= \frac{\delta+\lambda_1}{2\lambda_1\sqrt{p-r}} \frac{1}{\sqrt{p-w}} \quad \text{,for } r < w < \overline{w} \\ &= 0 \quad \text{otherwise} \end{aligned} \tag{2.10}$$

We substitute the equilibrium wage offer distribution in equations (2.1), (2.2), (2.3),and (2.4) to obtain the equilibrium reservation wage, unemployment rate, earnings distribution and employment.

$$r = \frac{(\delta+\lambda_1)^2 b + (\lambda_0-\lambda_1)\lambda_1 p}{(\delta+\lambda_1)^2 + (\lambda_0-\lambda_1)\lambda_1} \tag{2.11}$$

$$u = \frac{\delta}{\delta+\lambda_0} \tag{2.12}$$

$$G(w) = \frac{\delta}{\lambda_1}\left(1-\sqrt{\frac{p-r}{p-w}}\right) \quad \text{, for } r < w < \overline{w} \tag{2.13}$$

$$g(w) = \frac{\delta\sqrt{p-r}}{2\lambda_1} \frac{1}{(p-w)^{\frac{3}{2}}} \quad \text{, for } r < w < \overline{w} \tag{2.14}$$

$$l(w \mid r, F) = \frac{m\delta\lambda_0}{(\delta+\lambda_0)(\delta+\lambda_1)} \frac{p-r}{p-w} \quad \text{, for } r < w < \overline{w} \tag{2.15}$$

The model has dispersed equilibrium wage offer and earnings distributions. Because all workers and firms are identical, this implies that the law of one price does not hold in equilibrium. However, we obtain the competitive equilibrium, in which all wages are equal to p, and the monopsonistic equilibrium, in which all wages are equal to b, as limits of the equilibrium solution. If λ_0 approaches ∞, *i.e.* if the unemployed find jobs instantaneously, then the wage offer and earnings distributions degenerate in p. If λ_1 approaches 0, *i.e.* if the employed do not receive alternative job offers, then the distributions degenerate at b. For $\delta > 0$ the maximum offer $\overline{w}$ is strictly smaller than p, but for $\lambda_1 > 0$ it is also strictly larger than b. Hence, the equilibrium offers are those of firms that have a finitely elastic labor supply. This is confirmed by the wage elasticity of $l(w \mid r, F)$, which is equal to $(p-w)/w$, as it is for a monopsonistic firm.

The basic equilibrium search model is a highly stylized model with strong implications for the distribution of unemployment and job spells. Are these predictions consistent with empirical evidence? Of course, not much should be expected from a model that assumes that all workers and firms are identical. In equilibrium the lowest wage offer is equal to the reservation wage of the unemployed. Hence, all job offers are acceptable to the unemployed, and the re-employment hazard is equal to the offer arrival rate. This is consistent with the empirical evidence in *e.g.* Devine and Kiefer (1991) and and Van den Berg (1990). Although job search models originally were introduced as a potential explanation for the existence of unemployment, most empirical studies find that rejection of job offers is rare. In the basic model equilibrium unemployment is due to lags in the arrival of job offers. The homogeneous model does not allow for structural unemployment. The rate at which job spells end, decreases with the wage. This is consistent with empirical evidence (Lindeboom and Theeuwes (1991)). In equilibrium there is a positive association between firm size and wage. Hence, the model is consistent with the employer size wage effect.

The wage offer and earnings distributions have an increasing density. In figure 2.1 these densities are drawn.

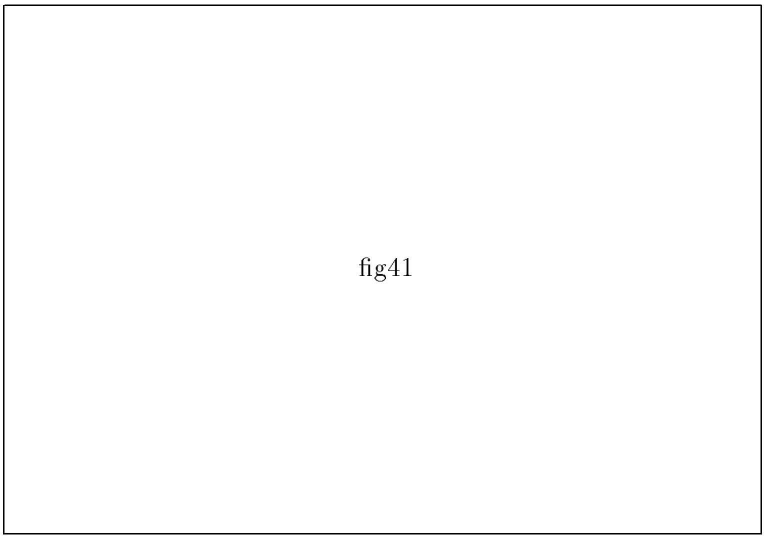

Figure 2.1: *Earnings and wage offer density;* $\lambda_0 = \lambda_1 = .047, \delta = .025, b = 1192, p = 2208$

Observed distributions of wages do not resemble this earnings distribution. In particular, they do not have an increasing density. As shown in Ridder and Van den Berg (1996), allowing for heterogeneity in p improves the fit to observed wages dramatically, and we use such an extension of the basic model to obtain our estimates.

There are empirical results that the model can not describe. In labor economics there has been a lively debate on the positive relation between wages and labor market experience. Although the debate is still active, the available evidence suggests, that wage growth is due to both wage growth on the job and wage increases that are associated with transitions from lower to higher paying jobs (Abraham and Farber (1987), Altonji and Shakatko (1987), Topel (1991), Wolpin (1994)). The present model only allows for the second type of wage growth. Attempts have been made to construct an equilibrium search model in which firms offer a wage path, but thus far the resulting models are unappealing from an empirical viewpoint, because they do not allow for direct job-to-job transitions, and as a consequence have counterfactual implications for the relation between wages and firm size (Coles and Burdett (1992).

2.2 The minimum wage and heterogeneity in p

We consider two extensions of the basic model. First, we allow for a minimum wage w_L. Next, we introduce heterogeneity in productivity. If the minimum wage is lower than the reservation wage of the unemployed, then it does not affect the equilibrium solution of the model. If it exceeds this reservation wage, than the lowest wage offer is equal to the minimum wage. The maximum offer is as in equation (2.9) with the reservation wage r replaced by the minimum wage w_L. With a binding minimum wage the equilibrium is independent of the level of unemployment income b. Hence, the equilibrium depends either on b or on w_L but not on both.

As long as the minimum wage is lower than p, the level of unemployment is independent of the level of the minimum wage. An increase in the minimum wage lowers the profits of the employers and raises the income of the workers. If the minimum wage exceeds the productivity p, firms will close, and all workers become permanently unemployed.

Although we could let all parameters vary in the population, we choose to have heterogeneity in p. As argued in Ridder and Van den Berg (1996), heterogeneity in p is essential to obtain an acceptable fit to the observed wage distribution. The fit to the duration data is also improved. We can distinguish between within-market and between-market heterogeneity in p. In the first case, we consider a single or a few markets, in which firms with different levels of productivity coexist. This alters the equilibrium solution. Here, we consider the second case, in which we have a large number, in the sequel we assume a continuum, of markets, each with its productivity level p. In each market, the equilibrium is as in the basic model. With between-market heterogeneity it does not matter whether we associate the productivity with the worker or with the firm. We shall not relate the productivity to characteristics of workers and/or firms. Our aggregate data do not allow us to make distinctions. Instead, we assume that p has some distribution with p.d.f. h and c.d.f. H.

Although between-market heterogeneity in p does not alter the equilibrium solution, it enriches the model by adding the possibility of structural unemployment. If $p < max(w_L, b)$, then the firms in the corresponding market close down, and the workers become unemployed. If the measure of the affected workers is $h(p)m\mathrm{d}p$, then the unemployment rate is equal to

$$\frac{u}{m} = \frac{\delta}{\delta + \lambda_0}(1 - H(\underline{w})) + H(\underline{w}) \tag{2.16}$$

The first term on the right-hand side of this equation reflects frictional unemployment and the second-term structural unemployment. A further distinction could be made between voluntary and involuntary (structural) unemployment, but because the data will not allow us to make this distinction, this is of little importance.

3 Inference

The equilibrium search model with between-market heterogeneity in p specifies the joint distribution of wages and unemployment and job spells. Panel data, in which individuals are followed during some period, contain the required information. Ridder and Van den Berg (1996) discuss the estimation of the model with panel data. Here we use aggregate data to estimate the parameters of the model. The advantage of aggregate data is that they are available for a larger number of countries and for more years. However, aggregate data on the joint distribution of wages and spells are not available. The data that are available refer to the marginal distributions of wages and unemployment and job spells.

Fortunately, all parameters can be identified from the marginal distributions. The basic model implies that the marginal distribution of unemployment spells t_0 is exponential with parameter λ_0. Hence, the average length of an unemployment spell is $\frac{1}{\lambda_0}$. To obtain the marginal distribution of job spells t_1, we note that upon substitution of equation (2.8) in the job-leaving rate we obtain

$$\delta + \lambda_1(1 - F(w)) = (\delta + \lambda_1)\sqrt{\frac{p-w}{p-r}} \tag{3.1}$$

If we integrate with respect to the density of earnings of equation (2.14), we obtain the marginal density of t_1

$$k(t_1) = \frac{\delta(\lambda_1+\delta)}{\lambda_1}\int_{\delta}^{\lambda_1+\delta} z\exp(-zt_1)\frac{1}{z^2}\mathrm{d}z \tag{3.2}$$

This is a mixture of exponentials with a fully specified mixing distribution with bounded support. Note that this distribution does not depend on p. Hence, we obtain the same marginal distribution of job spells, irrespective of the assumed distribution of p. The average job spell is

$$E(t_1) = \frac{\lambda_1 + 2\delta}{2\delta(\lambda_1+\delta)} \tag{3.3}$$

In theory, we can recover λ_0, λ_1 and δ from the marginal distributions of t_0 and t_1. Because for some countries we only have the average spell lengths, we can only identify two parameters. For that reason we assume in the sequel that

$$\lambda_0 = \lambda_1 = \lambda \tag{3.4}$$

In words, we assume that the offer arrival rate is the same when employed or unemployed. This implies that the reservation wage r is equal to unemployment income b (see equation (2.1)). In an empirical study with individual panel data we found that the two arrival rates do not differ by much (Koning, Ridder, and Van den Berg (1995)).

The marginal distribution of wages in a cross-section of employees is obtained by integration of the density in equation (2.14) with respect to the density of p truncated at $max(b, w_L)$. The mean and variance of this distribution are

$$E(w) = \underline{w} + \frac{\lambda}{\lambda+\delta}(\mu_T - \underline{w}) \tag{3.5}$$

and

$$Var(w) = \left(\frac{\lambda_0}{\lambda+\delta}\right)^2\left(1 + \frac{\delta}{3(\delta+\lambda)}\right)\sigma_T^2 + \frac{\delta\lambda^2}{3(\delta+\lambda)^3}(\mu_T - \underline{w})^2 \tag{3.6}$$

with μ_T and σ_T^2 the mean and variance of the distribution of p truncated at $\underline{w} = max(b, w_L)$.

Data on unemployment spells allow us to estimate λ. After substitution in the density of t_1, we estimate δ with data on job spells. Substitution of the estimates in equations (3.5) and (3.6) gives two equations in two unknowns, which after substitution of the observed mean wage and wage variance, can be solved for μ_T and σ_T^2. Finally, we can estimate the structural unemployment rate $H(\underline{w})$ by solving equation (2.16) after substitution of the observed unemployment rate and the estimates of λ_0 and δ.

4 The aggregate data

We have aggregate data for five OECD countries: The Netherlands (NL), Western-Germany (D), France (F), United Kingdom (UK) and the USA. The aggregate data are not reported in a uniform format, but fortunately our estimation procedure is flexible in that respect. Here we give a short description of our data.

Job spells. Data on job spells categorized in 6 intervals for NL, D, F and UK can be found in the OECD Employment Outlook of June 1993. These data have been obtained either from special panel surveys (NL, D) or from the yearly Labor Force Survey that is conducted in all countries of the European Union (F, UK). These data are for 1990 (NL, D) or 1991 (F, UK). The Employment Outlook also contains similar data for the USA, obtained from the Current Population Survey. These data are for 1991.

Unemployment spells. The distribution of unemployment spells categorized in 7 intervals have been obtained from the Labor Force Survey (NL, D, F, UK). These data refer to 1990 (NL, D) or 1991 (F,UK). For the USA we have the average spell length as reported by the Bureau of Labor Statistics, which obtains these from the Current Population Survey.

Wage data. Categorized data on before-tax monthly wages of full-time employees (NL from Sociaal-economische maandstatistiek, UK from Annual Abstract of Statistics). Mean and standard deviation of before-tax monthly wages of full-time employees (D from Löhne und Gehälter, Statistisches Bundesamt). Categorized data on after-tax monthly wage (F from Annuaire Statistique de la France). For the USA we have only average monthly before-tax wages from the Current Population Survey.

Unemployment rate. Average rate during the year from the OECD Quarterly Labor Force Statistics (all countries).

If the wage data are categorized we compute the mean and variance by fitting a log-normal distribution. For France we have after-tax wages. If the tax is approximately proportional, then it can be shown that the tax rate is applied to the moments of p as well. The resulting estimates are in the following table. Note that the UK does not have a minimum wage.

5 Results

First, we report our estimates of λ and δ. For NL, D, F and UK, the estimate of λ is obtained by maximum likelihood. We assume that individuals with an unemployment spell longer than 23 months are structurally unemployed, *i.e.* these spells are not used in the estimation of λ. This is rather arbitrary, and an alternative procedure is to estimate a mixture model that allows for differences in λ among the (un)employed. This is left to future research. We do not report standard errors, because for some countries we only have the relative frequency of the duration

Table 4.1: *Average, standard deviation of monthly wage and minimum wage in local currency 1990/1991*

	NL	D	F	UK	USA
Average	3825	4074	8286	1241	1416
Stand. dev.	1602	1635	3720	585	
Min. wage	2041	2000	2588	-	663

Table 5.1: *Offer arrival rate and job destruction rate per month*

	NL	D	F	UK	USA
λ	.162	.147	.143	.195	.316
δ	.00591	.00360	.00376	.00534	.00616

intervals. For the USA the estimate is obtained from the reported average spell length. The estimates of δ are obtained by maximum likelihood. The likelihood takes account of the length bias in the stock sample.

The US has the largest offer arrival rate and also the largest job destruction rate. The next largest arrival rate is that of the UK. However, the job destruction rate is larger in The Netherlands. It is almost as large as that in the US. The offer arrival rate and job destruction rates are the smallest in France and Western-Germany.

From the estimates we obtain a decomposition of the observed unemployment rate into a frictional and structural component. Note that structural unemployment is due to a wage floor, which is equal to $max(b, w_L)$. For the computation of the structural component of the unemployment rate, it does not matter which is larger. The frictional rate is highest in The Netherlands and lowest in the US. The structural rate is highest in France and the UK, and relatively small in Western-Germany.

Finally, we estimate the mean and standard deviation of the productivity distribution in active markets. We use these estimates to compute an average monopsony index

Table 5.2: *Unemployment rate: frictional and structural*

	NL	D	F	UK	USA
Unempl. rate	.075	.049	.094	.087	.066
Frictional	.034	.023	.024	.025	.018
Structural	.041	.026	.070	.062	.048

Table 5.3: *Mean and standard deviation of productivity in active markets (national currency), average monopsony index, and decomposition of wage variation*

	NL	D	F	UK	USA
μ_T	3890	4125	8436	1264	1430
σ_T	1539	1658	3763	593	
Monopsony index	.017	.012	.018	.018	.0098
Frac. var. due to p	.94	.98	.97	.97	
Monopsony index, $\underline{w} = 0$	.035	.024	.026	.027	.019
Frac. var. due to p, $\underline{w} = 0$	.79	.90	.95	.61	

$$\frac{\mu_T - E(w)}{\mu_T} \tag{5.1}$$

and a decomposition of the wage variance into a component due to heterogeneity in p and a component due to search frictions. These quantities do not depend on the currency. We assume that the lowest wage is equal to the minimum wage, except for the UK. The lowest monthly wage is set equal to 400 for the UK.

The results show that the search frictions do not give a substantial monopsony power to the employers. They are only able to set the average wage about 1.5 per cent lower than the competitive wage. This is a direct consequence of the relative size of arrival rate and the job destruction rate. The ratio of λ and δ is the expected number of job offers during an employment spell, which is an index of the search frictions in the market. The larger this index, the smaller the frictions. The monopsony index decreases in the wage floor. We also report the index for a wage floor equal to 0. The the role of search frictions in explaining wages is limited. The fraction explained by search frictions increases if the wage floor decreases. Again we report the upper bound. In particular, in The Netherlands and in the UK wage floors keep the market equilibrium close to the competitive equilibrium.

6 Conclusion

This paper is a first attempt to use aggregate data to estimate the key parameters of a simple equilibrium search model. The estimates suggest, that the equilibrium in the five labor markets under consideration is not far from the competitive outcome, at least for the employed. Wage floors play a role in keeping the equilibrium close to the competitive outcome. However, these wage floors also lead to structural unemployment.

The model is simple. In particular, the assumed equality of the offer arrival rate in unemployment and employment may give an underestimate of the job destruction rate, and hence an underestimate of the level of frictional unemployment, and the monopsony index. Data on employment spells, in addition to data on job spells, would allow us to investigate this.

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