IFAU – OFFICE OF LABOUR
MARKET POLICY EVALUATION

Ranking of job applicants, on-the-job search, and persistent unemployment

Stefan Eriksson, Nils Gottfries

WORKING PAPER 2000:8

Ranking of job applicants, on-the-job search, and persistent unemployment*

by

Stefan Eriksson and Nils Gottfries†

October 9, 2000

Abstract:

We formulate an efficiency wage model with on-the-job search where wages depend on turnover and employers may use information on whether the searching worker is employed or unemployed as a hiring criterion. We show theoretically that ranking of job applicants by employment status affects both the level and the persistence of unemployment and numerically that these effects may be substantial. More prevalent ranking in Europe compared to the US (because of more rigid wage structures etc.) could potentially help to explain the high and persistent unemployment in Europe.

Keywords: Efficiency wage, Turnover, On-the-job search, Labor mobility, Persistence, Ranking, Unemployment.

JEL classification: E24, J64.

---

* We are grateful for helpful comments from Peter Diamond, Per-Anders Edin, Peter Fredriksson, Erik Hernaes, Bertil Holmlund, Kenneth Koford, Torsten Persson, Avi Weiss and seminar participants at CESifo Summer Institute, EEA Annual Congress, Econometric Society World Congress, Institute for International Economic Studies, IZA, Stockholm School of Economics and Uppsala University. Financial support from the Office of Labor Market Policy Evaluation and the Swedish Council for Research in the Humanities and Social Sciences is gratefully acknowledged.

† Department of Economics, Uppsala University, Box 513, SE-751 20 Uppsala, e-mail: Stefan.Eriksson@nek.uu.se and Nils.Gottfries@nek.uu.se.

When one compares European and US labor markets, several differences are apparent. Unemployment rates are much higher, turnover is much lower, and the adjustment back to equilibrium after a shock is much slower in Europe. While high unemployment may plausibly be blamed on unions and labor market rigidities and low turnover may be due to cultural differences, the last observation is especially intriguing. In several European countries, temporary cyclical shocks have raised unemployment and then it has remained high for a long time. In univariate models of unemployment, the coefficient on lagged unemployment is close to unity for many European countries (see references below). Adjustment costs and insider-outsider models can explain some persistence, but they can hardly generate the extreme persistence found in the data. Why is unemployment so persistent in Europe? In this paper we take a new look at this question, emphasizing two aspects of the labor market.

The first is that turnover between jobs is substantial and firms consider the implications for turnover when they set wages. The importance of voluntary turnover is well documented. Holmlund (1984) and Akerlof, Rose and Yellen (1988) report quit rates of around two percent per month for the US, Sweden and Japan and Boeri (1999) finds that job flows from one job to another constitute around 50 per cent of all hiring in several European economies. Pissarides and Wadsworth (1994) report that around 5 per cent of all employed workers in Britain search for a new job and according to Holmlund (1984) about 8 percent of employed workers in Sweden engage in job search during a year. Lane, Stevens and Burgess (1996) show that worker reallocation is two to three times as great as job reallocation and total worker turnover is procyclical because procyclical quits dominate counter-cyclical layoffs (Anderson and Meyer (1994)). McCormick (1988) shows that total separations, many of which are job-to-job flows, depend strongly on the number of available vacancies. Furthermore, survey evidence shows that firms do care about turnover. Concerns about training/ hiring costs as a result of quits, as well as fears that the most productive workers would quit, deter firms from wage cuts (Blinder and Choi (1990), Campbell and Kamlani (1997)).

The second starting point is that unemployed workers are sometimes at a disadvantage compared to employed workers in the competition for jobs because some employers prefer to hire already employed workers. Blau and Robins (1990) show that in the US employed job searchers receive almost twice as many job offers as unemployed searchers with the same search effort. Winter-Ebmer (1991) finds that employment status is used as a screening device for productivity in Austria. In surveys of US and Swedish firms, Bewley (1999) and Agell and Lundborg (1999) found that a substantial fraction of employers view unemployment as a signal of lower productivity.

If turnover is costly, then the firm's optimal wage will depend on the probability that its employees find other jobs; if this probability increases, firms will raise wages to prevent costly turnover. If, in addition, unemployed workers do not compete for jobs on an equal basis with employed applicants, this must raise the probability for employed workers to get the jobs they apply for and this in turn will tend to raise the wage. In other words, we should expect an *interaction* between the turnover considerations that affect wage decisions and the fact that unemployed workers have a disadvantage compared to employed workers when applying for the same jobs. The bigger this disadvantage, the higher is the chance for employed workers to get a new job, and the higher is, ceteris paribus, the "efficiency wage" that is optimal from the firm's point of view.

To formalize this intuition, we formulate a model where a fraction of all employed workers apply for new jobs while maintaining their current jobs. Whether a person applies for a new job or not depends on the wage offered by the current employer, wages elsewhere, and a stochastic job satisfaction factor associated with the current job. The firm takes the effect on turnover into account when it sets the wage. We first consider the case without ranking, i. e. when employers chose whom to hire randomly. Without ranking, unemployment is somewhat persistent. Because firms fear costly turnover as the economy recovers from a recession, a permanent negative shock is not fully accommodated in the next wage contract, and hence employment remains low for some time after a negative shock.

We then introduce *ranking* by assuming that some employers prefer to hire *employed* applicants. Ranking increases the probability that an employed worker gets the job he applies for and this makes it optimal for firms to set higher wages. The result is both higher equilibrium unemployment *and* slower wage adjustment following a shock. When the economy is recovering from a recession, there are relatively many job openings, which tend to raise wages, and high unemployment has only a weak effect on wages because unemployed workers do not compete well with those searching on the job. Simulations show that the quantitative effects of ranking may be substantial.

We also use the model to interpret the different labor market outcomes in the US and Europe. As noted above, both the *level* and the *persistence* of unemployment are much higher in Europe. Our simulations show that, within this model, wage pressure due to strong unions can explain high unemployment in Europe, but not the extreme persistence observed empirically. Instead, our analysis points to ranking of job applicants as a potentially important explanation of the high persistence of unemployment observed in many European labor markets. Unfortunately, we do not have direct measures that allow us to compare the extent of ranking across countries, but we argue that ranking is likely to be more prevalent in Europe because of more rigid wage structures etc.

The idea that unemployment persists because unemployed workers have difficulty competing for jobs is not new. Phelps (1972), Layard and Nickell (1986) and others[1] have made arguments along those lines, but there are few microeconomic models formalizing the idea. The insider bargaining model developed by Blanchard and Summers (1986) and Gottfries and Horn (1987) emphasizes the distinction between employed and unemployed workers, but can hardly generate the extreme amount of persistence found in the data.[2] Other related papers are Huizinga and Schiantarelli (1992) and Gottfries and Westermark (1998), who show that persistence may arise due to the forward looking nature of wage decisions, and Pissarides (1992), who showed that interaction between skill loss in unemployment and job creation by firms can make unemployment more persistent. Neither of these papers consider the interaction between on-the-job search and ranking that we emphasize here.[3]

---

[1] See also references in Machin and Manning (1999).

[2] In univariate models of unemployment, the coefficient on lagged unemployment is close to unity for many European countries (see references below). The Blanchard and Summers (1986) version of the insider bargaining model generates hysteresis, which is an extreme form of persistence, but only because they make very special assumptions concerning union preferences etc. - see the discussion in Blanchard (1991) or Bean (1994).

[3] While there is a substantial literature on on-the-job search, the interaction with ranking has not been explored (see e. g. Pissarides (1994)). Supply side explanations of unemployment emphasize that with a generous unemployment benefit system, workers may search less intensely and be unwilling to take jobs. Such mechanisms can explain high unemployment, but it seems hard to explain a high persistence (serial correlation) of unemployment using this type of model. The dynamic simulation model of Ljungqvist and Sargent (1998) illustrates this point.

The paper that is most closely related to ours, is Blanchard and Diamond (1994). They examine how *wages* are affected if firms rank job applicants according to the length of unemployment. Workers and firms match in a random way and wages are determined by Nash bargaining with the expected utility of a recently laid off worker as threat point. Their result is that ranking affects wage dynamics but has small effects on the long run wage level. Our analysis differs in several ways. First, we replace the "quasi labor supply curve" implied by Nash bargaining by an efficiency wage model with turnover between jobs; as a consequence, the utility that workers get if they are unemployed plays no role in our model. Second, we focus on the advantage of employed job searchers relative to the unemployed workers rather than on the distinction between short-term and long-term unemployed. Third, while Blanchard and Diamond examine the effects on wages of exogenous movements in employment, employment is endogenous in our model, so we can solve for employment, calculate persistence, and evaluate the effects quantitatively. Fourth, our *results* differ from those of Blanchard and Diamond. In our model, ranking has substantial effects not only on the dynamics, but also on the long run equilibrium levels of wages and employment.[4]

In Section I we formulate the basic turnover model without ranking and calculate steady state employment and persistence. In Section II we introduce ranking and show that this increases both the level and the persistence of unemployment. In Section III we extend the model to allow for wage contracts spanning several periods and in Section IV we discuss potential explanations of the observed differences between European and the US labor markets.

I. The Model without Ranking

The model is intended to capture the fact that job-to-job flows are substantial and turnover considerations are important for firms when they set wages. There are a large number of firms and many workers per firm. The labor force is assumed to be constant and is normalized to one. The sequence of events in each period is the following. Near

[4] Another related paper is the recent paper by Tranaes (2000), where firms can choose between searching among the unemployed and making job offers to workers employed by other firms. Unemployed workers have a disadvantage because there are some unemployable workers among them. He does not address the persistence problem, however.

the end of every period a fraction s of the workers leaves employment and enters the pool of unemployed. This fraction is exogenously given and represents workers quitting or being laid off for exogenous reasons. Then firms set wages and the remaining employed workers decide whether to look for a new job or not, considering the wage offered by the firm, wages elsewhere, and a non-pecuniary "job satisfaction" factor. All unemployed workers also search and every searcher submits one application to a randomly chosen firm.[5] Firms receiving the applications then make their choices of whom to hire.

We have three distinct decisions: firms set wages, workers decide whether to search and firms decide whom to hire. We now proceed by first analyzing search and turnover in a specific firm for a given wage, then analyzing the firm's optimal wage decision. Finally we turn to employment dynamics in a symmetric general equilibrium and calculate long-run unemployment and persistence.

On-the job Search

Every worker who remains employed when a period begins has to decide whether to look for a new job or not. We assume that each worker employed at the beginning of a period draws a number that determines his job satisfaction from working at his present job in the current period.[6] This number is drawn from a random distribution with cumulative distribution function $G(\nu)$ which is unimodal with mean equal to unity. To keep the model simple, we assume that every worker makes a new independent draw from $G(\nu)$ every period.[7] Let w_t^i denote the wage set by firm i in period t. If an individual worker in that firm draws the number $\hat{\nu}$ his utility from staying this period is $w_t^i / \hat{\nu}$. Assuming that all other firms set wage w_t the expected utility from a randomly chosen new job is $\lambda E(w_t / \nu)$ where λ is smaller than unity, reflecting costs of switching

[5] Whether workers send in one or more applications is less important. The important assumption is that search intensity is taken as given for all searchers.

[6] Akerlof, Rose and Yellen (1988) emphasize that both wages and non-pecuniary factors influence quit decisions.

[7] The assumption that the gain from switching jobs is purely temporary is made to simplify the analysis. Of course, we would expect ν to be serially correlated in practice. Allowing for this in the theoretical model would make the analysis extremely complicated, however, since the state of the model would include the changing *distribution* of workers across different levels of job satisfaction. Also, the workers would have to consider effects on utility in future periods when they decide whether to switch jobs.

jobs. Workers find out the level of job satisfaction in a new job only after they have taken it.

There are no costs associated with on-the-job search, so a worker who has drawn $\hat{v}$ will search for a new job if $\lambda E(w_t / v) > w_t^i / \hat{v}$. We assume that $\lambda E(1/v) < 1$, so if wages are the same, most workers prefer to stay at the job they have. These assumptions imply that the fraction of workers in firm i who search in period t is

$$S(w_t^i / w_t) = 1 - G(w_t^i / w_t \lambda E(1/v)), \tag{1}$$

where S is decreasing and convex when the relative wage is near unity.[8]

All searching workers apply for one job each period and submit their applications randomly. The fraction of previously employed workers quitting to take another job is then $(1-s)S(w_t^i / w_t)a_t$, where a_t is the probability that an employed searcher finds a job.

Wage setting

Every worker produces one unit of the good, $q_t^i = n_t^i$, and the demand for the firm's product is a constant-elastic function of the firm's relative price and the real money supply: $q_t^i = (p_t^i / p_t)^{-\eta} m_t / p_t$. The stochastic "money supply" m_t represents various aggregate demand shocks and firms set prices and wages at the beginning of the period, before they observe m_t. When setting the wage, a firm takes account of the fact that labor turnover is costly.[9] For every worker the firm hires, it incurs a hiring cost equal to c times the average wage, w_t. We assume that voluntary quits are sufficiently large so that all employment adjustment can be made by variations in hiring.[10] The firm has discount factor β and hence it will choose w_t^i and p_t^i to maximize:

---

[8] For a very low relative wage, most workers leave the firm and S is concave but this region will not be relevant in equilibrium.

[9] In this section we assume that the wage can be changed every period (month). In Section III we generalize this to the case when the wage is set for N periods

[10] This assumption simplifies, but it is not crucial for the present analysis. It is important for the optimality of nominal wage contracts, however – see Gottfries (1992). Note that we could include some random (exogenous) closure and birth of some firms – creating microeconomic job destruction – without changing the macroeconomic analysis.

$$\mathrm{E}_{\mathrm{t}} \sum_{\tau=t}^{\infty} \beta^{\tau\text{-t}} \left((p_\tau^i - w_\tau^i) \left(\frac{p_\tau^i}{p_\tau} \right)^{-\eta} \frac{m_\tau}{p_\tau} - c w_\tau \left(\left(\frac{p_\tau^i}{p_\tau} \right)^{-\eta} \frac{m_\tau}{p_\tau} - (1-s)\left(1 - S\left(w_\tau^i / w_\tau\right) a_\tau\right) \left(\frac{p_{\tau-1}^i}{p_{\tau-1}} \right)^{-\eta} \frac{m_{\tau-1}}{p_{\tau-1}} \right) \right) \tag{2}$$

The first order conditions for period t are

$$E_t\left[-n_t^i - c(1-s)S'(w_t^i / w_t)a_t n_{t-1}^i\right] = 0, \tag{3}$$

$$E_t\left[\left((1-\eta)\left(\frac{p_t^i}{p_t}\right)^{-\eta} \frac{m_t}{p_t} + \left(w_t^i + c w_t - \beta c w_{t+1}(1-s)(1 - S(w_{t+1}^i / w_{t+1}) a_{t+1})\right)\eta \left(\frac{p_\tau^i}{p_\tau}\right)^{-\eta} \frac{m_\tau}{p_\tau^i p_\tau}\right)\right] = 0\,. \tag{4}$$

The optimal ”efficiency wage” is such that the direct cost of a marginal wage increase equals the reduction in turnover costs associated with a higher wage. It depends on the average wage level, the hiring cost, and the probability that a searcher gets a job. The pricing decision is complicated by the fact that the marginal cost includes not only the hiring cost this period, but also the reduction of hiring costs next period if a worker is hired today rather than the next period. To solve the model, we do not need to use the price equation, however.

The Level and Persistence of Unemployment

Since we are interested in aggregate employment, we consider a symmetric general equilibrium where all firms set the same wage. This is the natural situation since all firms are assumed to be identical and therefore solve the same problem.[11] Then we have from equation (3):

$$E_t[n_t] = \Omega(1-s) n_{t-1} E_t[a_t], \tag{5}$$

[11] We assume that all firms set the wage at the same time so we do not have overlapping contracts. Obviously, overlapping contracts of the Taylor variety may generate persistence, but we want to examine how much persistence we get in the model without this additional source of persistence.

where Ω = -c S'(1) is a measure of the "wage pressure" arising from the efficiency wage mechanism. Wage pressure is higher the higher the turnover cost and the more sensitive quits are to wage changes. We assume that Ω(1-s)>1 so that $E_t[a_t] < 1$ when employment is expected to be constant.

The final step is to find an equation for a_t, the probability to get a job. There are many more workers than firms and we assume that each firm gets at least as many applicants as it has job openings. In this section we consider the case without ranking where the firm has no preferences between employed and unemployed workers but simply draws the desired number of workers randomly from the pile of applications. Then the probability to get a job is total hiring divided by the total number of workers searching:

$$a_t = \frac{n_t - (1-s)(1-Sa_t)n_{t-1}}{1-(1-s)n_{t-1} + (1-s)Sn_{t-1}}, \tag{6}$$

where we simplify notation by writing S(1)=S. Hiring is the number of workers the firm wishes to employ minus the workers who remain from last period, taking into account exogenous and endogenous separations. Searchers consist of both unemployed workers, $1-(1-s)n_{t-1}$, and employed workers searching on-the-job $(1-s)Sn_{t-1}$. Solving equation (6) for a_t we get:

$$a_t = \frac{n_t - (1-s)n_{t-1}}{1-(1-s)n_{t-1}}, \tag{7}$$

which is simply *net* hiring divided by the number of unemployed job seekers. The chance to get a job does not depend on the number of employed workers looking for jobs. The intuition is that every worker who changes jobs leaves one job and takes one job, so the number of jobs available for the remaining searchers remains the same.

Combining (5) and (7) we can solve for expected employment as a function of employment in the previous period:

$$E_t[n_t] = f(n_{t-1}) = \frac{\Omega(1-s)^2 n_{t-1}^2}{(1-(1-s)(1+\Omega)n_{t-1})} \quad . \tag{8}$$

From this equation we can find the steady state employment rate if there are no shocks:

$$n^{SS} = \frac{1}{(1-s)(1+s\Omega)} \quad . \tag{9}$$

Higher wage pressure Ω results in lower employment. An increased flow from employment to unemployment (s) has an ambiguous effect on the natural rate, but for plausible parameter values it raises unemployment.

Since $n_t = m_t / p_t$ and $E_t(n_t) = E_t(m_t)/ p_t$ we can use (8) to derive an explicit dynamic equation for employment as a function of past employment and the monetary shock:

$$n_t = f(n_{t-1})\frac{m_t}{E_t(m_t)}. \tag{10}$$

Because of wage and price rigidity, unexpected shocks to money supply affect employment, and once employment has increased or decreased, it will tend to remain high (or low) in subsequent periods. As a measure of persistence from one period (month) to the next we use the derivative of the function f evaluated at the steady state level of employment:

$$\rho_m \equiv f'(n^{SS}) = \frac{(1-2s)u^{SS} - s^2 n^{SS}}{(1-s)(u^{SS} + sn^{SS})}, \tag{11}$$

where u denotes unemployment. This expression is positive for reasonable values for the parameters.

To understand why employment depends positively on employment in the previous period, imagine that we are initially in steady state. Then the money supply falls unexpectedly and permanently. This happens after wages and prices have been fixed, so firms respond by cutting employment (reducing hiring) and employment stays at this lower level until the end of the period. In the next period firms cut their wages, but not so much that employment immediately returns to its steady state value. If wages would immediately fall by the same per cent as the money supply, there would be a large increase in employment, many vacancies, and high turnover. Foreseeing this, each individual firm would then have an incentive to deviate by not cutting the wage so much, so as to reduce turnover. Therefore, the equilibrium solution must be that firms reduce wages less than the decrease in the money supply and employment remains low for some periods after the negative shock.[12]

II. Effects of Ranking

Having formulated the basic model we are now ready to analyze the effects of ranking. How will ranking affect the basic decisions made by the agents in our model? How will ranking affect the steady state level of employment and the degree of persistence? How big are the effects quantitatively? These are the questions to which we now turn.

Before we incorporate ranking in the model it is important to be clear about what we mean by ranking. In this model, ranking means that employers sometimes, when choosing between applicants for a particular job, prefer to employ someone who has a job rather than to employ an unemployed worker. Formally, we assume that firms rank applicants in this way for a fraction r of the jobs. Since there are many applicants of each category per job, only employed applicants are hired to those jobs.

Why Ranking?

This definition of ranking raises an important question. Why do firms sometimes prefer to hire already employed applicants? A natural argument is that the perceived productivity of an unemployed worker may be lower than that of an unemployed worker because workers lose human capital in unemployment. In fact, it is enough that unemployed workers are perceived to be slightly less productive to justify ranking, provided that the wage is the same. Then, as long as there are employed applicants available, unemployed workers will never be hired and the lower productivity is never

---

[12] A similar argument is made by Huizinga and Schiantarelli (1992) and Gottfries and Westermark

observed. Equivalently, the training cost may be higher for unemployed workers; again this higher training cost would never be paid in equilibrium.

Yet another possibility is that there may be a small number of workers among the unemployed who are unemployable, but this can only be observed after hiring and training, in which case the worker is fired. Then, if the firm hires an unemployed worker, it runs a (small) risk that it will pay the training cost in vain and this will be equivalent to a higher hiring cost for *all* unemployed workers. Again, firms will rationally discriminate unemployed workers. To prevent complete discrimination of the unemployed, and in line with empirical evidence, we assume that the arguments above apply only to a fraction r of the job openings in a given period.

All these arguments can be criticized, however, by arguing that the firm could offer different wages for the different groups, each wage corresponding to the expected productivity (net of hiring cost) of a worker in that group. Thus there must be some rigidity of the wage structure that prevents firms from differentiating wages according perceived productivity differences. We will not try to explain this rigidity in the present paper but we take it as a fact of life. One would expect such a rigidity to be especially pronounced in unionized labor markets because unions tend to insist on "equal pay for equal work", but also without unions, firms seem to find it important to have a "company wage policy" which is perceived as fair by the workers. This may prevent wage differentiation based on productivity differences, which are not readily observed by workers. Evidence that wages tend to be equalized for a given type of job can be found in Bishop (1987), Campbell and Kamlani (1997) and Bewley (1999).[13]

The level and persistence of Unemployment

With ranking, the search and wage setting decisions are made as before, but employed workers are more likely to get hired than unemployed workers are. We assume that workers do not know for which jobs ranking are applied but send in their applications at random. Using a_t to denote the probability that an *employed* searcher gets a job we now have:

(1998), but those papers did not consider on-the-job search.

$$a_t = r\frac{n_t - (1-s)(1-Sa_t)n_{t-1}}{(1-s)Sn_{t-1}} + (1-r)\frac{n_t - (1-s)(1-Sa_t)n_{t-1}}{1-(1-s)n_{t-1} + (1-s)Sn_{t-1}}. \qquad (12)$$

With probability r the worker applies for a job where employed searchers are preferred and in this case the probability to get a job is hiring per firm divided by the number of employed searchers per firm. With probability (1-r) the worker applies for a job where the employer does not have any preference for a particular type of worker and in this case the probability to get a job is hiring divided by the total number of searchers per firm.[14] We see immediately that a_t is higher if more firms rank applicants. Solving (12) for a_t we get:

$$a_t = \frac{(n_t - (1-s)n_{t-1})(r - (r-S)(1-s)n_{t-1})}{(1-(1-s)n_{t-1})(1-s)S(1-r)n_{t-1}}. \qquad (13)$$

Contrary to the case without ranking the fraction of employed workers looking for jobs, S, affects a_t directly. Looking back at equation (12) we see that an increase in S has two counteracting effects on the probability for employed workers to get a job. More on-the-job search means that more workers leave their jobs and this increases the number of job openings, but there are also more applicants for jobs, especially for those jobs which are predestined for employed applicants. Inspecting the right hand side of (12) we see that the latter effect dominates; the more workers that do on-the-job search the smaller is their chance to get a job.

Proceeding exactly as before, we can use (3) and (13) to solve for $E_t[n_t]$ as a function of n_{t-1} (see Appendix 1). Now the employment rate to which the economy converges if there are no shocks is

[13] In the model, all workers are paid the same wage, but more generally, it is enough that wages do not fully reflect productivity differentials.

[14] A probability cannot be higher than unity, however. In case of an extremely positive shock to money supply, employment in period t could potentially be so large that the right-hand side becomes larger than unity. Then all employed job-searchers would be hired (a=1) and the ranking firms would also hire some unemployed workers. We disregard this possibility because it would require an extremely large positive shock.

$$n^{SS} = \frac{S(1-r) - s\Omega r}{(1-s)(s\Omega(S-r) + (1-r)S}. \tag{14}$$

For the steady state level of employment to be positive the following condition must be fulfilled:

$$\frac{1-r}{r} > \frac{s\Omega}{S}. \tag{15}$$

Equation (15) gives a limit to how much ranking our model can take. If r gets very high we get a situation where equilibrium employment is equal to zero. That r cannot be too large is most evident if we consider the extreme case when employers hire almost only employed workers. Then unemployed workers have a very small chance to be hired. Since every period a share s leaves employment but very few unemployed workers get hired employment is only stable at zero. In the following we assume that condition (15) is satisfied.

One may suspect employment to be lower the more ranking there is since ranking implies a less well functioning labor market. In Appendix 1 we show that this is in fact the case:

$$\frac{\partial(n^{SS})}{\partial r} < 0 \quad . \tag{16}$$

This result can be explained as follows. In our model the flow from employment to unemployment is a constant fraction of employment. The flow from unemployment to employment on the other hand is depends on the probability for an unemployed worker to get a job. If more firms rank by employment status this probability is reduced, ceteris paribus, and the only way this can be reconciled with the steady state condition that inflow equals outflow is that the level of unemployment is higher.

Another interesting question is how ranking affects the persistence of unemployment. Solving (3) and (13) for expected employment, differentiating with respect to n_{t-1} and evaluating in steady state we get a measure of persistence (ρ) and differentiating once more with respect to r we can show that ranking increases persistence (see Appendix 1):

$$\frac{\partial \rho_m}{\partial r} > 0. \tag{17}$$

The intuition behind this result can be understood by extending the discussion in the non-ranking case. After a negative shock, the wage will not fall immediately to the new steady state level because, if it did, employment would recover very rapidly and there would be many vacancies and excessive turnover. Thus wages adjust slowly although the level of unemployment is high. This mechanism is reinforced by ranking, since when employed workers have priority for some jobs, their chance to get a new job depends less on the stock of unemployment and more on the number of vacancies. A large stock of unemployment therefore has a weak effect on wages.

Quantitative Effects of Ranking

Having showed analytically that ranking reduces the level of employment and raises persistence we now ask whether these effects can be quantitatively important. To answer this question we choose the following numbers for the fundamental parameters: s = 0.01, S =0.04, Ω = 4. These numbers are not meant to represent any specific economy, but they are in the range of parameter values "fitted" to the US and European labor markets in Section IV below. We then examine what happens to unemployment and persistence as we increase the fraction of jobs for which ranking occurs from zero to 40 percent. The period is taken to be one month.

The results are shown in Table 1. The last column shows the resulting *yearly* persistence of unemployment, defined as $\rho = \rho_m^{12}$. We see that without ranking there will be some, but not very much persistence. Ranking has large effects on both the *level* and the *persistence* of unemployment. If ranking is applied for 30 percent of the jobs, unemployment increases more than three times and becomes much more persistent.

Table 1. The Effect of Ranking on the Level and Persistence of Unemployment

	u	ρ
r=0.0	0.029	0.03
r=0.1	0.040	0.10
r=0.2	0.061	0.30
r=0.3	0.108	0.64
r=0.4	0.370	0.96

Comparing our results to those of Blanchard and Diamond (1994) who found substantial effects on wage dynamics, but only small effects on the steady state, one might wonder why we also get long run effects. Our interpretation is the following. In Blanchard and Diamond the wage is set according to the Nash bargaining solution and the state of the labor market affects wage setting via the ”threat point”, which they take to be the situation if the employed worker was to become unemployed.[15] This means that ranking has two competing effects on the wage. If an employed worker were to become unemployed, his chance to find a new job soon would be much better since he would be “first in line” for new jobs. But on the other hand he does run a small risk of becoming long-term unemployed himself, and then he is worse off by ranking. The simulations made by Blanchard and Diamond show that these two effects almost balance and the net effect on the wage is small - unless workers are very myopic.[16]

In our model the worker can continue to work at his old job if he does not get the one he applies for. Since employed job-searchers do not risk becoming long-term unemployed the second effect does not appear. Therefore, ranking has an unambiguous and strong effect on wages and employment also in the long run.

Effects of individual parameters

In Table 2 we report the effect on unemployment and persistence as we vary one parameter at the time, starting from a baseline case where 25 per cent of the firms rank applicants.

---

15 See Gottfries and Westermark (1998) for a criticism of this way of modeling wage bargaining.

16 Similar results have been obtained in other models; see Machin and Manning (1999).

Table 2. Effects of a 20% increase in each parameter in an economy with ranking.

	s	S	Ω	r	u	ρ
Baseline case	**0.010**	**0.030**	**4.00**	**0.25**	**0.078**	**0.45**
s increases	**0.012**	0.030	4.00	0.25	0.110	0.56
S increases	0.010	**0.036**	4.00	0.25	0.069	0.36
Ω increases	0.010	0.030	**4.80**	0.25	0.112	0.62
r increases	0.010	0.030	4.00	**0.30**	0.109	0.64

In order to understand the effects of changes in the parameters, note that firms are always on their labor demand curves, so if employment falls, it must be because wages increase, and conversely. Thus we can infer what happens to employment by examining how wages are affected by the parameter change for a given level of employment. Note also that persistence depends on *how quickly* wages adjust after a shock to employment.

A higher exogenous flow from employment to unemployment (s) implies that for a given level of employment there will be more job openings, it will be easier for searchers to get a job. Firms therefore raise wages and unemployment increases. Also, there is an increase in persistence.

An increase in on-the-job search (S) implies that there are more people applying for jobs and less chance to get a job, so firms will reduce wages. Employment increases and there is less persistence.

An increase in wage pressure (Ω) obviously raises wages and leads to higher unemployment, and it also slows down wage adjustment after a shock, so unemployment becomes more persistent. As discussed above, ranking (r) has the same qualitative effect as wage pressure, but from Table 2 we see that *ranking has a relatively stronger effect on persistence*. Intuitively, an increase in r not only raises the probability that employed job-searchers find jobs, but also makes this probability depend more on the number of job openings and less on the unemployment rate (c. f. equation (12)).

It is worth noting that unemployment benefits do not affect unemployment in our model because on-the-job search is unaffected by benefits and quits into unemployment are taken as exogenous.[17] Implicitly, we have assumed that workers who want to look for another job need not quit their current job to do so, and that those who quit into unemployment do this for other reasons. This is in line with evidence that unemployed workers spend a rather small fraction of their time on job search, so in most cases it is possible – often advantageous - to remain employed while searching for a new job.[18] In a more general model, where quits to unemployment were endogenous, there would be a role for unemployment benefits affecting turnover and wages.[19] Also, there are other ways in which unemployment benefits may matter in practice, e. g. affecting the search intensity of the unemployed or their reservation wages, or through direct effects on the outcome of wage bargains. Available empirical evidence shows that the effects of benefits on the behavior of the unemployed are rather small, however, and it is hard to see why benefits should affect wage bargains directly.[20] Thus, the unemployment benefit system may be much less important for wages and unemployment than conventional bargaining, off-the-job search, and shirking models would lead one to think.

III. Medium-term Wage Contracts

So far, we have assumed that wages are changed as often as search and hiring decisions are made, i. e. every week or month, but in practice wages are changed less frequently. Union contracts typically extend for 1-3 years, and less formal "implicit" contracts in non-union sectors probably also extend for some time. Since medium-term wage contracts themselves contribute to persistence, it is important to compare these two sources of persistence and to examine the interaction between them.[21] We now assume that wages are fixed for N periods. To be concrete, we may take the period (t) be one month and assume that wages are changed in January each year, so N=12.

[17] See Tranaes (2000) for a similar argument.

[18] For a review of such evidence, see Chapter 8 in Layard, Nickell and Jackman (1991).

[19] Endogenous quits to unemployment would complicate the dynamic analysis considerably. See Ljungqvist and Sargent (1995) for a model with endogenous quits.

[20] Layard, Nickell and Jackman (1991) and Holmlund (1998) review empirical work on the effect of benefits on exit rates from unemployment Gottfries and Westermark (1998) criticize the standard application of the Nash bargaining solution to wage negotiations.

[21] Also, the importance of unexpected shocks is much greater when wages are fixed for substantial periods.

To avoid some technical complications in this case, we assume that the firm has to choose one employment level for the whole year after it has observed the shock for the current year.[22] Turnover occurs throughout the year. Now the efficiency wage condition corresponding to (3) becomes:

$$E_T\left(Nn_T^i\right) = -(1-s)cS'(w_T^i / w_T)E_T\left(a_{1T}n_{T-1}^i + (N-1)a_{2T}n_T^i)\right), \tag{18}$$

where T is a time index for years, E_T denotes the expectation conditional on information available when firms set wages for year T, a_{1T} is the probability to get a job in the first period of the wage contract (in January) and a_{2T} is the probability to get a job in the remaining periods (February-December). For simplicity we ignore discounting within the year. Considering a symmetric general equilibrium, defining Ω as before and using (13) we now get:

$$NE_T(n_T) = \Omega(1-s)E_T\left[\frac{n_T - (1-s)n_{T-1}(r-(r-S)(1-s)n_{T-1})}{(1-(1-s)n_{T-1})(1-s)S(1-r)} + (N-1)\frac{sn_T(r-(1-s)(r-S)n_T)}{(1-(1-s)n_T)(1-s)S(1-r)}\right]$$

$$\approx \Omega(1-s)\frac{E_T(n_T) - (1-s)n_{T-1}(r-(r-S)(1-s)n_{T-1})}{(1-(1-s)n_{T-1})(1-s)S(1-r)} + \Omega(1-s)(N-1)\left[H(E_T(n_T)) + \frac{H''(E_T(n_T))}{2}\sigma^2\right] \tag{19}$$

where

$$H(x) \equiv \frac{sx(r-(1-s)(r-S)x)}{(1-(1-s)x)(1-s)S(1-r)},$$

where we have used a Taylor approximation to the function H(x), H"(x) denotes the second order derivative, σ^2 denotes the variance of employment and we have

[22] If the wage is set for a year, but the firm is allowed to change employment every month, there will be complicated within-year employment dynamics. When hiring, firms take account of the probability that a hired worker quits in the next period, in which case they do not save hiring costs in that period. Such within-year dynamics appear peripheral relative to our purpose and we avoid it by assuming that employment changes once each year.

disregarded terms involving higher moments of the distribution.[23] As expected, persistence increases and this is illustrated in Table 3 where we set s, S and Ω as in Table 1 and show yearly persistence (ρ) for wage contracts of different length and different levels of ranking.

Table 3. Persistence (ρ) with one-month, one-year and two-year wage contracts.

	N=1	N=12	N=24
r=0.0	0.03	0.19	0.32
r=0.1	0.10	0.28	0.41
r=0.2	0.30	0.44	0.53
r=0.3	0.64	0.69	0.72
r=0.4	0.96	0.96	0.96

We see that wage contracts contribute to persistence but the effect is fairly modest compared to the effect of ranking. For example, increasing the length of the wage contracts from one to twelve months increases ρ to 0.19 while increasing the fraction of jobs with ranking to 30 % raises persistence to 0.64. Note also that with r equal to 0.3 or higher, the speed of adjustment of employment is so low in any case that medium term wage contracts add very little to persistence.[24]

IV. Interpreting the Difference between Europe and the US

Compared to the US, unemployment is higher in Europe, turnover is lower, and fluctuations in unemployment are much more persistent. An interesting question is whether the mechanisms discussed above could potentially explain this difference. To answer this question we now ask what the values of the fundamental parameters have to be if the outcome in the model is to be consistent with key labor market statistics for

[23] In the simulations in Section IV the variance term is omitted since it does not affect the results in any significant way.

[24] We consider wage contracts that fix one wage for the whole contract period. In practice, union contracts that extend beyond one year typically specify one wage for each year and hence they are less rigid than the 24 months wage contract considered here. The one-year wage contract seems most relevant.

each of the labor markets in the US, Germany and France.[25] Our purpose is not to test the model, but simply to ask whether the mechanisms discussed here could *potentially* explain the dramatic differences that we see in labor market outcomes.

Before starting we should note that we did not allow for union bargaining in our model. Since unions tend to raise wages we can, informally, think of them as a factor that adds to wage pressure (Ω) in this model. Thus a high value of Ω may reflect a strong efficiency wage mechanism or strong unions or a combination of the two.[26]

We take the period to be one month and the length of wage contracts to be 12 months in all three countries. There are four fundamental parameters in the model: the fraction of the employed workers leaving to unemployment in each period, s, the fraction of employed workers that apply for a new job each period, S, wage pressure, Ω, and the fraction of jobs for which firms rank applicants, r. While s can be measured reasonably well we lack direct measures of the other parameters. However, we do have estimates of the following three empirical magnitudes: the job-to-job flow S times a, the fraction of the workforce that is unemployed u, and the persistence of unemployment ρ. These estimates, which have been collected from various sources, are reported in the first part of Table 4. The measurement of the different flows and stocks is discussed in Appendix 2. As we see in the table, turnover rates are much lower in the European countries: both quits into unemployment and turnover between jobs are between one quarter and half the rates observed for the US. Unemployment is higher in Europe and unemployment is much more persistent.

We now ask the following question: Are there plausible values of the fundamental parameters S, Ω, and r such that Sa, u and ρ take values consistent with empirical estimates?[27] Since we have three free parameters and three observable

---

[25] We think of Germany and France as examples of European economies with high and persistent unemployment. We choose not to look at the Scandinavian countries since centralized wage setting differs in fundamental ways.

[26] Gottfries and Westermark (1998) develop a wage bargaining model where the union wage turns out to be equal to the "efficiency wage" times a "union markup factor". This has approximately the same effect as an increase in Ω in the present model. Unfortunately, the dynamic nature of the present model makes explicit treatment of bargaining technically complicated.

[27] In principle, one could examine how well the model explains other observations. With comparable time series data on labor market flows one could examine whether the model is consistent with cyclical fluctuations of these flows in different countries. Also, one could examine the relation between employment and wages, but this requires a more explicit modeling of the shocks (real and nominal). These topics are left for future research.

magnitudes, we have zero degrees of freedom, meaning that we can just identify the values of the fundamental parameters using the steady state equations in our model - provided that a solution exists. But a priori, it is not obvious that a solution exists, and even if a solution exists, the resulting parameter values may be implausible.

As it turns out, a solution exists and the implied values for S, Ω and r are presented in the second part of Table 4. At the bottom of the table we also report the implied chance for employed and unemployed job-searchers to get a job in steady state.

Table 4 Observable magnitudes and implied values for the parameters.

	Parameter	US 1968-86	Germany 1986-88	France 1986-88
Empirical estimates:				
Separations to unemployment	s	0.015	0.004	0.006
Job-to-job flow	Sa	0.012	0.004	0.006
Unemployment rate	u	0.07	0.08	0.106
Persistence	ρ	0.36	0.90	0.90
Fitted parameter values:				
On-the-job search	S	0.042	0.010	0.014
Wage pressure	Ω	3.540	2.417	2.342
Ranking	r	0.185	0.446	0.448
Implied chance to get a job:				
Probability employed	a	0.29	0.41	0.43
Probability unemployed	a^u	0.17	0.044	0.044

It seems that in order to "explain" the observed smaller worker flows, higher unemployment rates and much higher persistence in Europe with this model, we must assume that there is much less on-the-job search, a bit lower wage pressure and much more ranking in Europe than in the US.[28]

[28] The result that there is lower wage pressure in Europe does not appear to be very robust to changes in input data but the other results are quite robust (see below).

Interpretation of the Results

Why do we get this result? Consider the difference between the US and France! First, s is lower in France and since job-to-job flows are much smaller in France, it seems reasonable that S is also lower in France. As we discussed in Section II, s and S have counteracting effects on unemployment and persistence so the net effect is ambiguous a priori. To see what a generally lower mobility implies in this model, consider what happens to employment and persistence as we change *both* s and S from the higher US values to the lower French values, keeping Ω and r at the US values. This is done in Table 5.

Table 5. Changes in unemployment and persistence as s and S change from the US values to the French values keeping Ω and r at US values.

s	S	u	ρ
0.01500	0.042	0.070	0.36
0.01275	0.035	0.061	0.37
0.01050	0.027	0.052	0.39
0.00825	0.020	0.043	0.40
0.00600	0.012	0.036	0.46

When we decrease the turnover rates, starting from values fitted to the US economy, we get *lower* unemployment and somewhat higher persistence. From this it is clear that the reduction in unemployment coming from lower s dominates the effect in the opposite direction from lower S. When it comes to persistence the opposite is true: the effect from lower S dominates. From this exercise we can conclude that the lower turnover rates characterizing European labor markets by themselves should imply *lower* unemployment and only somewhat higher persistence compared to the US. Thus, we have to find the explanation for the high and very persistent unemployment in Europe among the other two factors.

Wage pressure and ranking have similar effects in the model: both tend to raise the level and the persistence of unemployment. Thus, the higher level of unemployment and higher persistence in Europe could potentially be explained either by higher wage pressure due to strong unions or by more prevalent ranking, or by some combination of these factors. But as we have seen in Section II, ranking has a relatively stronger effect on persistence.[29] This is why the simulation points to more prevalent ranking as a potential explanation of the much higher persistence observed in Europe.

Are the results robust?

As discussed in Appendix 2, there is some uncertainty concerning several of the numbers used to describe the different economies. How sensitive are our conclusions to the precise choice of numbers? To check this, we change the input data one at a time holding the other parameters constant. As can be seen from Table 6, our conclusion that ranking is more prevalent in Europe seems to be quite robust to changes in input data. We can increase or decrease every flow parameter by at least around 50 per cent without changing our qualitative conclusions.

Table 6. The intervals for which our result that European economies have a higher degree of ranking than the US holds when one input is changed at a time.

Input	France	Germany
s	$0.0015 \leq 0.006 \leq 0.009$	$0.001 \leq 0.004 \leq 0.007$
Sa	$0.002 \leq 0.006 \leq 0.018$	$0.0015 \leq 0.004 \leq 0.016$
ρ	$0.70 \leq 0.90 \leq 0.94$	$0.70 \leq 0.90 \leq 0.95$

Are the results plausible?

The result that there is less on-the-job search in Europe is hardly surprising given the much lower turnover rates. European workers appear to be less mobile and this may be due to cultural differences, poorly functioning housing markets etc.

The simulations suggest that *ranking* could potentially be an important cause of high unemployment and, especially, high persistence in Europe. Unfortunately, we do not have direct measures of ranking which are comparable across countries, but the result is in line with what we would expect a priori. As discussed above, firms will rationally prefer to hire already employed workers if two conditions are fulfilled: i) they expect unemployed workers to have lower average productivity and ii) wages cannot be

[29] Put differently, if we increase wage pressure only until unemployment reaches the level observed for France, we get less persistence than what we observe empirically.

adjusted to make up for the difference in productivity. The loss of human capital in unemployment should be similar in different economies, but there are strong reasons to believe that wages are more rigid in Europe. Unions typically tend to compress wage distributions, especially within groups with similar jobs and qualifications, and insist on wage differentials being based on objective and verifiable criteria – "equal pay for equal work". This role of unions is strongly emphasized by Freeman and Medoff (1984), for example.[30] Thus it seems likely that employers in Europe find it much more difficult to differentiate wages according to perceived productivity differentials compared to the US where unions are nonexistent in most sectors. Consistent with this view, there is evidence that workers who are laid off in Europe get a smaller wage reduction compared to the previous job than US workers - *if* they get a new job.[31] Of course, their chance to get a new job is much smaller.

Wage pressure is found to be of the same order of magnitude in our three economies.[32] As we noted above, unions tend to raise wages and can, informally, be thought of as a factor that adds to wage pressure (Ω) in this model. Thus a high value of Ω may reflect a strong efficiency wage mechanism or strong unions. Unions are stronger in Europe, but the higher mobility of the US workforce should make the efficiency wage mechanism more important in the US. If US workers search more on the job (higher S) we would also expect their job search to be more responsive to wage changes (higher S').[33] Our result that the level of wage pressure is roughly similar may reflect these counteracting effects.

To sum up, these simulations should not be regarded as a test of the model, nor as proof that ranking is important, but they do show that ranking *may* be an important factor that explains the persistence of unemployment in general, and the persistence of European unemployment in particular.

30 See also Freeman (1982) and, for more general evidence that unions tend to equalize wages, Blau and Kahn (1996, 1999). Westermark (1999) develops a union formation model where unions tend to compress wage differentials.

31 Classical papers are Gibbons and Katz (1991) and Jacobson, Lalonde, and Sullivan (1993). Burda and Mertens (1999) review the evidence and report evidence for Germany. See also Grund (1999) and Bender et al. (1999).

32 In fact, it is somewhat lower in the European economies than in the US, but this conclusion is not very robust with respect to changes in input data.

33 This is not a necessary connection, however. It could be that higher microeconomic volatility and larger wage dispersion in the US raise turnover, but still the *effect* of the wage on turnover (S') is the same as in France.

References

Agell, Jonas, and Per Lundborg, “Survey Evidence on Wage Rigidity and Unemployment: Sweden in the 1990s,” Working Paper 1999:12, Uppsala University, 1999.

Akerlof, George A., Andrew K. Rose, and Janet L. Yellen, “ Job Switching and Job Satisfaction in the U.S. Labor Market,” *Brookings Papers on Economic Activity,* 2 (1988), 494-582.

Alogoskoufis, George S., and Alan Manning, “On the Persistence of Unemployment,” *Economic Policy*, 7 (1988), 428-469.

Anderson, Patricia M. and Bruce D. Meyer, “The Extent and Consequences of Job Turnover,” *Brookings Papers on Economic Activity* (1994), 177-248.

Assarsson, Bengt, and Per Jansson, “Unemployment Persistence: The Case of Sweden,” *Applied Economics Letters*, 5 (1998), 25-29.

Bishop, John, The Recognition and Reward of Employee Performance,” *Journal of Labor Economics*, 5 (1987), S36-S56.

Bean, Charles R., “European Unemployment: A Survey,” *Journal of Economic Literature*, 32 (1994), 573-619.

Bender, Stefan, Christian Dustmann, David Margolis and Costas Meghir, “Worker Displacement in France and Germany,” Working Paper W99/14, The Institute for Fiscal Studies, 1999.

Bewley, Truman F., *Why Wages Don't Fall During a Recession*, Harvard University Press, Cambridge, 1999.

Blanchard, Olivier J., “Wage Bargaining and Unemployment Persistence,” *Journal of Money, Credit and Banking*, 23 (1991), 277-292.

Blanchard, Olivier J., and Peter Diamond, “The Cyclical Behavior of the Gross Flows of U.S. Workers,” *Brookings Papers on Economic Activity*, 2 (1990), 85-155.

Blanchard, Olivier J., and Peter Diamond, “Ranking, Unemployment Duration and Wages,” *Review of Economic Studies*, 61 (1994), 417-434.

Blanchard, Olivier J., and Lawrence H. Summers, “Hysteresis and the European Unemployment Problem,” In: *NBER Macroeconomics Annual*, 1, MIT press, Cambridge, MA, 1986.

Blau, Francine D., and Lawrence M. Kahn, “International Differences in Male Wage Inequality: Institutions versus Market Forces,” *Journal of Political Economy*, 104 (1996), 791-836.

Blau, Francine D., and Lawrence M. Kahn, “Institutions and Laws in the Labor Market,” In *Handbook of Labor Economics*, Volume 3, Elsevier Science, North-Holland, 1999.

Blau, David M., and Philip K. Robins, “Job Search Outcomes for the Employed and Unemployed,” *Journal of Political Economy*, 98 (1990), 637-655.

Blinder, Alan S., and Don H. Choi, “A Shred of Evidence on Theories of Wage Stickiness,” *The Quarterly Journal of Economics*, 105 (1990), 1003-1015.

Boeri, Tito, “Enforcement of Employment Security Regulations, On-the-job Search and Unemployment Duration,” *European Economic Review*, 43 (1999), 65-89.

Burda, Michael, and Charles Wyplosz, “Gross Worker and Job Flows in Europe,” *European Economic Review*, 38 (1994), 1287-1315.

Burda, Michael, and Antje Mertens, “Wages and Worker Displacement in Germany,” CEPR Discussion Paper 1869, 1999.

Cambell III, Carl M., and Kunal S. Kamlani, “The Reasons for Wage Rigidity: Evidence from a Survey of Firms,” *Quarterly Journal of Economics*, 102 (1997), 759-789.

Freeman, Richard B., “Union Wage Practices and Wage Dispersion Within Establishments,” *Industrial-and-Labor-Relations-Review*, 36 (1982), 3-21.

Freeman, Richard B., and James L. Medoff, “*What Unions Do?*,” Basic Books, New York, 1984.

Gibbons, Robert, and Lawrence F. Katz, “Layoffs and Lemons,” *Journal of Labor Economics*, 9 (1991), 351-380.

Gottfries, Nils, “Insiders, Outsiders, and Nominal Wage Contracts,” *Journal of Political Economy*, 100 (1992), 252-270.

Gottfries, Nils and Henrik Horn, “Wage Formation and the Persistence of Unemployment,” *Economic Journal*, 97 (1992), 877-884.

Gottfries, Nils and Allan Drazen, “Seniority Rules and the Persistence of Unemployment,” *Oxford Economic Papers*, 46 (1994), 228-244.

Gottfries, Nils, and Andreas Westermark, "Nominal Wage Contracts and the Persistent Effects of Monetary Policy," *European Economic Review*, 42 (1998), 207-223.

Grund, Christian, "Stigma Effects of Layoffs? Evidence from German micro-data," *Economics Letters*, 64, 241-247.

Holmlund, Bertil, *Labor Mobility*, Almqvist & Wicksell, Stockholm, 1984.

Holmlund, Bertil, "Unemployment Insurance in Theory and Practice," *Scandinavian Journal of Economics*, 100 (1998), 113-141.

Huizinga, F., and Fabio Schiantarelli, "Dynamics and Asymmetric Adjustment in Insider-outsider Models," *Economic Journal*, 102 (1992), 1451-66.

Jacobson, Louis S., Robert J. Lalonde, and Daniel G. Sullivan, "Earnings Losses of Displaced Workers," *American Economic Review*, 83 (1993), 685-709.

Jaeger, Albert, and Martin Parkinson, "Some Evidence on Hysteresis in Unemployment Rates," *European Economic Review*, 38 (1994), 329-342.

Lane, Julia, David Stevens and Simon Burgess, "Worker Flows and Job Flows," *Economics Letters,* 51 (1996), 109-113.

Layard, Richard, and Stephen Nickell, "Unemployment in Britain," *Economica*, 53 (1986), S121-S169.

Layard, Richard, Stephen Nickell, and Richard Jackman, *Unemployment - Macroeconomic Performance and the Labor Market*, Oxford University Press, Oxford, 1991.

Ljungqvist, Lars, and Thomas J. Sargent, "The Swedish Unemployment Experience," *European Economic Review*, 39 (1995), 1043-1070.

Ljungqvist, Lars, and Thomas J. Sargent, "The European Unemployment Dilemma," *Journal of Political Economy*, 106 (1998), 514-550.

Machin, Stephen and Alan Manning, "The Causes and Consequences of Longterm Unemployment in Europe," In *Handbook of Labor Economics*, Volume 3, Elsevier Science, North-Holland, 1999.

McCormick, Barry, "Quit Rates over Time in a Job-rationed Labour Market: the British Manufacturing Sector, 1971-83," *Economica*, 55 (1988), 81-94.

OECD, *Employment Outlook*, OECD, Paris, 1999.

Pissarides, Christopher A., "Loss of Skill during Unemployment and the Persistence of Employment Shocks," *Quarterly Journal of Economics*, 107 (1992), 1371-1391.

Pissarides, Christopher A., “Search unemployment with On-the-job Search, *Review of Economic Studies,* 61 (1994), 457-475.

Pissarides, Christopher A., and Jonathan Wadsworth, “On-the-job Search - Some Empirical Evidence from Britain,” *European Economic Review*, 38 (1994), 385-401.

Phelps, Edmund S., *Inflation Policy and Unemployment Theory*, London, Macmillan, 1972.

Tranaes, Torben, “Raiding Opportunities and Unemployment,” forthcoming in the *Journal of Labor Economics*.

Westermark, Andreas, “A Model of Union Formation,” Working Paper 1999:8, Uppsala University, 1999.

Winter-Ebmer, Rudolf, “Some Micro Evidence on Unemployment Persistence,” *Oxford Bulletin of Economics and statistics*, 53 (1991), 27-43.

Appendix 1: The Effect of Ranking on Employment and Persistence

To show that employment is lower with more ranking, differentiate (14) with respect to r:

$$\frac{\partial (n^{SS})}{\partial r}=\frac{\left[-S-s\Omega\right]\left[(1-s)(s\Omega(S-r)+(1-r)S)\right]-\left[-s(1-s)\Omega-(1-s)S\right]\left[(1-r)S-s\Omega r\right]}{\left[(1-s)(s\Omega(S-r)+(1-r)S)\right]^{2}}. \tag{A1}$$

To show that (A1) is negative we have to show that the numerator is negative. Factorization gives us:

$$\left[-S-s\Omega\right]\left[(1-s)s\Omega(S-r)+(1-s)(1-r)S-(1-s)(1-r)S+(1-s)s\Omega r\right]$$

$$=-\left[S+s\Omega\right]\left[(1-s)s\Omega S\right], \tag{A2}$$

which is clearly negative.

To find out how ranking affects the persistence of employment we need to derive the employment equation. Using (3) and (13) we get:

$$E[n_{t-1}]=\Omega\frac{(E_t(n_t)-(1-s)n_{t-1})(r-r(1-s)n_{t-1}+(1-s)Sn_{t-1})}{(1-(1-s)n_{t-1})S(1-r)}. \tag{A3}$$

Differentiation of (A3) with respect to n_{t-1} gives us:

$$\rho_m\equiv\left.\frac{\partial\left(E_t(n_t)\right)}{\partial n_{t-1}}\right|_{n=n^{SS}}=\frac{(1-s)(r-r(1-s)n^{SS}+(1-s)Sn^{SS})(1-(1-s)n^{SS})}{(1-s)(r-r(1-s)n^{SS}+(1-s)Sn^{SS})}$$

$$\frac{-sn^{SS}(-r(1-s)+(1-s)S)(1-(1-s)n^{SS})-sn^{SS}(1-s)(r-(1-s)rn^{SS}+(1-s)Sn^{SS})}{(1-(1-s)n^{SS})} \tag{A4}$$

where n^{SS} is given by equation (14). Equation (A4) can now be differentiated with respect to r. Let N and D denote the numerator and denominator in (A4) respectively. To show that the resulting expression is negative it is sufficient to show that D>N and that the derivative of the numerator is bigger than the derivative of the denominator.

By looking at the equation above we clearly see that D>N since the expressions in the numerator and denominator is similar except that the numerator contains two extra terms which can be written as:

$$-s(1-s)Sn^{SS} < 0 . \tag{A5}$$

Furthermore, it can easily be verified that the derivative of the numerator is bigger than the derivative of the denominator. The only thing that differs is the term

$$-s(1-s)S\frac{\partial n^{SS}}{\partial r} > 0 \tag{A6}$$

in the derivative of the numerator and this expression is clearly positive so the derivative of the numerator is bigger than the derivative of the denominator. Combining these two facts concludes the proof.

Appendix 2: Data

The flow into unemployment (s)

We generally have fairly good estimates of this parameter. Before discussing the data sources, however, there are two things worth noting. First, since we are interested in steady state situations the flows in and out of employment/unemployment have to be equal. Second, in our model a worker is always either employed or unemployed and we do not formally model movements in and out of the labor force. These two factors add a bit of complication because empirical studies often present results where the flows are not perfectly equal and where out-of-the labor force is included with flows to and from it. In a complete model the flows in and out of the labor force should be included but for simplicity we choose to ignore such flows and take the steady state flows between employment and unemployment as the average of the in and out flows.

The exclusion of labor force dynamics can partially be justified by arguing that these flows merely represent the exchange of workers between in and out of the labor force; i.e. workers retiring and being replaced by workers directly out of school, parents taking child leave etc. Furthermore, as is shown in Blanchard and Diamond (1990) the most important dynamics in a recession is the increase in the net flow from employment to unemployment while the net flows to and from the labor force vary much less dramatically.[34]

For the US economy we use values from Blanchard and Diamond (1990). The data are Abowd-Zellner adjusted gross flow series, which are seasonally adjusted data from CPS studies. The data set covers the period January 1968 to May 1986 and gives us monthly figures. The flow to/from unemployment averages 1.4 million per month. To get this in fractional form we divide it with the average stock of employment taken from the CPS, which is 93.2 million. The result is a flow from employment to unemployment equal to 1.5 percent of employment.

For the continental European economies we use data from Layard, Nickell and Jackman (1991) based on OECD sources. These data measure the total inflow into unemployment so it includes flows from out-of-the labor force into unemployment but

[34] Alternatively, we may think of some of the people out of the labor force as “semi-unemployed”. In theory, we may define unemployment to include this stock, but it implies that our measure underestimates the true amount of unemployment.

it also excludes workers who flow in and out of unemployment very quickly. For Germany they report an inflow rate into unemployment of 0.4 per cent monthly for the period 1986-88. For France the corresponding flow is 0.6 per cent.

The flow from job-to-job (Sa)

Data on this flow is generally of lower quality compared to data for the flows discussed above. Since there do not exist any direct studies of this flow we instead have to rely on approximations from other data. This is often done by using series of separations and new hires. The result is obviously less precision in the estimates than ideally but for our calibrations these data are sufficient.

For the US economy we continue to use Blanchard and Diamond (1990) as our data source. They conclude that job-to-job movements represent 60 per cent of quits in the manufacturing sector from 1968-88. Furthermore, they approximate quits to 0.401 million out of 19.739 million employed workers for the period 1968-81. This figure is confirmed by Akerlof, Rose and Yellen (1988) who report a monthly quit rate from 1948-81 of around 2 per cent. This implies a fraction of job-to-job movements of Sa=(0.401 / 19.739) 0.6 = 0.012.

For the continental European economies we have had some problems obtaining accurate data. We have found two principal data sources; Burda and Wyplosz (1994) report data for 1987 from national statistics and Boeri (1999) who report data from the year 1992. Boeri gets his data by taking the annual hiring rate and subtracting all annual inflows into employment from unemployment and inactivity to obtain an employment to employment flow. For Germany, Burda and Wyplosz report a job-to-job flow of 0.0797 million per month implying a fraction of 0.0797 / 27.070 = 0.003. For France the corresponding figures are 0.0358 million and 0.0358 / 15.685= 0.002. These are extremely small numbers compared to the US. Boeri, on the other hand, reports corresponding flow rates of 0.0095 for Germany and 0.0073 for France. This means that around 60 per cent of all hiring in Germany as well as 50 per cent of hiring in France are job-to-job flows. Although the figures cover different time periods it is puzzling that they diverge so markedly.[35] In the simulation we assume that 50 per cent

[35] A potential explanation for the difference can be the fact that Boeri uses measures consisting of point-in-time observations that are 12 months apart and therefore does not take into account events occurring within the 12-month period between observations. This can lead to an overstatement of job-to-job flows.

of hiring in both Germany and France is job-to-job flows and thus we assign the same numerical value to the job-to-job flow as to the flow from unemployment to employment, i.e. 0.004 for Germany and 0.006 for France.

Unemployment rate (u):

For the US we use the above mentioned average stocks from the CPS for the time period 1968-86 of 93.2 million employed and 6.5 million unemployed workers. This gives us an unemployment rate of 0.07.

For the European economies OECD (1999) reports an average unemployment rate between 1986-96 of 8 per cent for Germany and 10.6 per cent for France.

Persistence (ρ)

Different authors use very different techniques to estimate persistence and this means that it is difficult to compare different studies. Some studies estimate persistence in simple autoregressive models while some newer studies use the unobserved components (UC) technique. All studies conclude that persistence is higher in the European labor markets.

Two similar studies using standard econometrics are Blanchard and Summers (1986) and Alogokoufis and Manning (1988). The former estimate the persistence of unemployment with yearly data for a number of countries including a time trend and their estimates of ρ are 0.36 for the US, 0.94 for Germany and 1.04 for France. The second study, also with a time trend included, report estimates for the US 0.48, Germany 0.94 and France 1.04.

In our calibration below we use the following estimates; 0.36 for the US and 0.90 for Germany and France. This means that we follow Blanchard and Summers but adjust the European values downwards a bit.

Obviously, the exact numbers can be questioned, but our simulations are meant to illustrate the importance of various mechanisms and, as we show in the text, our qualitative conclusions are quite robust.