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EVALUATION

The persistence of unemployment: Does competition between employed and unemployed job applicants matter?

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Abstract

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This thesis consists of four self-contained essays

Essay 1 (with Nils Gottfries) investigates why unemployment is so persistent in Europe. 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.

Essay 2 investigates the consequences of skill loss as a result of unemployment in an efficiency wage model with turnover costs and on-the-job search. Firms are unable to differentiate wages and therefore prefer to hire employed searchers or unemployed workers who have not lost human capital. It is shown that if some fundamental factor in the economy changes, this will result in a lengthy adjustment process with substantial long run unemployment effects. Moreover, the model is capable of generating persistence but the amount depends on the duration of the shock itself.

Essay 3 considers the optimal hiring strategy of a firm that is unable to observe the productive abilities of all its applicants. Whom the firm considers as hireable, will depend crucially on the extent to which the firm can use its wage setting to mirror productivity differences. However, when setting its wages the firm has to consider other factors as well, e.g. turnover, that may make it optimal not to set wages that fully reflect productivity differences. Instead, it may be optimal to avoid hiring workers that have certain characteristics; i.e. to use a discriminatory hiring strategy. In the paper it is shown that discrimination based on employment status is an equilibrium hiring strategy even when the firm is free to set different wages for workers with different expected productivities. It is also shown that if all firms use such hiring procedures this will have strong implications for the aggregate economy and welfare.

Essay 4 (with Jonas Lagerström) investigates whether being unemployed per se reduces the probability to get contacted by a firm. We use Swedish data from the Applicant Database (Sökandebanken), which contains both employed and unemployed workers who search for a new job. The key advantage with this dataset is that we have access to the same information as firms have when they choose whom to contact. Our results indicate that an unemployed worker faces a lower probability to get contacted by a firm and receives fewer contacts over the sample period. These findings support the claim that firms view employment status as an important signal for productivity.

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Stefan Eriksson

Introduction

Today most European countries suffer from a chronically high unemployment rate. In major countries, such as Germany and France around ten percent of the workforce is unemployed and almost half of those are classified as long-term unemployed. In continental Europe the rise in unemployment started in the late seventies and it has since remained high. In Sweden the unemployment rate remained low until the early nineties and has only recently fallen back. The fact that it takes considerable time for unemployment rates to fall back after a negative shock is often called the persistence of unemployment. A simple measure is the degree of serial correlation in unemployment time series. Empirical estimates of persistence often find that the coefficient on lagged employment is close to unity using European data. Thus, the data indicate that it takes considerable time for employment to return to its equilibrium value following a negative shock.

It has been hard to find a single explanation for the rise in unemployment and the current consensus among economists seems to be that a combination of different shocks contributed to its rise; see for example the discussion in Bean (1994). However, irrespective of what economic disturbances that caused the initial rise in unemployment, the question why the adjustment back to equilibrium has taken so long must be answered before we can claim to understand the dynamics of unemployment.

A theoretical explanation of the persistence of unemployment has to include some mechanism that keeps wages high even when a high unemployment rate exerts downward pressure on wages. In the literature, two such mechanisms have received particular attention. The first idea is that if employed workers with relatively safe jobs control the unions, they will be reluctant to reduce wages even when unemployment is high. Such insider-outsider models can generate persistence following a shock (see for example the models in Gottfries and Horn (1987) and Blanchard and Summers (1986)). However, it has been difficult to show empirically that these effects are important for understanding the high and persistent unemployment rates (see Bean (1994)).

The second idea is based on the argument that employers may perceive some unemployed workers as unattractive to hire because they have lost skills etc and as a result these workers are ignored when wages are set. This idea has been around since the early seventies (see for example Phelps (1972)) but has seldom been formalized in a micro-based model. Examples of the few models that do exist are Blanchard and Diamond (1994) that considers a situation where firms prefer to hire the applicant with the shortest unemployment spell and Pissarides (1992) where firms respond to an average lengthening of unemployment durations by creating fewer jobs. These ideas have received some empirical support but the results are still inconclusive (see Bean (1994)).

This thesis consists of four self-contained essays aimed at trying to increase our understanding of why unemployment, once it has been allowed to rise to a high level, tends to persist. The explanation for the persistence of unemployment being pursued in this thesis is related to the second strand of the literature discussed above and focuses on the characteristics of unemployed searchers and how their ability to compete for jobs interacts with wage setting. It is based on two central ideas; that unemployed workers have to compete with on-the-job searchers for the vacant jobs and that employers may find unemployed searchers less attractive to hire than employed searchers. As will be evident from the analysis later, the implication of these two ideas is that firms will be reluctant to lower their wages following a shock because this would lead to excessive job-to-job turnover, and this will keep wages high and employment low. Thus, this thesis argues that competition between employed and unemployed job applicants does matter for the persistence of unemployment.

The first two essays focus on the macro-economic implications for wages and unemployment if firms, for some reason, prefer to hire employed applicants rather than unemployed and/or long-term unemployed applicants. Theoretical models are formulated and analyzed using numerical solution techniques to determine how the model economies respond to shocks and whether the mechanisms analyzed are sufficiently strong to generate the amount of persistence found in the data. The third essay focuses on one of the key assumptions of the models in the first two essays: i.e. that firms do not set differentiated wages that make them indifferent between groups of applicants with different expected productivity; e.g. employed and unemployed applicants. The purpose of the analysis is to show that, even when firms are allowed to set their wages freely, it can still be optimal not to differentiate wages but rather to avoid hiring from certain groups of applicants such as unemployed or long-term unemployed workers; i.e. that it is an optimal hiring strategy to use discrimination. The last essay, investigates empirically whether or not the key assumption in the theoretical essays, that the probability to get contacted by a firm is higher for employed applicants than for unemployed applicants, is true. In the following, I summarize each essay and present the main findings.

Essay I, *Ranking of Job Applicants, On-the-job Search, and Persistent Unemployment*, written with Nils Gottfries, considers the persistence of unemployment from a macro-economic perspective. The central question being asked is: Why is unemployment so persistent in Europe? The paper emphasizes two aspects of the labor market as important for understanding the persistence of unemployment; that turnover considerations affect wage setting and that firms sometimes prefer to hire employed rather than unemployed job applicants.

To capture these aspects of labor markets, an efficiency wage model is formulated where workers search on the job and where firms set their wages taking into account that turnover is costly. Ranking is then introduced by assuming that some employers prefer to hire employed applicants. It is shown that 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. The model is used to interpret the different labor market outcomes in the US and Europe. Both the level and the persistence of unemployment are much higher in Europe. The 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, the analysis points to ranking of job applicants as a potentially important explanation of the high persistence of unemployment observed in many European labor markets.

Essay II, *Skill Loss, Ranking of Job Applicants, and the Dynamics of Unemployment*, investigates the consequences of skill loss as a result of unemployment, concentrating on its macro-economic implications.

The paper takes as a starting point the ideas in a seminal paper by Blanchard and Diamond (1994) that the duration structure of unemployment might be important for understanding the persistence of unemployment. In that paper, the authors examine how the composition of unemployment affects wage determination in a matching model. They assume that employers always hire the applicant with the shortest unemployment spell. Wages are set in a Nash bargain with the threat point of workers being the utility they would get if they become unemployed. Their main conclusion is that "ranking" affects the short-run dynamics but has only minor long-run effects. The reason being that, since employed workers face a (small) risk to become long-term unemployed themselves, they do not demand too high wages. Thus, their study indicates that explanations based on the duration structure of unemployment are not, by themselves, satisfactory as explanations for the European unemployment experience. My paper takes a new look at this issue by analyzing another mechanism through which the duration structure of unemployment affects wage setting. This is done by adapting the efficiency wage model with turnover costs and on-the-job search developed in Essay I to a situation with two different types of unemployed workers; one group that is identical to employed workers and one group that has lost human capital and thus is not attractive to hire. Since firms are unable to differentiate wages, they prefer to hire employed applicants or unemployed applicants who have not lost human capital

The paper demonstrates that if turnover considerations, skill loss as a result of unemployment, and inability to differentiate wages are important features of real world economies this will affect how the economies respond to both permanent and temporary shocks. The steady state analysis shows that more ranking, a higher risk to lose human capital or more wage pressure all raise equilibrium unemployment, and that the effects are concentrated to the stock of long-term unemployed workers. It is also shown that quite modest permanent changes in the key parameters in the model will result in very lengthy adjustment processes, involving substantial long run effects on the unemployment level. If such slow adjustment processes are a feature of real economies, it is not surprising that economists have difficulties finding the structural causes of the rise in European unemployment. The dynamic analysis shows that temporary shocks have persistent effects, but the magnitude depends on the duration of the shock itself.

Essay III, *Imperfect Information, Wage Formation, and the Employability of the Unemployed*, takes a more micro-oriented perspective and focuses on why an information-constrained firm, that is free to set its wages unilaterally, might find it optimal not to differentiate wages according to productivity differences, but rather to avoid hiring from some groups of workers; i.e. to use a discriminatory hiring strategy.

The paper considers the optimal hiring strategy of a firm that is unable to observe the productive abilities of all its applicants. Whom the firm considers as hireable, will depend crucially on the extent to which the firm can use its wage setting to mirror productivity differences. However, when setting its wages the firm has to consider other factors as well, e.g. turnover, that may make it optimal not to set wages that fully reflect productivity differences. Instead, it may be optimal to avoid hiring workers that have certain characteristics; i.e. to use a discriminatory hiring strategy.

In the paper it is shown that discrimination based on employment status is an equilibrium hiring strategy even when the firm is free to set different wages for workers with different expected productivities. It is also shown that if all firms use such hiring procedures this will have strong implications for the aggregate economy and welfare. The expected probability to find a job will be lower for an unemployed searcher than for an employed searcher and this will tend to put upwards pressure on wages and generate unemployment. It is also shown that it probably is welfare improving to use policy interventions to increase employment. The objective with all such policy measures must be to create incentives for firms to increase their hiring and this can be done in two ways. The first method is to eliminate unproductive job seekers from active search and instead train them to become productive. The second method is to help unemployed workers showcase their abilities to prospective employers. This could, for example, be achieved with some type of trial employment scheme.

The analysis in this paper extends the analysis in two important papers by Gibbons and Katz (1991) and Sattinger (1998). In the first paper, employers who cannot observe the productivity of prospective employees use the layoff history of these workers as a basis for offering different wages; i.e. some fully productive workers suffer by having to accept a lower wage. In the second paper, employers find it optimal to use different employment criteria for groups with different characteristics when they are constrained not to differentiate wages; i.e. some fully productive workers suffer by not finding a job. My paper extends the analysis by showing that even if we allow for flexible wages, this will not necessarily prevent discrimination against groups of workers; i.e. a similar outcome as in Sattinger's paper may arise even if firms are allowed to set different wages as in Gibbons and Katz. This means that we cannot simply assume that flexible wages always will make a firm indifferent between different groups of applicants unless we are willing to allow for implausible arrangements like job fees etc. Instead, it is possible that the wage that the firm considers as optimal for a particular group, taking turnover consequences into account, is so high that it is less profitable to hire from that group than from some other group of applicants.

Essay IV, *Competition between Employed and Unemployed Job Applicants: Swedish Evidence*, written with Jonas Lagerström, investigates empirically whether or not employers prefer to hire employed applicants rather than unemployed applicants.

The purpose is to empirically investigate whether being unemployed *per se* reduces the probability to get contacted by a firm. We use data from the Applicant Database (Sökandebanken) kept by the Swedish Employment Office (AMS) where workers, both employed and unemployed, themselves over the Internet submit their personal details and information about the type of job they want to find. A key feature of this dataset is that we have access to exactly the same information as firms have when they choose whom to contact. This means that we do not need to worry that firms use information that is unobservable to us when they choose whom to contact. Thus, given that we include properly designed control variables for all other factors that affect the contact probability, we can claim to get estimates of the true extent of discrimination based on employment status.

The empirical analysis indicates that an unemployed worker faces a lower probability to get contacted by a firm and receives fewer contacts over the sample period. For the typical searcher, being unemployed reduces the chance to get contacted by a firm with around 7 percent and, if the worker does get contacted, he gets around 12 percent fewer contacts. All results are statistically significant at conventional levels and appear stable over different specifications as well as over different estimation methods.

The findings in this essay support the proposition that employers do view the employment status of the applicants as important when determining whom to hire. The reason for this must be that they believe that there exists a correlation between employment status and the productive abilities of the applicants. Thus, the empirical findings in this chapter support the theoretical explanation of the persistence of unemployment being proposed in the previous essays.

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Essay I

Ranking of Job Applicants, On-the-job Search, and Persistent Unemployment*

1 Introduction

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, unemployment has remained high for a long time after it was raised by temporary cyclical shocks. 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: that turnover considerations affect wage setting and that firms sometimes prefer to hire employed rather than unemployed job applicants.

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

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for the US, Sweden and Japan, and Boeri (1999) finds that worker flows from one job to another constitute around 50 percent of all hiring in several European economies. Pissarides and Wadsworth (1994) report that around 5 percent 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 labor 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 consider the implications for turnover when they set wages. Concerns about hiring and training costs and loss of competence due to turnover 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) find that a substantial fraction of employers view unemployment as a signal of lower productivity.

If there is search on the job, and 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 raise the wage. In other words, we should expect an *interaction* between the turnover considerations that affect wage setting 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 choose whom to hire randomly. We find that, 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. 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 find it plausible that ranking is 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

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

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 shows that interaction between skill loss in unemployment and job creation by firms can make unemployment more persistent. Neither of these papers considers the interaction between on-the-job search, ranking, and wage setting that we emphasize here.[3]

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 with 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 unemployed workers rather than on the distinction between short-term and long-term unemployed workers. 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. Also, 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]

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[2] 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] Pissarides (1992) assumes that long-term unemployment leads to loss of skills. Firms cannot distinguish long-term and short-term unemployed workers, so all job seekers have the same chance to get a job. Unemployment is persistent because long-term unemployment implies a deterioration of the average quality of unemployed workers, which makes it less profitable for firms to create vacancies. Thus the mechanisms are quite different from those considered here. Pissarides (1994) introduces on-the-job search into an equilibrium search-matching model, but the interaction with ranking is not explored.

[4] In a recent paper by Tranæs (2001), 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.

In Section 2 we formulate the basic turnover model without ranking and calculate steady state employment and persistence. In Section 3 we introduce ranking and show that this increases the level and the persistence of unemployment. In Section 4 we extend the model to allow for wage contracts spanning several periods and in Section 5 we discuss potential explanations of the observed differences between European and the US labor markets. In Section 6 we discuss some of the simplifying assumptions in our model and relate our results to the relevant literature.

2 The model without ranking

The model is very stylized and formalizes the idea that job-to-job flows are substantial and that firms care about turnover when they set wages. There are many monopolistic firms and many workers per firm. The labor force is constant and normalized to one. The sequence of events in each period is the following:

i) At the beginning of the period, some of the workers leave employment and enter the pool of unemployment. The fraction leaving to unemployment, s, is exogenously given and represents workers quitting or being laid off for exogenous reasons.

ii) Firms set wages and prices.

iii) The remaining employed workers decide whether to apply for a new job or not, considering the wage offered by the current employer, 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]

iv) Firms receive the applications and observe the aggregate demand shock, m_t. Since price exceeds marginal cost, it is optimal to hire the number of workers required to satisfy demand. We assume that the shocks are never so large that they cannot find workers to hire. In the no-ranking case they choose randomly among the job applicants. In the case of ranking, firms prefer to hire employed applicants for some, randomly chosen jobs.

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

Since the decision in stage iv is trivial, we proceed by first analyzing the search decision of the worker in stage iii, and then analyzing the firm's optimal wage and price decision in stage ii. Finally we examine employment dynamics in a symmetric general equilibrium and calculate the natural rate of unemployment and its persistence.

2.1 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 ν 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(ν) which is unimodal with mean equal to unity and an upper support $\bar{\nu}$. To keep the model simple, we assume that every worker makes a new independent draw from $G(\nu)$ every period.[7] If an individual worker in firm *i* draws the number $\hat{\nu}$, his utility from staying this period is $w_t^i / \hat{\nu}$, where w_t^i is the wage set by firm *i* in period t. 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 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 $\hat{\nu}$ will search for a new job if $\lambda E(w_t / \nu) > w_t^i / \hat{\nu}$. We assume that $\lambda E(1/\nu) < 1$, so if wages are the same, most workers prefer to stay at the job they have. We also assume that the upper support is not so high that workers may prefer to quit into unemployment. These assumptions imply that the fraction of on-the-job searchers in firm *i* in period t is

$$S(w_t^i / w_t) = 1 - G(w_t^i / w_t \lambda E(1/\nu)), \qquad (1)$$

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

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

[7] This assumption is discussed below.

[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.

because there is no cost of search, the decision to search does not depend on the chance to get a job – only on whether the worker would like to change jobs.

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. This probability will be determined below.

2.2 Wage- and price-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, and negative shocks are not too large, so that all employment adjustments can be made by variations in hiring.[10] Then, the number of workers hired is $n_t^i - (1-s)(1-S(w_t^i / w_t)a_t)n_{t-1}^i$. The firm has discount factor β and it will choose w_t^i and p_t^i to maximize:

$$\mathrm{E}_t \sum_{\tau=t}^{\infty} \beta^{\tau\text{-}t} \left\{ \left(p_\tau^i - w_\tau^i\right) n_\tau^i - c w_\tau \left[n_\tau^i - (1-s)\left(1 - S\left(w_\tau^i / w_\tau\right) a_\tau\right) n_{\tau-1}^i \right] \right\} \qquad (2)$$

subject to $n_\tau^i = \left(\dfrac{p_\tau^i}{p_\tau} \right)^{-\eta} \dfrac{m_\tau}{p_\tau}$.

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[9] In this section we assume that the wage can be changed at the beginning of every period (month). In Section 4 we generalize this to the case when the wage is set for N periods

[10] This assumption simplifies the analysis because firms always hire some workers. Without it, the probability to get a job, a_t, would hit the lower bound of zero when there are no job openings. Although expected a_t would always be larger than zero, a sufficiently large negative demand shock may imply that

Substituting the constraint into the objective function and maximizing with respect to w_t^i and p_t^i, we get the first order conditions for period t:

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

$$p_t^i: \quad E_t\left\{(1-\eta)n_t^i + \left(w_t^i + cw_t - \beta cw_{t+1}(1-s)(1-S(w_{t+1}^i / w_{t+1})a_{t+1})\right)\eta \frac{n_t^i}{p_t^i}\right\} = 0. \tag{4}$$

The first condition says that 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. The optimal wage depends on the average wage level, the hiring cost, and the probability that someone searching on the job will get a job.

Since the firm will always satisfy demand ex post, the firm is effectively choosing expected employment when it sets the price. The pricing decision is complicated by the fact that the marginal cost includes not only the hiring cost this period, but also the reduction in hiring costs the next period if a worker is hired today rather than the next period. The probability that a worker, who is hired today, remains with the firm the next period depends on the labor market situation the next period. Thus, the firm faces a dynamic optimization problem in its price/employment decision. As we will see, we do not need to solve this dynamic optimization problem to solve the model, however.

2.3 The level and persistence of unemployment

Since we are interested in aggregate employment, we consider a *symmetric general equilibrium* where all firms enter with the same employment and set the same wage.[11] Then we have from equation (3):

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there are no job openings. We would then have two regimes for a_t, but it should not fundamentally alter the conclusions. Note also that s includes layoffs for personal reasons etc.

[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.

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

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 approximately 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 the parameters to be such that each firm gets at least as many applicants as it has job openings.[12] 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:

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

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:

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

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.

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[12] We check that this is true for the numerical parameter values used in the simulations below.

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

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

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 the 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 percent 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 such that wages fall by less than the initial decrease in the money supply, and employment remains low for some periods after the negative shock.[13] Of course, our model is highly stylized, but we would expect the basic mechanism to operate in more general models.[14]

2.4 Nominal prices and wages

We have solved for the expected level of employment without using the first order condition with respect to the price. This was possible because the model is recursive so that we can find expected employment in a period without considering what happens in the product market. This is analogous to static models where the natural rate of unemployment is independent of the position of the aggregate demand curve. Unexpected demand shocks do affect employment, however, because of short-term wage and price stickiness. To see this more clearly, we evaluate (4) in a symmetric general equilibrium:

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[13] A similar argument is made by Huizinga and Schiantarelli (1992) and Gottfries and Westermark (1998), but those papers do not consider on-the-job search.

[14] The assumption that the gain from switching jobs is purely temporary is made to generate turnover without making the model too complicated. Of course, we would expect "job dissatisfaction" ν to be serially correlated in practice. Allowing for persistence in job satisfaction would make the analysis very complicated, however, because different workers' levels of job satisfaction would affect their propensity to search in future periods. Thus the state of the model would include the changing distribution of workers across different levels of job satisfaction. Intuitively, it seems that this would strengthen the persistence, however: if aggregate employment was low in period t-2, turnover was low in that period, and there are many workers with a relatively low level of job satisfaction. This will induce firms to set a high wage, so employment remains low. In this case, wages and employment depend on the whole employment history.

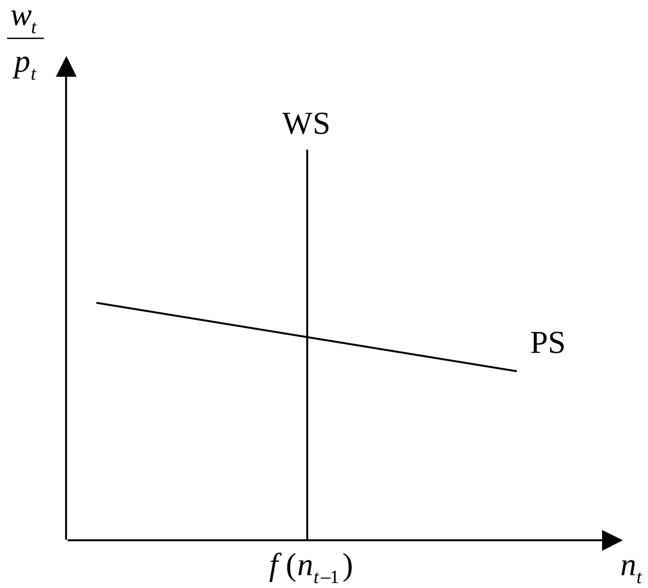
$$1-\eta+(1+c)\eta\frac{w_t}{p_t}-\beta c(1-s)\eta\frac{E_t\left(w_{t+1}(1-S(1)a_{t+1})\right)}{p_t}-\beta c(1-s)\eta\kappa_t=0\,, \tag{12}$$

where κ_t is the conditional covariance between $w_{t+1}(1-S(1)a_{t+1})$ and n_t divided by $p_tE_t(n_t)$.[15] Solving for the real wage we get what may be called a "quasi labor demand curve" or a "price setting curve", i. e. the real wage implied by price setting:

$$\frac{w_t}{p_t}=\frac{\eta-1+\beta c(1-s)\eta\kappa_t}{(1+c)\eta-\beta c(1-s)\eta E_t\left(\frac{w_{t+1}}{w_t}(1-S(1)a_{t+1})\right)}. \tag{13}$$

Figure 1 illustrates the price setting (PS) curve corresponding to equation (13) and the wage setting curve corresponding to equation (8) in real wage-employment space.

Figure 1: The real wage and the aggregate employment level.



[15] Recall that wages and prices are set simultaneously before the stochastic demand variable m_t is observed. In equilibrium, firms realize that all firms are setting the same wages and prices.

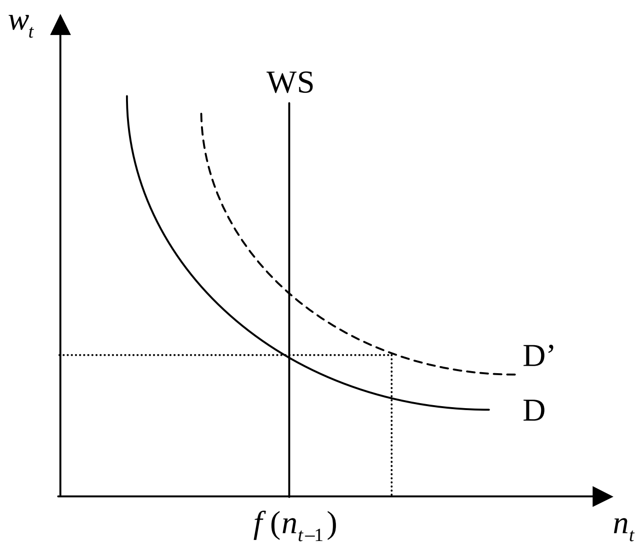
In Figure 1 we have drawn the price setting (PS) curve downward sloping but this is not important for the argument.[16] The important point is that the wage setting curve is vertical so whatever expectations firms have about the future, labor market equilibrium implies that firms set wages so that expected employment equals $f(n_{t-1})$.

We may also consider the relation between the nominal wage and employment. Since $n_t = m_t / p_t$, equation (13) implies:

$$n_t = \frac{\eta - 1 + \beta c(1-s)\eta\kappa_t}{(1+c)\eta - \beta c(1-s)\eta E_t\left(\frac{w_{t+1}}{w_t}(1-S(1)a_{t+1})\right)}\frac{m_t}{w_t}. \tag{14}$$

Figure 2 illustrates the model in nominal wage-employment space.

Figure 2: The nominal wage and the aggregate employment level.



Given expectations about future wage growth etc., aggregate employment is a decreasing function of the nominal wage. This relation is denoted D in Figure 2. Whatever the expectations about m_t, w_{t+1} etc., the nominal wage is set so that expected employment equals $f(n_{t-1})$. Unexpected shocks to nominal demand affect employment

[16] We have drawn it downward sloping because the expectation in the denominator depends on current employment. If current employment is high, wages are expected to rise and employment to fall. Thus

after nominal wages and prices have been set. In order to find nominal wages and prices, we would need to use the price setting and aggregate demand relations, but if we are only interested in labor market dynamics, we can solve the model using only the wage-setting equation and the equation for the probability to get a job.

3 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 hire someone who has a job rather than to hire an unemployed worker. Formally, we assume that firms rank applicants in this way for a fraction r of the jobs. We assume that there are always enough employed job applicants to fill the jobs, so only employed applicants are hired to those jobs.[17]

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

$E(w_{t+1} / w_t)$ is high and $E(a_{t+1})$ is low.

[17] This is not necessarily true in the model, so we have to check that it is true for the parameter values used in the simulations below.

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.[18]

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. It seems to be important for firms to have a "company wage policy" which the workers perceive as fair. Within-firm wage rigidity should be especially pronounced in unionized labor markets because unions tend to insist on "equal pay for equal work", and this prevents 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).[19]

3.2 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 is 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:

[18] We may imagine that some firms always rank, but job applicants do not know this, or that some personnel managers rank. Formally, firms are indifferent between ranking and not ranking in the model.

[19] What is important is not that all workers are paid the same wage, but that wages do not fully reflect productivity differentials.

$$a_t = r\frac{n_t - (1-s)(1-Sa_t)n_{t-1}}{(1-s)Sn_{t-1}} + (1-r)\frac{n_t - (1-s)(1-Sa_t)n_{t-1}}{1-(1-s)n_{t-1} + (1-s)Sn_{t-1}}. \tag{15}$$

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.[20] We see immediately that a_t is higher if more firms rank applicants. Solving (15) for a_t we get:

$$a_t = \frac{(n_t - (1-s)n_{t-1})(r-(r-S)(1-s)n_{t-1})}{(1-(1-s)n_{t-1})(1-s)S(1-r)n_{t-1}}. \tag{16}$$

Contrary to the case without ranking the fraction of employed workers looking for jobs, S, affects a_t directly. Proceeding exactly as before, we can use (3) and (16) to solve for $E_t[n_t]$ as a function of n_{t-1} (see Appendix A). Now the employment rate to which the economy converges if there are no shocks is

$$n^{SS} = \frac{S(1-r) - s\Omega r}{(1-s)\left(s\Omega(S-r) + (1-r)S\right)}. \tag{17}$$

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

$$\frac{1-r}{r} > \frac{s\Omega}{S}. \tag{18}$$

[20] For this equation to make sense it must be the case that there are more employed job applicants than jobs i. e. $(1-s)Sn_{t-1} > n_t - (1-s)(1-Sa_t)n_{t-1}$. In case of a very large positive demand shock, employment in period t could potentially be so large that there are not enough employed job applicants. We disregard this possibility in our theoretical analysis, and check that the inequality is fulfilled for shocks of reasonable magnitude in our numerical simulations below.

Equation (18) 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 employed job searchers have a very good chance to get a job even if there is massive unemployment, so firms will raise wages, and employment falls. In the following we assume that condition (18) 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 A we show that this is in fact the case:

$$\frac{\partial(n^{SS})}{\partial r} < 0. \qquad (19)$$

The intuition is the same as above: more ranking makes it easier for employed job searchers to get a job, so firms raise wages and the demand for labor falls.

Another interesting question is how ranking affects the persistence of unemployment. Solving (3) and (16) 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 A):

$$\frac{\partial \rho_m}{\partial r} > 0. \qquad (20)$$

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 a very large number of vacancies and excessive turnover. Thus, wages adjust slowly although the level of unemployment is high. Ranking reinforces this mechanism. When employed workers have priority for some jobs their chance to get a new job will depend less on the stock of unemployment and more on the number of vacancies. Put differently, a large stock of unemployment has a weak effect on wages when unemployed workers cannot compete well for the jobs, and this slows down wage and employment adjustment after aggregate demand has fallen.

3.3 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: $s = 0.01$, $S = 0.04$, $\Omega = 4$. 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 5 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.[21] 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 the 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.[22]

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.

3.4 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 percent of the firms rank applicants.

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, it is important to realize 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

[21] See Gottfries and Westermark (1998) for a criticism of this way of modeling wage bargaining.
[22] Similar results have been obtained in other models; see Machin and Manning (1999).

level of employment. Note also that persistence depends on *how quickly* wages adjust after a shock to employment.

A higher exogenous *flow into 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.

To understand the effect of an increase in *on-the-job search (S),* consider equation (15). We see that an increase in job search 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, particularly for the ranking jobs. Inspecting the right hand side of (15) we see that the latter effect dominates, so the more workers search on the job, the smaller is their chance to get a job. Therefore, firms reduce wages, employment increases, and there is less persistence.

It may appear counterintuitive that more on-the-job search implies less unemployment. Won't employed job searchers take jobs, which would otherwise be given to unemployed workers? In our model, this is not true because every job switcher leaves a new job opening, which is filled immediately.[23]

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 (15)).

[23] If there was some delay in filling jobs, more job search would imply that more jobs are vacant, but this should be a minor effect.

4 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.[24] 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.

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.[25] Turnover occurs throughout the year. Now the efficiency wage condition corresponding to (3) becomes:

$$E_T\left(Nn_T^i\right) = -(1-s)cS'(w_T^i / w_T)E_T\left(a_{1T}n_{T-1}^i + (N-1)a_{2T}n_T^i\right), \tag{21}$$

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 (16) we now get:

$$NE_T(n_T) =$$

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

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

[25] 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.

$$\approx \Omega(1-s)\frac{E_T(n_T)-(1-s)n_{T-1}(r-(1-s)(r-S)n_{T-1})}{(1-(1-s)n_{T-1})(1-s)S(1-r)}+$$

$$\Omega(1-s)(N-1)\left[H(E_T(n_T))+\frac{H''(E_T(n_T))}{2}\sigma^2\right] \qquad (22)$$

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 disregarded terms involving higher moments of the distribution. 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.[26]

[26] 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

5 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 each of the labor markets in the US, Germany and France.[27] 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.[28]

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 B. Obviously, the exact numbers can be questioned, but our simulations are only meant to illustrate the importance of various mechanisms.

rigid than the 24 months wage contract considered here. The one-year wage contract seems most relevant.

[27] 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.

[28] 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.

Also, we show below that our qualitative results are quite robust with respect to changes in input parameters.

We see that the flow between jobs is of the same order of magnitude as the flow into (and out of) unemployment in all three countries, but turnover rates are much lower in the European countries. All flows 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: can we explain the observed differences between countries using this model? Put differently, are there plausible values of the fundamental parameters S, Ω, and r such that Sa, u and ρ take values consistent with empirical estimates?[29] Since we have three free parameters and three observable 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. 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.

[29] 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.

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	0.80	0.80
Fitted parameter values:				
On-the-job search	S	0.042	0.025	0.029
Wage pressure	Ω	3.540	6.174	4.855
Ranking	r	0.185	0.364	0.383
Implied chance to get a job:				
Probability employed	a	0.29	0.16	0.21
Probability unemployed	a^u	0.17	0.04	0.05

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 less on-the-job search, higher wage pressure, and more ranking in Europe than in the US.[30]

5.1 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 3, 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.

[30] Note that our assumption that there are enough employed job searchers is fulfilled for all countries. For France, 1.2 percent of the jobs are filled every period and 2.9 percent of the employed workers search on the job. This leaves room for a 1.7 percent unexpected increase in employment within a month without running out of employed applicants to the ranking jobs.

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 the US values.

s	S	u	ρ
0.01500	0.042	0.070	0.36
0.01275	0.03875	0.058	0.35
0.01050	0.03550	0.047	0.33
0.00825	0.03225	0.035	0.32
0.00600	0.02900	0.025	0.30

When we decrease the turnover rates, starting from values fitted to the US economy, we get *lower* unemployment and also somewhat lower persistence. The reduction in unemployment and persistence coming from lower s dominates the effect in the opposite direction from lower S. According to our model, the lower turnover rates characterizing European labor markets by themselves should imply *lower* unemployment and *less* persistence compared to the US. Thus, we have to find the explanation for the high and 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, but we saw in Section 3 that ranking has a relatively stronger effect on persistence.[31] This is why the simulation points to more prevalent ranking as a potential explanation of the much higher persistence observed in Europe.

5.2 Are the results robust?

As discussed in Appendix B, 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 parameters in our simulation one at the 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

[31] 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.

robust. We can increase or decrease every flow parameter by at least around 50 percent without changing our qualitative conclusion.

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	$0.0025 \leq 0.006 \leq 0.0088$	$0.0019 \leq 0.004 \leq 0.0065$
Sa	$0.0023 \leq 0.006 \leq 0.058$	$0.0016 \leq 0.004 \leq 0.055$
ρ	$0.66 \leq 0.80 \leq 0.90$	$0.69 \leq 0.80 \leq 0.91$

5.3 Are the results plausible?

The wage pressure (Ω) and ranking (r) parameters do not have any obvious empirical counterparts. What is potentially observable is the magnitude of on-the-job search, and the chance to get a job for employed job searchers. By construction, a^u is consistent with the observed stocks and flows in the labor market, so we may alternatively consider the *relative* chance to get a job for employed and unemployed job searchers.[32] According to our simulations, employed job searchers in the US have almost twice as large a chance to get a job as unemployed workers, while employed job searchers in Germany and France have about four times greater chance to get a job.

Unfortunately, there are very few empirical studies of on-the-job search that we can use to examine whether the magnitudes in Table 4 are reasonable. One of the few relevant studies is Blau and Robins (1990), who examined US data. They found that employed job searchers got about twice as many job offers as unemployed searchers, a number very close to what we get in our simulations. At the same time, they got higher frequencies of job offers than is implied by our simulations, but this may be due to cyclical effects.[33] We have not found any comparable studies for Germany or France.

We may also ask whether institutional differences between the countries would lead us to expect more ranking in Europe. As discussed above, firms will rationally prefer to hire already employed workers if they expect unemployed workers to have

[32] By construction $a^u = sn/(1-(1-s)n)$.

[33] Their study concerned job search in 1979 and the authors note that their dataset has a “considerably higher offer rate than other data”.

lower average productivity, and wages cannot be adjusted to make up for the difference in productivity. The loss of human capital (or negative signal) associated with 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.[34] 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.[35] Of course, their chance to get a new job is much smaller.

Wage pressure is found to be somewhat higher in Germany and France than in the US. As we noted above, unions 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 strong unions. The finding that wage pressure is higher in Europe is quite sensitive to our choice of input parameters, however.[36]

These simulations should not be regarded as a test of the model, or as proof that ranking is important. The purpose of the simulations is only to illustrate the potential magnitudes of the effects. What we have shown is that ranking may be an important factor that affects the level and persistence of unemployment, particularly in Europe.

[34] 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.

[35] 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).

[36] If we set $\rho = 0.9$ in Europe, we get even more ranking and somewhat lower wage pressure in Europe.

6 Discussion

The main purpose of the paper is to point to ranking as a potential reason for high and persistent unemployment. As the economy recovers from a recession, employment grows, and there are many job openings. This raises turnover and creates an upward pressure on wages, which slows down employment growth. High unemployment puts downward pressure on wages, but if unemployed workers cannot compete well for the jobs, unemployment will have a weak effect on wages and the return to equilibrium will be slow.

It should be emphasized that this is not a purely mechanical effect that arises because employed job searchers take some of the available jobs.[37] Every job switcher leaves a job which is immediately filled, so the number of jobs available for unemployed workers is not *directly* affected by on-the-job search or ranking. In fact, it is readily verified that a^u is independent of r and S for given employment.[38] The persistence of unemployment is solely due to indirect effects of turnover on wages and labor demand.

Obviously, our model is very stylized. Many simplifying assumptions are made to make the model solvable and to highlight the main argument. We have abstracted from matching problems, search is modeled in a very simplistic way, quits into unemployment are taken as exogenous, and we disregard disincentive effects of unemployment benefits. We now discuss some of these simplifications and try to relate our analysis to the relevant literature.

In our model, there is excess supply in the labor market and employment is always determined by labor demand. *No matching frictions* prevent firms from immediately hiring the workers they want. Presumably, we could add some frictions without overturning the conclusions, but it is essential to our argument that firms

[37] Burgess (1993) and Anderson and Burgess (2000) discuss congestion effects of on-the job search taking the number of job openings as exogenous. For other references, see Pissarides (2000). Note also that e.g. Pissarides (1994, 2000) uses the word persistence to mean that unemployment *responds slowly to shocks*. We refer to the fact that unemployment *returns slowly to equilibrium* after a temporary (cyclical) shock.

[38] In fact, a^u is always given by (7) – independent of r and S for given employment. This is readily verified by considering the stock/flow relations, or by noting that a^u is equal to the last term in (15), and using (16) to substitute for a_t.

typically face a *choice* between different applicants, some of whom are employed. We view this as a realistic feature of the model.

Search is modeled in a very simple way. There are no costs of search, so employed workers always search if they would like to change jobs. Unemployed workers always search and they are ready to take any job they can get. More realistically, there would be some search costs, so the search decision, particularly that of employed workers, would depend on the expected return to search, which depends on the state of the labor market. This point is emphasized by Burgess (1993) and Anderson and Burgess (2000) who document that labor turnover is so procyclical that the *share* of job openings going to unemployed workers is counter-cyclical.

Allowing for this in the model would make job search an increasing function of the chance to get a job: $S(w_t^i / w_t, a_t)$. We would expect the cross derivative to be negative: search is more sensitive to the wage if there is a higher probability to find a job. This modification will have an ambiguous effect on unemployment persistence. Consider an economy, which is recovering after a recession, so employment grows and there are many job openings. Higher a_t will make search more sensitive to wages, and this tends to raise wages. At the same time, more on-the-job search reduces the chance to get a job for employed job searchers (c. f. equation (15)) so firms can cut wages. Thus it is not clear whether labor demand will recover more or less quickly.

Quits into unemployment are taken as exogenous in the model. Implicitly, we assume 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 assumption 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.[39]

Since both search by unemployed workers and quits into unemployment are taken as exogenous, *unemployment benefits* do not matter. If some workers have to quit their job in order to look for a new job, or job search by unemployed workers is made endogenous, there will be a role for unemployment benefits, and quits will be more

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

procyclical. Also, the dynamic analysis will be complicated by the forward-looking aspects of quits and search.[40]

Our model emphasizes the demand side of the labor market. Supply side explanations of unemployment emphasize that generous unemployment benefits make unemployed workers, who have lost some of their human capital, search less intensely and unwilling to take the jobs they can get. Such mechanisms can explain high unemployment, but they seem less plausible as explanations of the *persistence* of unemployment. While it is true that unemployment persists if some of those laid off due to a negative shock are slow to return to employment, this type of effect becomes progressively less important as those who became unemployed at the time of the shock find jobs. So this type of model cannot explain a persistence of unemployment that is much larger than the average duration of unemployment for individual workers (see Pissarides (1992) and Bean (1994)). The dynamic simulation model of Ljungqvist and Sargent (1998) illustrates this point. Assuming that workers lose on average 40 percent of their human capital when they become unemployed, and that the replacement ratio is as high as 70 percent, they get a very modest amount of persistence in their model.[41] Thus it seems hard to explain the extreme persistence of unemployment that we see in Europe using this type of model.[42]

In the model, we did not explain why some firms prefer to hire employed job applicants. Instead, our purpose was to examine *consequences* of such behavior for the level and the persistence of unemployment. The questionnaire studies quoted in the introduction suggest that ranking occurs, but to find out whether it is really important, we need more direct evidence on the hiring strategies of firms and the magnitude and effectiveness of on-the-job search. If our picture of the labor market has any relevance, ranking and on-the-job search are very under-researched areas of labor economics.

[40] See Ljungqvist and Sargent (1995) for a model with endogenous quits.

[41] About 1/8 of the shock remains after two years; see Table 4 and Figure 8 in Ljungqvist and Sargent (1998).

[42] Available empirical evidence shows clear statistical effects of benefits on exit rates from unemployment, but most studies find a rather small effect. For reviews, see Layard, Nickell and Jackman (1991) and Holmlund (1998).

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Appendix A: Derivation of selected expressions

To show that employment is lower with more ranking, differentiate (17) 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 (16) we get:

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

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

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

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

where n^{SS} is given by equation (17). 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 positive, 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 are 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 B: 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.[43]

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 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 percent monthly for the period 1986-88. For France the corresponding flow is 0.6 percent.

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 percent of quits in the manufacturing sector for the period 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 to 1981 of around 2 percent. 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 job-to-job flows. 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 percent of all hiring in Germany as well as 50 percent of hiring in France are job-to-job flows. Although the figures cover different time periods, it is puzzling that they diverge so

[43] 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.

markedly.[44] In the simulations, we assume that 50 percent 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.

The 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 7 percent.

For the European economies, OECD (1999) reports an average unemployment rate between 1986-96 of 8 percent for Germany and 10.6 percent 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 Alogoskoufis 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, reports the following estimates: 0.48 for the US, 0.94 for Germany and 1.04 for France.

In our calibration, we set ρ to 0.36 for the US and 0.80 for Germany and France. This means that we follow Blanchard-Summers but adjust the European values downwards. We do this partly because ρ may easily be overestimated if there are long-

[44] 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.

term structural changes affecting the natural rate of unemployment, and partly to avoid pushing the model to very extreme values.[45]

[45] If we set ρ very high, we get much ranking and little search on the job, and after a positive shock, there may not be enough employed job applicants for ranking firms to hire. Allowing for this would complicate the model.

Essay II

Skill Loss, Ranking of Job Applicants, and the Dynamics of Unemployment*

1 Introduction

Most European countries suffer from a chronically high unemployment rate. In major continental economies, such as Germany and France, around ten percent of the labor force is unemployed. Moreover, almost half are classified as long-term unemployed; i.e. they have been unemployed for twelve months or more. Another fact is that shocks seem to have effects on employment long after the shocks themselves have disappeared. For some reason it seems to take considerable time for European economies to return to their equilibrium employment levels following a shock. This makes it important to try to understand how shocks, both temporary and permanent, affect the employment level.

One potential explanation of both the high level of unemployment and its persistent behavior following a shock is that the duration structure of unemployment somehow plays a role. Many authors have argued that long-term unemployed workers do not compete well with other searchers for the available jobs because they have lost the abilities that employers find attractive etc. It is then argued that this duration dependence, through some mechanism, affects the wage setting in the economy, and thus puts upward pressure on wages.[1] One important paper that tries to formalize these

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[1] Machin and Manning (1999) discuss these issues in some detail and also survey the literature.

ideas is Blanchard and Diamond (1994), who examine the effect of the composition of unemployment on wage determination in a matching model. They assume that a firm that receives multiple job applications always picks the applicant with the shortest unemployment spell; a strategy they call ranking. The wage is determined by Nash bargaining with the expected utility of a recently laid off worker as the threat point. Their main conclusion is that ranking affects the dynamics but has only minor permanent effects.

In this paper, the consequences of skill loss as a result of unemployment is studied further by analyzing a new mechanism through which the duration structure of unemployment affects the wage setting. This is done by adapting the efficiency wage model with turnover costs and on-the-job search developed in Eriksson and Gottfries (2000), to a situation with two different types of unemployed workers; one group that is identical to employed workers and one group that is less attractive to hire.[2]

There are a number of reasons why a person who is unemployed for some time might lose some of his human capital. Inability to keep up with technological advances, loss of social skills and loss of motivation can make it less attractive for employers to hire unemployed workers. These factors should be particularly relevant for those who have been unemployed for a long time. At the same time, it is hardly likely that all workers suffer a loss of human capital after a specific duration of unemployment (e.g. twelve months) but rather that the timing differs between individual workers. Some workers lose skills rapidly while others maintain them for a long period of time. To capture these facts, the model contains two stocks of unemployed workers called short-term unemployed (STU) and long-term unemployed (LTU), where workers in the second group have suffered a loss of human capital. Every STU worker faces a constant risk of becoming LTU every period.

If wages were perfectly flexible, firms should be indifferent among all job applicants since the wage can be adjusted to reflect differences in productivity/training costs. In real world labor markets this is hardly the case, because factors such as fairness considerations, union influence, unemployment insurance and minimum wages tend to compress wages relative to productivity differentials. In such a situation, employers have incentives to screen job applicants for differences in productivity/training costs and then hire those with the best score. Hence, unemployed workers that have lost some of their human capital will not get hired if the employer receives enough applications from other more productive searchers. Thus, there might be complete discrimination of those in LTU. At the same time, there are two factors that might prevent this. First, not all jobs are the same. Differences in human capital are important for some jobs while they are much less important in other types of jobs. Second, a lot of other factors than perceived productivity/training cost differences seem to affect the hiring process. To capture these facts in the model, it is assumed that, for a fraction of the jobs, firms prefer to hire employed or STU applicants while for the rest of the jobs they are indifferent among all applicants.

In this paper, a theoretical model with these features is set up. Firms set their wages recognizing that labor turnover is costly since they encounter a hiring/training cost for every newly hired worker. Employed workers choose whether or not to search based on both the wages and their job satisfaction. Those who lose their jobs become STU and face a risk of becoming LTU every period. Searchers send in job applications to a randomly chosen firm and firms then choose whom to hire from the pile of applications. As mentioned above, firms discriminate against the LTU for a fraction of the available jobs. The model is then solved for a general equilibrium solution. Due to the complexity of the model, numerical solution methods are used. The model is calibrated with data for the German economy, and it is investigated what happens, both in and out of steady state, when different parameters are changed.

The steady state analysis shows that more ranking, a higher risk to become LTU or more wage pressure all raise equilibrium unemployment, and that the effects are concentrated to the stock of LTU workers. It is also shown that quite modest permanent changes in the key parameters in the model will result in very lengthy adjustment processes, involving substantial long run effects on the unemployment level. For example, a permanent increase in the probability to become LTU - e.g. due to more rapid technological advances - results in a situation where the unemployment rate increases for years until reaching its new steady state value. If such slow adjustment processes are a feature of real economies, it is not surprising that economists have difficulties finding the structural causes of the rise in European unemployment.

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[2] Eriksson and Gottfries (2000) focus on a situation where employers discriminate against all unemployed

The dynamic analysis shows that temporary shocks have persistent effects, but the degree of persistence is quite moderate after a temporary shock to employment. A prolonged shock where many workers fall into LTU generates more persistence. Still it is difficult to generate the extreme amount of persistence found in time series regressions for employment. However, it should be remembered that the model abstracts from a lot of other factors that probably also add to persistence.

The model presented here differs in a number of ways from the analysis in Blanchard and Diamond (1994). Most importantly both the wage setting assumptions and the mechanism through which the duration structure of unemployment affects the wage setting differ substantially. First, the “quasi labor supply curve” implied by Nash bargaining with unemployment as the threat point is replaced by an efficiency wage constraint. Second, the duration structure affects the probability that an employed searcher gets the job he applies for, inducing the firm to set a higher wage to keep costly turnover down. In Blanchard and Diamond, the duration structure of unemployment affects the outside option in the wage negotiation. It is these two facts that explain the large permanent effects found in my paper. In Blanchard and Diamond, the threat point of the worker is affected by the fact that he runs a risk of becoming long term unemployed himself. Unless the discount rate of the worker is very high, this will tend to keep the wage from rising in the long run. In my paper, it is optimal for the firm to raise its wage, at its own initiative, following a rise in the probability to get a job for on-the-job searchers, and this has nothing to do with the utility workers get if they become unemployed. Another difference is that while Blanchard and Diamond assume that the person with the shortest spell is always preferred, workers in my model lose human capital stochastically at different points in time, thus adding a bit of realism. A second related paper is Pissarides (1992) who formulates a matching model with the so called “thin market externality”; i.e. that the supply of jobs decreases when the duration of unemployment increases since those who have been unemployed for a long time have less human capital. In that model, an employer always hires the first unemployed worker he comes in contact with. Thus, Pissarides abstracts from the behavior of the employer in the hiring process, the focus in my paper.[3]

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workers, and thus do not consider the duration structure of unemployment.

[3] Other related papers are Acemoglu (1995) and Lockwood (1991) that both focus on a situation where employers cannot perfectly observe the productivity of unemployed workers and therefore use statistical

The rest of the paper is organized as follows. Section 2 briefly discusses empirical evidence on the employability of LTU workers. In Section 3 the theoretical model is formulated, the general equilibrium is derived and some analytical results are shown. In Section 4 the model is calibrated with German labor market data and the effects of parameter changes and shocks are analyzed both in steady state and dynamically. Section 5 concludes.

2 Empirical evidence on the employability of LTU workers

Two empirical questions are particularly relevant for the present analysis. First, does the probability to find regular employment decline with the duration of unemployment? Second, do employers discriminate against LTU workers?

The first question is analyzed in the substantial literature on duration dependence. It is fairly clear from raw data that the exit rate from unemployment declines with the duration of unemployment for most European economies. However, the more interesting question is if there exists so called true duration dependence; i.e. whether the probability to leave unemployment for a particular worker declines with the duration of his unemployment. Essentially, this boils down to trying to eliminate observed as well as unobserved heterogeneity. Machin and Manning (1999) review this issue in some depth. They point out that in order to obtain identification it is normally necessary to make assumptions about the specific functional forms of the baseline hazard function and the distribution of unobserved heterogeneity.[4] Moreover, they conclude "it does not seem possible to identify separately the effect of heterogeneity from that of duration dependence without making some very strong assumptions about functional form which have no foundation in any economic theory"[5]. This, at the very least, implies that one should be very careful when interpreting results on duration dependence.

Turning now to the studies that have been performed the results are mixed. A particularly large number of studies have looked at data for the UK and Sweden.

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discrimination against them. Ljungqvist and Sargent (1998) try to explain the high and persistent unemployment rates from the supply side by arguing that generous welfare benefits encourages workers, who have lost human capital, to demand higher wages than employers are willing to pay.

[4] For example, a proportional hazard function and a gamma distribution for unobserved heterogeneity.

Studies of UK data normally find strong evidence of negative duration dependence while studies using Swedish data find only weak or even positive duration dependence. Studies of data for other European countries are more rare but often do not find strong duration dependence. However, three factors might complicate the interpretation of these results. The first is exits to out-of-the labor force. A number of studies of duration dependence do not distinguish between exits to different states whereas others do.[6] Second, Pissarides (1992) emphasizes that since most studies are cross sections they use samples that do not contain very long durations. This can result in a situation where too much of the duration dependence is classified as being due to heterogeneity.[7] Third, the widespread use of active labor market policy can result in breaks in unemployment spells and reclassification of workers as newly unemployed.

The conclusion from the empirical studies of duration dependence seems to be that it still is uncertain whether this is an important problem or not. The research so far shows that it is a problem in some countries, such as the UK, while it does not seem to be a problem in other countries like Sweden, though the extensive use of active labor market policy may explain the latter finding.

The idea that employers do view LTU as a negative factor when making hiring decisions has received quite strong support.[8] Bewley (1999) interviewed a large number of employers in the US about, among other things, their hiring procedures. He finds that a quite substantial fraction view unemployment as a negative factor. Agell and Lundborg (1999) find that around one forth of the Swedish employers in their sample view LTU as a strong negative signal.[9] Atkinson, Giles and Meager (1996) find similar evidence for the UK. They emphasize that LTU, at least, makes employers suspicious that the worker has lost abilities like social skills and work motivation etc.[10]

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[5] Machin and Manning (1999) page 3111.

[6] Intuitively, it is natural to think that exits to out-of-the labor force exhibit positive duration dependence; e.g. discouraged worker effects.

[7] One example of a study that takes account of this is Jackman and Layard (1991) who, using time series data, finds strong duration dependence effects for the UK.

[8] It should be noted that, since employers are unlikely to admit that they avoid hiring LTU workers, the studies mentioned probably only gives a lower bound on the actual extent of this type of discrimination.

[9] Other studies using Swedish data are Klingvall (1998), who reports that 25 percent of firms view workers who have been unemployed long unfavorably, and Behrentz and Delander (1996), who report that 40 percent of firms would not choose the unemployed worker when having two otherwise similar applicants to choose from.

[10] An interesting finding in this study is that most respondents did not support the idea that those becoming unemployed are less productive than other workers but rather that it is unemployment *in itself*

Klingvall (1998) reports that around half of the Swedish employers in his survey state that the duration of unemployment is important when evaluating the suitability of an applicant. The stated reasons are loss of skills as well as loss of social abilities.[11] Layard, Nickell and Jackman (1991) cite several studies that indicate that unemployment causes demotivation and demoralization. Thus, the conclusion from the survey and interview based literature is that employers really seem to view LTU as a negative worker characteristic for a substantial number of jobs and that one important reason for this is the belief that workers lose human capital while being unemployed.

Does unemployment result in the loss of skills? Though the literature on duration dependence does not give any clear answers, the survey based literature supports this idea. Thus, it seems quite likely that unemployment results in skill loss and a declining probability to find a job as the duration of unemployment increases. This makes it important to investigate the consequences of such behavior theoretically.

3 The model

Events take place in discrete time and we may think of a period as one month long. There are a large number of workers who can be in either of three different states; employed, short-term unemployed (STU) or long-term unemployed (LTU). It should be noted that the terms short- and long-term are not equivalent with the definitions normally found in labor market statistics. In this model, a person who has become unemployed faces a risk of becoming LTU every period rather than automatically falling into LTU after six or twelve months. At the same time, the terms STU and LTU are appropriate since, on average, a person belonging to the LTU group has been unemployed a longer time and is expected to remain unemployed for a longer period of time.[12] The total labor force is assumed to be constant and is normalized to one. There

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that makes LTU workers less attractive; i.e. this study indicates that state dependence is more important than heterogeneity.

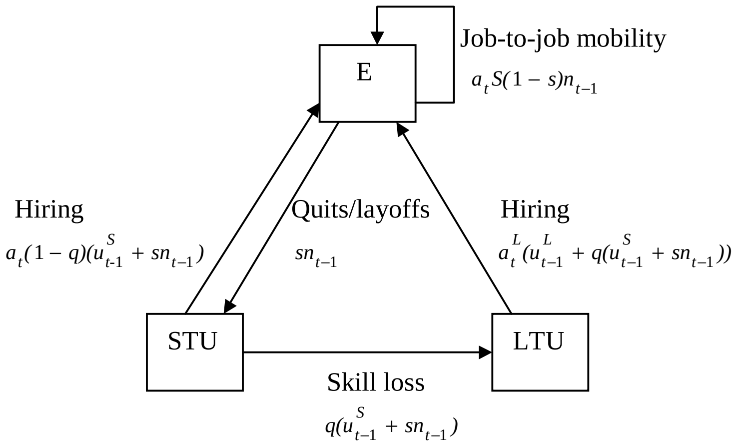
[11] Not surprisingly the data indicate that the fraction of employers that view the duration of unemployment as an important factor is an increasing function of duration. The function is not smooth but rather exhibits jumps at 3-6, 9-12 and 21-24 months.

[12] An alternative is to call the LTU workers “stigmatized”.

are a large number of identical firms in the economy, although the fixed number of firms is much smaller that the number of workers.[13]

The sequence of events in the model is the following. At the beginning of every period an exogenous fraction, s, of the employed workers lose their jobs and fall into STU. This fraction includes both workers quitting into unemployment and workers being laid off for some exogenous reason. Firms set their wages recognizing that wages affect turnover. Turnover is costly since firms have to pay a hiring/training cost for every newly hired worker. Those remaining employed choose whether or not to search on the job considering both the wage level offered by their present employer and their job satisfaction. An exogenous fraction, q, of the workers in STU, including those who just became unemployed, then fall into LTU. On-the-job searchers and all unemployed workers then submit one application to a randomly chosen firm. Finally, firms choose whom to hire amongst the pile of applications. For a fraction, r, of the jobs employers prefer to hire a worker who has a job or is STU while for the rest of the vacant jobs employers are indifferent among all applicants. Figure 1 illustrates the stocks and flows of the model.

Figure 1: An illustration of the stocks and flows in the model.[14]



There are three basic micro-economic decisions that must be made every period: (i) the wage setting decisions made by the firms, (ii) the decision whether or not to search made by every worker who is employed at the start of the period, and (iii) the

[13] The model could easily be extended to a situation with an endogenous number of firms for example by imposing a fixed set-up cost.

hiring decisions made by the firms.[15] The following sections discuss these decisions starting with the last, and describe the general equilibrium outcome of the economy.

3.1 Job applications and hiring

On-the-job searchers and both types of unemployed workers search with the same intensity. Every worker looking for a new job submits one application per period. Furthermore, the applications are sent to a randomly chosen firm.[16]

Since there are many more workers than firms in this economy, every firm receives a large number of applications. The crucial assumption is that a firm always receives a sufficient number of applicants, so that every vacancy can be filled within the period from the pile of applications. Therefore, the firm has to make a decision of whom to hire. The following assumptions are made: (i) firms can observe whether the applicant is employed, STU or LTU, (ii) for a fraction of the jobs, employed and STU applicants have identical training costs while LTU workers have higher training costs[17], (iii) all applicants are equal for the rest of the jobs, and (iv) the division of jobs between these two types is fixed. In such a situation, one would expect the employer to only consider hiring employed or STU workers for a fraction, r, of the jobs and choose a random applicant for the rest of the jobs. In this paper, such a hiring strategy is called ranking.

[14] The notation will be introduced in the sections below.

[15] The first two of these decisions are simplified versions of those analyzed in Eriksson and Gottfries (2000).

[16] This is of course a simplification of real world behavior. However, the assumptions made have some empirical support. Layard, Nickell and Jackman (1991), point out that the time spent on search is fairly limited and does not seem to diminish with the duration of unemployment in the UK. They also report that job searchers in the UK submit between one and three applications per month. Blau and Robins (1990) show that, in a US sample, the search intensity differs little between employed and unemployed searchers.

[17] That is, it is assumed that after the training all workers are equally productive in these jobs. Also note that LTU workers never are employed in these jobs and no firm ends up paying the higher training cost. Therefore, this high training cost does not appear in the profit maximization problem.

3.2 On-the-job search[18]

Every worker who remains employed has to decide whether to start on-the-job search or not. It is assumed that both the wage levels and non-pecuniary factors matter for the decision whether or not to quit.[19] Let w_t^i and w_t denote the wage in company i and the average wage respectively. Each period every employed worker draws a number ν_t that determines his current job dissatisfaction from a random process with cdf G(ν) which is unimodal and has a mean smaller than unity.[20] The utility function of a worker is the discounted sum of expected wages divided by the expected job dissatisfactions. Since the worker is back in the same position the next period regardless of whether he changes jobs or not, only the current period payoff affects his decision. The worker, therefore, compares the utility from continuing at his present job, given by w_t^i / ν_t^i, with the expected utility from finding a new job $\lambda E[w_t / \nu]$, where $\lambda < 1$ represents the cost of switching jobs.[21] This means that there exists a cut-off value for ν_t^i for which the worker is indifferent between quitting and remaining in his present job.[22] It is assumed that $\lambda E[1/\nu] < 1$; i.e. given the same wage most workers prefer to stay in their present jobs. The fraction of workers that searches on-the-job is given by:

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

where S is decreasing with S''(1)>0.

[18] It should be noted that what is important is that the decision whether or not to search on the job is a function of the relative wage. This section sketches a highly simplified micro-foundation for this assumption.

[19] Akerlof, Rose and Yellen (1988) emphasize that non-pecuniary factors are as important as the wage levels for quit decisions

[20] The assumption that the worker makes an independent new draw every period is obviously a simplification of real world behavior. It is motivated purely by the fact that the model, otherwise, would be severely complicated to solve since we would need to keep track of a distribution of workers with different levels of job satisfaction. However, intuitively the results should not change if we introduce some degree of serial correlation in the job satisfaction component.

[21] Note that when making this decision, the worker knows the average wage level, w_t, but does not know the non-pecuniary factor associated with a new job.

[22] Note that $\nu_t^i = w_t^i /(w_t \lambda E(1/\nu))$ for the cut-off value of ν_t^i.

3.3 Wage setting

Firms are assumed to face a hiring/training cost for every worker they hire implying that labor turnover is costly.[23] The hiring/training cost is given by a constant c times the average wage level w_t[24], the production function is given by $\theta_t F(n_t^i)$ where θ_t represents a shock factor, voluntary quits are sufficiently large to accommodate all employment adjustment and firms optimize as if the world was known with certainty.[25] Let n_t^i denote the employment level of firm i in period t, a_t the probability to find a job for an employed/STU worker in period t and β the discount factor. Hiring in period t is given by $n_t^i - (1-s)(1-S(w_t^i / w_t)a_t)n_{t-1}^i$. The maximization problem solved by the firm is then

$$\max \sum_{\tau=t}^{\infty} \beta^{\tau\text{-t}} \left(\theta_\tau F(n_\tau^{\mathrm{i}}) - w_\tau^i n_\tau^i - c w_\tau (n_\tau^i - (1-s)(1-S(w_\tau^i / w_\tau)a_\tau)n_{\tau-1}^i)\right) \tag{2}$$

This problem looks like a dynamic optimization problem that requires standard dynamic programming techniques to solve. However, a closer inspection clearly shows that the only dynamic part of the problem is the fact that if the firm hires one more worker in period t this will affect the number of workers it needs to hire in period t+1. Since we primarily are interested in an equation for the optimal wage, we can we can solve the problem quite easily by simply using the first order conditions for period t. These are equal to:

$$-n_t^i - cS'(w_t^i / w_t)(1-s)a_t n_{t-1}^i = 0, \tag{3}$$

$$\theta_t F'(n_t^i) - w_t^i - cw_t + \beta c w_{t+1}(1-s)(1-S(w_{t+1}^i / w_{t+1})a_{t+1}) = 0\,. \tag{4}$$

[23] In practice, the prevention of excessive turnover seems to be important for real world firms and hiring/training costs appear to be substantial (see Blinder and Choi (1990) and Campbell and Kamlani (1997)).

[24] The average wage is used here to simplify the analysis.

[25] It is possible to explicitly incorporate uncertainty in the model and obtain the same results. To keep the model simple this is neglected in this paper. For details of how to model the wage setting with uncertainty see Eriksson and Gottfries (2000). Here the timing of events are the following: the wage is set, the shocks are observed and then the hiring decisions are made.

The intuition behind the wage setting mechanism is that the firm finds it optimal to raise the wage until the marginal benefit of the reduction in turnover costs is equal to the marginal cost of increasing the wage.

Note that it is assumed that the same wage is set for all workers. This means that the firm cannot differentiate wages according to perceived productivity/training cost differences among workers. There is some rigidity in the wage structure that prevents such wage differentials. Such an assumption can be justified by fairness considerations, union influence or by arguing that for some other reason there exists a "company wage policy" that prevents wage dispersion.[26]

3.4 General equilibrium

Consider a symmetric general equilibrium where all firms set the same wage ($w_t^i = w_t$). This is the natural situation to analyze since all firms are assumed to be identical and, therefore, face the same wage setting problem. To derive the aggregate equilibrium, we use the aggregate versions of the first-order conditions in equations (3) and (4). However, as a result of the recursive nature of this equation system we only need to use equation (3) to derive an expression for aggregate employment.[27] Let n_t, u_t^S and u_t^L denote the aggregate levels of employment, STU and LTU respectively. Then aggregate employment is given by:

$$n_t = \Omega(1-s)a_t n_{t-1}, \qquad (5)$$

where Ω=-cS'(1), Ω being a measure of "wage pressure" due to the efficiency wage mechanism.[28]

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[26] See for example Akerlof and Yellen (1990) or Manning (1994) for a discussion about why a firm might not want to differentiate wages

[27] Obviously, the aggregate versions of both of the first-order conditions in (3) and (4) have to hold in equilibrium. However, due to the way we have formulated the model we do not need to use the aggregate version of equation (4) to solve for the aggregate employment level. Essentially, the aggregate version of equation (3) defines a vertical curve in wage-employment space that determines aggregate employment whereas the aggregate version of equation (4) defines a negatively sloped curve that determines the aggregate wage. The interested reader can benefit from the discussion in Eriksson and Gottfries (2000).

[28] Intuitively, this factor might also include other factors that raise the wage like union influence. See for example Gottfries and Westermark (1998) for a discussion of how to model this.

Now a_t, the probability that an employed or STU worker gets the job he applies for, has to be determined. This probability is defined as:

$$a_t = r\frac{n_t-(1-s)n_{t-1}+a_tS(1-s)n_{t-1}}{(1-s)Sn_{t-1}+(1-q)(sn_{t-1}+u^S_{t-1})}+(1-r)\frac{n_t-(1-s)n_{t-1}+a_tS(1-s)n_{t-1}}{1-(1-s)n_{t-1}+(1-s)Sn_{t-1}}. \qquad (6)$$

It consists of two parts; the probability to get a job for which ranking is used plus the probability to get a job for which ranking is not used. Note that the number of vacant jobs consist of new jobs and existing jobs left unfilled after both exogenous and endogenous quits. The first term consists of the fraction of jobs for which firms rank divided by the number of employed workers searching on-the-job, plus all STU workers. The second term comprises the fraction of jobs the firm does not use ranking for divided by all applicants.[29] Equation (6) can be solved for a_t to obtain

$$a_t = \frac{(n_t-(1-s)n_{t-1})(r(1-(1-s)n_{t-1})+S(1-s)n_{t-1}+(1-r)(1-q)(sn_{t-1}+u^S_{t-1}))}{(1-(1-s)n_{t-1})((1-r)(1-s)Sn_{t-1}+(1-q)(sn_{t-1}+u^S_{t-1}))+rS(1-s)n_{t-1}(1-q)(sn_{t-1}+u^S_{t-1})}. \qquad (7)$$

Let us now turn to the state variables in the model. The two unemployment stocks evolve according to the following equations:

$$u^S_t = u^S_{t-1}+sn_{t-1}-a_t(1-q)(u^S_{t-1}+sn_{t-1})-q(u^S_{t-1}+sn_{t-1}), \qquad (8)$$

$$u^L_t = u^L_{t-1}+q(u^S_{t-1}+sn_{t-1})-a^L_t(u^L_{t-1}+q(sn_{t-1}+u^S_{t-1})). \qquad (9)$$

Equation (8) says that the current stock of STU workers consists of four components; the stock the previous period plus those becoming unemployed minus those finding a job minus those who fall into LTU. Similarly, equation (9) says that the current stock of LTU workers consist of the stock the previous period plus those who become LTU in the period minus those who find a job. Note that a_t denotes the chance to get a job for

[29] Note that if q equals one we are back in the situation analyzed in Eriksson and Gottfries (2000); i.e. an employer that has a bias against all unemployed workers.

a worker in the pool of STU and a_t^L denotes the corresponding chance for a LTU worker. Using equations (8) and (9) in (5) gives us the following expressions:

$$u_t^S = 1 - u_{t-1}^L - q(u_{t-1}^S + s(1 - u_{t-1}^S - u_{t-1}^L)) + a_t^L(u_{t-1}^L + q(s(1 - u_{t-1}^S - u_{t-1}^L) + u_{t-1}^S)) \\ - \Omega(1-s)a_t(1 - u_{t-1}^S - u_{t-1}^L), \tag{10}$$

$$u_t^L = 1 - u_{t-1}^S - s(1 - u_{t-1}^S - u_{t-1}^L) + a_t(1-q)(u_{t-1}^S + s(1 - u_{t-1}^S - u_{t-1}^L)) \\ + q(u_{t-1}^S + s(1 - u_{t-1}^S - u_{t-1}^L)) - \Omega(1-s)a_t(1 - u_{t-1}^S - u_{t-1}^L). \tag{11}$$

Substituting the expressions for a_t and a_t^L into equations (10) and (11), we get an equation system which in principle can be solved for u_t^S and u_t^L. Analytically though this would be very complex since both a_t and a_t^L are nonlinear functions of u_t^S and u_t^L. Further analysis of this system is therefore deferred to the numerical section below.

3.5 Initial effects of changes in parameters

Some further understanding of the model can be gained by combining equations (5) and (7) to a dynamic employment equation:

$$n_t = h(n_{t-1}, u_{t-1}^S). \tag{12}$$

This equation is written out explicitly in Appendix A and gives the desired aggregate employment in the current period as a function of employment and STU the previous period. Consider for a moment the intuition behind equation (12). Employment dynamics arise because the optimal wage depends positively on the probability to get a job for an *employed* searcher. Therefore, it is obvious that the employment level of the previous period matters. The division of unemployment between STU and LTU also matters because if a larger fraction of the unemployed workers are in the LTU pool this results in a higher probability to get a job for on-the-job searchers. This induces firms to raise the wage even more to keep their employees and, in equilibrium, the employment level falls.[30]

Expression (12) cannot be solved for steady state employment since it contains two state variables but it is possible to ask, for a given number of employed/unemployed workers in the previous period, what are the effects of changes in the parameters on employment. Clearly, this gives us only the initial effects but it does provide some useful intuition.

First, one might be interested in the effect of ranking on the current employment level. In Appendix A it is shown that

$$\frac{\partial n_t}{\partial r} < 0. \tag{13}$$

In other words, if a larger fraction of the vacant jobs is reserved for employed and STU applicants we get a lower aggregate employment level. If more jobs are reserved for the privileged group, this will tend to increase the chance for employed workers to get a job. To prevent costly turnover firms will then raise their wages, leading to lower employment.

Second, consider the effects from faster skill loss among the unemployed, which in this model is captured by an increase in q. In Appendix A, it is shown that

$$\frac{\partial n_t}{\partial q} < 0 \quad \text{if } r > 0. \tag{14}$$

In other words, if the probability that an unemployed worker falls from STU to LTU increases this will tend to decrease aggregate employment. This result holds only if some firms rank job applicants since the division of workers between STU and LTU would otherwise be irrelevant. The intuition is that if q increases this implies a reduction in the pool of privileged job seekers. This increases the probability to find a

[30] Note that an individual firm perceives this probability as exogenous. The only way for a firm to reduce turnover is by raising the wage to discourage search among its employees. Since all firms are identical all firms have the same incentive, all wages rise, and employment falls.

job for employed workers, resulting in higher wages and, in equilibrium, lower employment.

4 Numerical analysis

In order to gain some further understanding of the model, it is useful to set numerical values for the different parameters. This makes it possible to solve the model for steady state values of employment, STU and LTU and look at how these variables are affected by parameter changes. In addition, it allows us to study the dynamic adjustment process following both permanent and temporary shocks. Choosing reasonable values for the parameters, we can get a sense of how large the effects are and how long the adjustment takes.

4.1 Calibration

In steady state, the model contains the following five parameters: (i) the fraction that leaves employment for unemployment every period, s, (ii) the fraction searching on the job, S, (iii) the amount of wage pressure, Ω, (iv) the fraction of jobs for which firms use ranking, r, and (v) the risk that a STU worker faces of becoming LTU, q. Although estimates of several of these key parameters do not exist, it turns out that it is possible to use other facts about the labor market to deduce the values the parameters have to take for the steady state solution to be consistent with these facts. To implement this strategy, it must be decided which facts the model should be fitted against. What is needed is at least as many facts as unknown parameters, and preferably some more to check the model against. Table 1 presents values for the German economy (all steady state values).[31] Essentially, these facts are of two types; data about labor market stocks and flows and data about the probability to find a job for an unemployed worker at different durations of unemployment. The details of the data are presented in Appendix B.

[31] In view of the purpose of this paper it is natural to choose a typical European continental economy.

Table 1: Data for the German economy.

Fraction of employed workers entering unemployment	s	**0.005**
Fraction of employed job-to-job switchers	$x^{E\to E}$	**0.005**
Employment	n	**0.934**
Probability to remain unemployed after one month	$y^{1\,\text{month}}$	**0.90**
Probability to remain unemployed after three months	$y^{3\,\text{months}}$	0.70
Probability to remain unemployed after six months	$y^{6\,\text{months}}$	0.54
Probability to remain unemployed after nine months	$y^{9\,\text{months}}$	0.44
Probability to remain unemployed after twelve months	$y^{12\,\text{months}}$	**0.36**
Fraction of all unemployed with duration <12 months	$u^{<12\,months}/u$	0.51
The outflow rate from unemployment	$x^{U\to E}$	0.076
Fraction searching on the job (estimate for the UK)	S	≈ 0.05

To be able to calibrate the model, we need an explicit definition of a steady state. It is natural to define it as a situation where all stocks remain constant. In the context of this model, this means that the numbers of employed, STU and LTU are kept constant. Note that it is sufficient to write conditions that ensure that two of the stocks are kept unchanged to know that all three stocks remain constant. Therefore, these conditions can be written in the form most beneficial to solving the model. First, to ensure that employment is kept constant, it is assumed that equation (5) satisfies:

$$n_t = n_{t-1} = n . \tag{15}$$

Furthermore, to keep the two stocks of unemployed workers constant, it is sufficient that the flows in and out of STU remain equal. This requirement can be written as:

$$sn = q(u^S + sn) + a(1-q)(u^S + sn) . \tag{16}$$

The facts reported with bold face numbers in Table 1 are used to calculate the values of the parameters identified above. The facts in the rest of the rows are then used as a check of the model. Equations linking the facts in Table 1 to the theoretical model and the details of the calibration are presented in Appendixes C and D respectively. This exercise yields the values summarized in Table 2.

Table 2: Calculated parameter values for the German economy.

Parameter:		
Fraction of employed workers falling into STU	s	0.005
Fraction of employed workers searching on the job	S	0.048
Wage pressure	Ω	9.706
Fraction of jobs for which ranking is used	r	0.497
Risk a STU worker faces of becoming LTU	q	0.056
Implied variable value:		
STU	u^S	0.026
LTU	u^L	0.040
Probability to find a job for an employed/STU worker	a	0.104
Probability to find a job for a LTU worker	a^L	0.041
Risk of remaining unemployed after three months	$y^{3\text{ months}}$	0.74
Risk of remaining unemployed after six months	$y^{6\text{ months}}$	0.56
Risk of remaining unemployed after nine months	$y^{9\text{ months}}$	0.44
Fraction of all unemployed with duration <12 months	$u^{<12\,months}/u$	0.49
Outflow from unemployment	$x^{U\rightarrow E}$	0.07

Looking at the parameter values in Table 2, it should be noted that none of them seem unreasonable. Since there do not exist empirical estimates for several of them, it is difficult to judge the accurateness of these values, but the reader should note that the exact numbers are not important for the analysis. Generally, what are interesting are the signs and rough magnitudes of the effects. It should be noted that the calibration implies that employed and STU workers have around a two and a half times higher probability to find a job than those being LTU.

4.2 Steady-state analysis

Using the parameter values in Table 2, it is possible to investigate the steady state effects of parameter changes. Table 3 shows the effects of changing one parameter at a time by 20 percent of its initial value.

Table 3: Steady state effects of 20 percent parameter changes.

	Base value	New value	STU	LTU	U
Base case			2.57	4.03	6.60
r increases	r=0.50	r=0.60	2.52	5.82	8.34
q increases	q=0.056	q=0.068	2.37	4.74	7.11
Ω increases	Ω=9.71	Ω=11.65	2.86	5.81	8.67
s increases	s=0.005	s=0.006	3.03	4.93	7.96
S increases	S=0.048	S=0.058	2.57	3.91	6.48
Ω/r increase	Ω=9.71/r=0.50	Ω=11.65/r=0.60	2.76	9.00	11.76
Ω/q increase	Ω=9.71/q=0.056	Ω=11.65/q=0.068	2.60	6.92	9.51
r/q increase	r=0.5/q=0.056	r=0.60/q=0.068	2.31	7.05	9.36

Now consider these results in detail. First, if the degree of ranking in the economy increases we see that this results in substantial increases in LTU and total unemployment while STU remains essentially unchanged. The result that total unemployment increases is expected from the previous discussion. More ranking implies higher LTU for two reasons. First, for a given number of jobs more ranking implies higher LTU since these workers face a decreased chance to find a job; fewer of the vacancies are open to them. Second, more ranking has a negative effect on the total number of jobs in the economy and this also implies higher LTU. Moreover, these two factors have opposite effects on the stock of STU and roughly seem to cancel each other out.

Second, if the probability to become LTU for an unemployed worker increases we see that STU decreases while LTU and total unemployment increases. As was discussed in the previous section, higher q leads to an increased chance to get a job for on-the-job searchers, upwards pressure on wages and lower aggregate employment. Turning to the STU, it should be noted that there are two opposing effects at work here. First, higher q means an increased outflow from STU, which tends to decrease this stock. Second, higher q means fewer jobs in the economy something that implies higher STU. Using the calculated values it seems that the first effect dominates; higher q tends to reduce STU. LTU on the other hand increases due to both of the mentioned effects.

Third, if the degree of wage pressure increases all unemployment stocks increase. It should be noted that the numerical analysis indicates a difference between the effects of wage pressure and the degree of ranking in the economy. More ranking implies that the whole increase in unemployment is concentrated to LTU. More wage pressure, on the other hand, results in increases in both STU and LTU even though the effect on LTU is stronger.

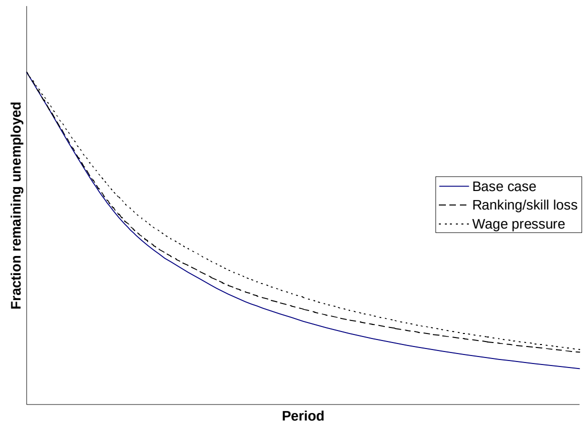
Fourth, an increase in the flow from employment to unemployment implies an increase in all unemployment stocks. The reason is that a higher s implies more job vacancies, increased opportunities for on-the-job searchers, upward pressure on wages and lower employment. It is natural that both stocks of unemployed workers increase since nothing really changes in the relation between STU and LTU.

Fifth, an increase in the number of on-the-job searchers implies less LTU and total unemployment and essentially no change in STU. More on-the-job searchers imply an increase in the number of searchers something that induces firms to reduce wages and employ more workers. Again this does not really affect the relative position of those who are STU or LTU.

Finally, it is interesting to look a little bit at how Ω, r and q interact. The last three rows in Table 3 show that the effects of parameter changes are reinforced when we increase another parameter. This can be seen by noting that the unemployment rate increases by more than the sum of the individual effects. In other words, if skill loss and ranking are widespread in an economy this reinforces the negative employment effects of increased wage pressure etc. too.

Before leaving the steady state discussion, it is worthwhile to briefly look at differences in the effects of the various factors that might generate both persistence and long run effects; wage pressure, ranking and skill loss. Intuitively, the different effects of these three factors can be understood by thinking in terms of survivor functions, where surviving means remaining unemployed after different durations of unemployment. This is illustrated in Figure 2.

Figure 2: An illustration of the different effects of r, q, and Ω.



In Figure 2 the solid curve shows the survivor function with the calibrated parameter values. The other two curves show what happens when either ranking or wage pressure are changed keeping all other parameters constant. Here, the differences between changing the amount of ranking and changing the amount of wage pressure are apparent. More wage pressure shifts the whole curve upwards implying that the probability to get a job declines at all durations. More ranking on the other hand mostly harms those with long durations of unemployment.[32]

4.3 Dynamic adjustment to permanent shocks

A natural starting point for a dynamic analysis is to analyze what the adjustment path looks like after a permanent change in one or more of the parameters. Since the inflow rate into unemployment seems to have remained virtually unchanged, this means that we have three factors that potentially could have caused rising unemployment; skill loss, ranking and wage pressure.[33] The first two may result from more rapid technological advances or changes in the organization of firms that increase the skill requirements of individual workers. The latter one may change as the result of

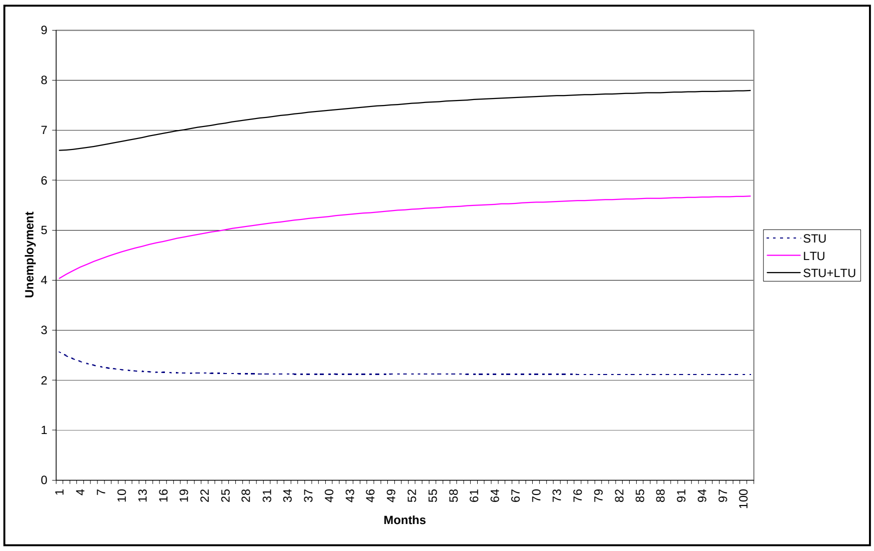
[32] This also helps us understand the numbers falling out of the calibration. The model is essentially calibrated using such a curve as an input and the curve used implies that the probability to leave unemployment declines with duration. Since Ω cannot generate such an outcome $r>0$ and $q>0$ are needed.

[33] Evidence that s has remained essentially unchanged can be found in Layard, Nickell and Jackman (1991). It is of course also possible that the extent of on-the-job search has increased.

increased training costs, more focus on keeping down turnover or increased union strength.[34]

Let us start by investigating the effects of a permanent increase in the risk to become LTU for a STU worker (q). This is illustrated in Figure 3.

Figure 3: The effects of a 50 % increase in q.



Recall the discussion above where it was shown that an increase in q leads to lower STU and higher LTU with the net effect on unemployment positive. In Figure 3, it is clear that these effects are present, but we also see that the timing of the effects differ markedly.[35] The decrease in STU seems to occur during the first few periods while the increase in LTU is drawn out over a very long period of time. The implication for an economy, that for some reason experiences an increase in the risk to become LTU, is a steady increase in unemployment for years to come. These effects eventually die out, but the analysis indicates that it takes a very long time. The effect might be even more severe if the economy suffers several increases in the LTU risk due to technological advances that increase the mismatch in the labor market.

[34] Remember that the effects of increased union strength intuitively are identical to an increase in Ω.

[35] It is interesting to look at the effects of an increase in q on the number of workers that have been unemployed for less than one year. Using equation (18) gives us $u^{<12\,months}$ =0.033; i.e. a slight increase. Remember that those workers, in the model, can be both STU and LTU even though most are STU. An increase in q has three effects; the advantage to be STU increases, more workers fall into LTU and fewer jobs are available.

Turning now to the effects of an increase in the degree of ranking one might expect the outcome to be similar; a substantial increase in LTU and smaller effects on STU. Figure 4 shows the adjustment after an increase of r from 50 to 75 percent.

Figure 4: The effects of a 50 % increase in r.

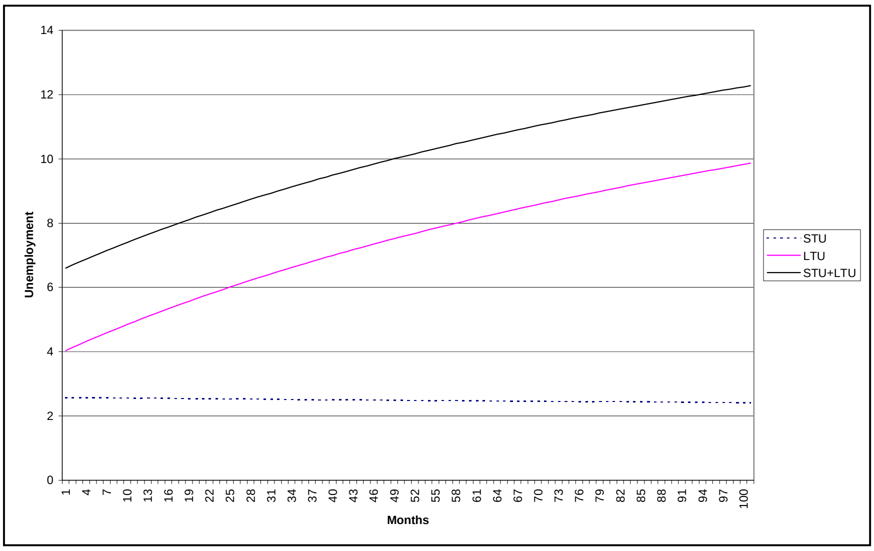
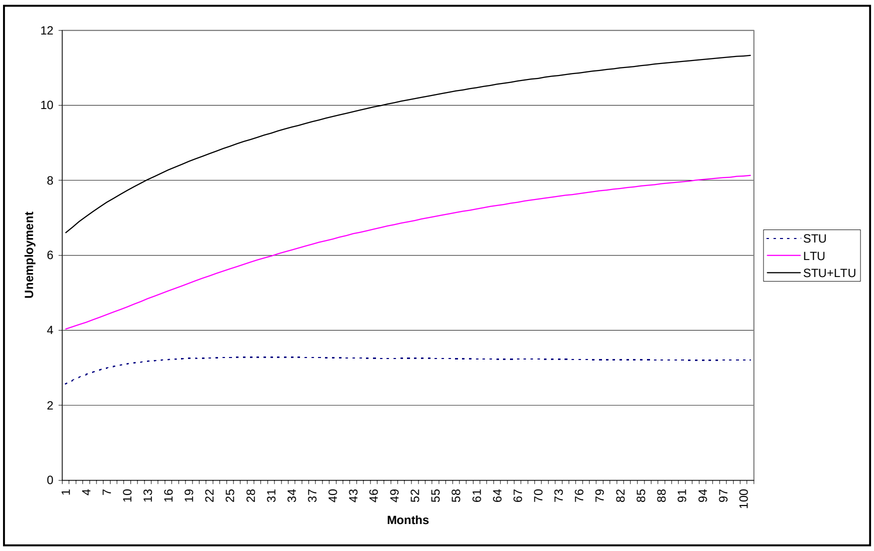


Figure 4 shows that the effects from more ranking really are similar to those in Figure 3. The intuition behind this result is that r and q in some sense are substitutes; more discrimination against the LTU with the same inflow or a bigger inflow and the same amount of discrimination are somewhat similar in their effects. However, two differences are worth noting.[36] First, if r increases this results in a nearly unchanged STU whereas an increase in q leads to a decrease in STU. Second, the effect on LTU appears to be much stronger from ranking.

Finally, let us turn to the consequences of an increase in the degree of wage pressure. Figure 5 shows what happens after such a change.

[36] Another difference is the consequences for the number of workers that have been unemployed for less than one year. Here, we get $u^{<12\,months}$ =0.030; i.e. a slight decrease. Remember that this stock contains both STU and LTU workers. More ranking has three effects; the advantage to be STU increases, the disadvantage to be LTU increases and there are fewer jobs in the economy.

Figure 5: The effects of a 50 % increase in Ω.



Recall the steady state analysis where it was shown that more wage pressure results in an increase in both stocks of unemployed workers. That result is confirmed in Figure 5.[37] However, note that the STU increase occurs during the first year whereas the LTU increase is much more substantial and drawn out.

To summarize these experiments, it is obvious that the mechanisms analyzed in this paper can have strong effects on the unemployment level. Quite moderate changes in the parameters can lead to a prolonged period of adjustment to a new equilibrium that entails a substantial change in the unemployment level. It should also be noted that it is quite possible that real world labor markets have suffered permanent shocks that are a combination of the three types analyzed in this section.

An interesting question is whether these experiments can help us to understand the rise in European unemployment.[38] During the last decades both short- and long-term unemployment have increased even though the increase has been particularly big in long-term unemployment. This means that the relative incidence of long-term unemployment has increased substantially over time.[39] From Figures 3 and 4 it is clear

[37] The consequences for the number of workers who have been unemployed for less than one year is now a substantial increase; $u^{<12\,months}$ =0.037. More wage pressure results in fewer jobs in the economy. Over time though the effect becomes concentrated to the stock of workers who have been unemployed for one year or more.

[38] It should be noted that STU and LTU in the model are not identical to short- and long-term unemployment in the data (see the discussion in Section 3).

[39] For example, in Germany the incidence of long-term unemployment increased from around 30 percent 1979 to almost 50 percent in the mid 80's (OECD 1993).

that ranking and skill loss alone cannot explain what has happened since both short- and long-term unemployment have increased. From Figure 5 we see that wage pressure affects both STU and LTU. However, it is impossible to distinguish between different combinations of factors in a purely theoretical analysis. What is needed to fully analyze this important question is data about the evolution over time of the probability to find a job at different durations and such data are not readily available. Further empirical research is clearly needed to distinguish between hypotheses.

4.4 Temporary shocks

We may also analyze what the dynamic adjustment path looks like after a temporary shock. Let us start by stating the difference equations that determine the stocks of STU and LTU respectively. Linearizing these equations and evaluating them in steady state yields the following two expressions:

$$u_t^S = 0.841 u_{t-1}^S - 0.00434 u_{t-1}^L , \tag{17}$$

$$u_t^L = 0.0494 u_{t-1}^S + 0.963 u_{t-1}^L . \tag{18}$$

Consider first an increase in STU with one percent. According to these equations, this implies an increase in STU the next period by 0.84 percent as well as an increase in LTU the next period by 0.05 percent. The intuition is that firms are reluctant to cut wages since this would lead to costly turnover. Hence, the employment level returns only slowly to equilibrium following a shock. If LTU is one percent higher, this implies an increase of LTU the next period by more than 0.96 percent but has a small effect on STU the next period. The explanation is the slow employment adjustment effect combined with the limited number of jobs open to LTU workers.

Now let us look more closely at the adjustment back to equilibrium following a shock to unemployment. As a first experiment let us study the effects of a temporary increase in the flow from employment to unemployment, s.[40] This experiment can be

[40] This situation is analyzed with the assumption that all agents assume the change in s to be permanent. Otherwise the structure of the optimization problem would have to be changed to accommodate several different values of s.

motivated by the fact that a recession seems to be a fairly short period of high job destruction and the model equivalent of this is an increase in s. To be concrete, let us assume that s doubles for six periods and then returns to its original level. Figure 6 shows how the two stocks of unemployed workers are affected by such a shock.

Figure 6: Adjustment back to equilibrium after a 6 months shock to STU.

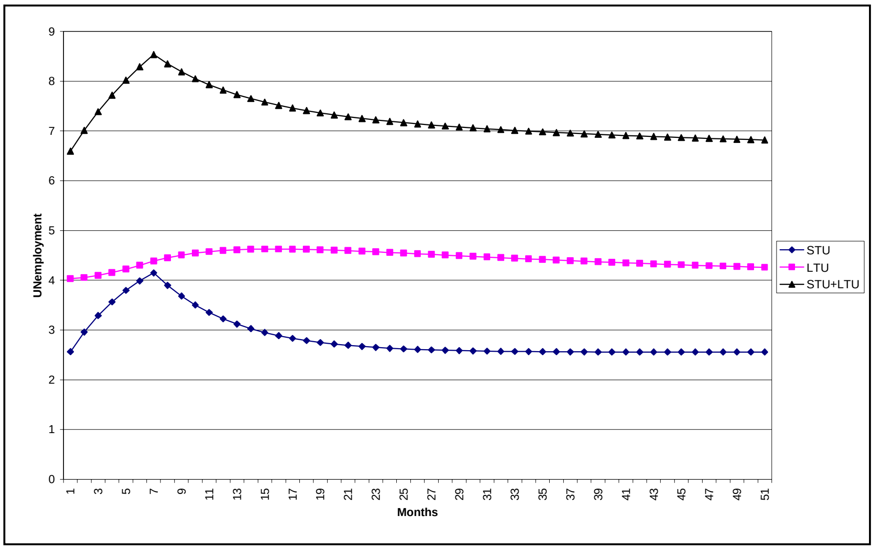
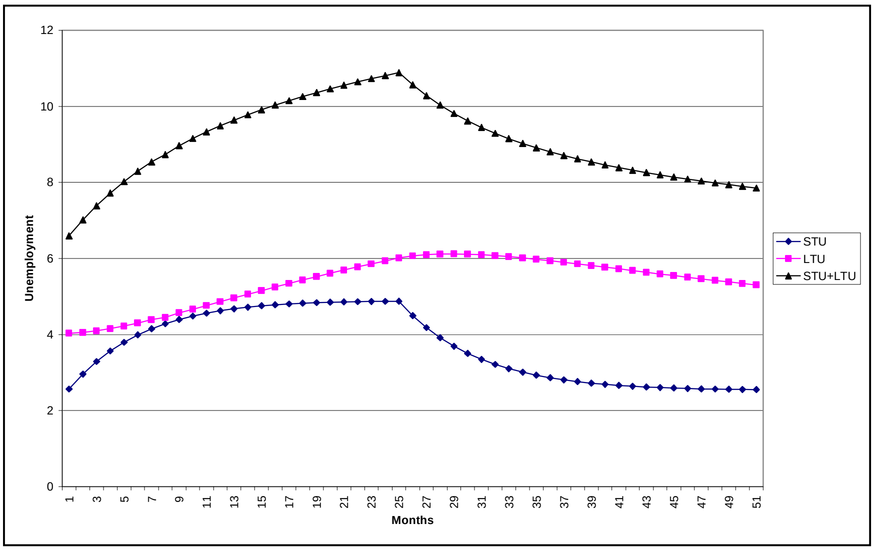


Figure 6 reveals several interesting facts. First, STU increases during the period with a big inflow but then returns fairly quickly to its steady state value. This is hardly surprising since employers perceive these workers to be equivalent to their present employees in all jobs. Meanwhile, LTU initially increases slowly but instead continues to increase several periods after the shock and then only very slowly adjusts back to its steady state value. This is the result of two forces; a bigger stock of STU workers implies a larger inflow into LTU for a number of periods and, in addition, employers to a large extent refuse to hire LTU workers, since they are perceived as more costly to hire than other applicants. Total unemployment falls during the whole period after the shock but due to the lengthy adjustment path of LTU it takes some time for total unemployment to return to its pre-shock value; i.e. unemployment shows persistence (after 12 months around 40 percent of the shock remains).

One might expect more persistent effects from a shock that lasts longer since, in such a situation, more workers would fall into LTU. Figure 7 shows what happens if the economy suffers a shock lasting two years.

Figure 7: Adjustment back to equilibrium after a 24 months shock to STU.



Since the shock lasts longer, more workers fall into LTU and this results in a more drawn out adjustment back to equilibrium than in the previous experiment (after 12 months around 50 percent of the shock remains). Similar results are obtained if we let the shock last for six months, as in Figure 6, but also let the risk to become LTU be twice as large. This would correspond to a shock that involves more job destruction as well as an increased mismatch in the labor market.

The conclusion from this section is that the model implies persistence but that the degree of persistence depends on the nature of the shock. A shock that involves a bigger inflow into unemployment for only a short period results in some persistence. A more prolonged shock to this inflow or a short shock that affects both the inflow and the probability to become LTU results in more persistence. Essentially, the key to getting a substantial amount of persistence is that the shock implies a substantial increase in LTU and not just STU. Depending on the duration and type of the shock the model generates yearly persistence rates of 40-60 percent. It should be noted though that the model cannot generate the near unit root persistence found in empirical studies of total unemployment time series.[41] At the same time it should be remembered that the model abstracts from several factors that probably also add to persistence such as wage contracts spanning several periods and overlapping wage contracts.

[41] Empirical estimates of the serial correlation of unemployment series for Germany often find persistence around 90 percent (see for example Blanchard and Summers (1986)).

5 Conclusions

This paper investigates the consequences of skill loss as a result of unemployment. Unemployed workers risk losing some of their human capital every period and firms, who are unable to differentiate wages according to productivity/training cost differences, partly avoid hiring workers who have lost human capital. Firms set a wage above the market-clearing wage to prevent costly turnover. The paper then analyzes how such an economy responds to both temporary and permanent shocks.

It is shown that both an increased risk of losing human capital, an increased degree of ranking or more wage pressure result in higher steady state unemployment with the effects being concentrated to the stock of LTU workers. Moreover, the negative employment effects of both skill loss and wage pressure increase when combined with ranking. It is also shown that permanent changes in these key factors generate lengthy adjustment phases involving substantial effects on the employment level. The numerical analysis indicates that it takes several years for the economy to reach the new steady state level, even when the parameter change is quite moderate.

It is also shown that temporary shocks have persistent effects on employment. The amount of persistence depends on the type and duration of the shock but the model is not capable of producing the near unit root serial correlation found in empirical studies. It should be remembered, though, that we are abstracting from several factors that might add persistence such as wage contracts that span several periods and overlapping contracts. Another way to get more persistence is to allow for discrimination against all unemployed workers as in Eriksson and Gottfries (2000).

What conclusions can be drawn from this study about the high and persistent European unemployment rates? The main contribution of this paper is the demonstration that if turnover considerations, skill loss as a result of unemployment, and inability to differentiate wages are important features of real world economies this will affect how the economies respond to both permanent and temporary shocks, resulting in lengthy adjustment phases involving substantial effects on the unemployment rates.

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Appendix A: Derivation of selected expressions

Combining equations (5) and (7) the employment equation in (12) can be written as:

$$n_t = \frac{-\Omega(1-s)^2 n_{t-1}^2 (r(1-(1-s)n_{t-1}) + S(1-s)n_{t-1} + (1-r)(1-q)(sn_{t-1} + u_{t-1}^S))}{(1-(1-s)n_{t-1})((1-r)(1-s)Sn_{t-1} + (1-q)(sn_{t-1} + u_{t-1}^S)) + rS(1-s)n_{t-1}(1-q)(sn_{t-1} + u_{t-1}^S)}$$

$$\overline{-\Omega(1-s)n_{t-1}r(1-(1-s)n_{t-1}) - \Omega(1-s)^2 n_{t-1}^2 S - \Omega(1-s)n_{t-1}(1-r)(1-q)(sn_{t-1} + u_{t-1}^S)}.$$

(A1)

Differentiation of equation (A1) with respect to r and q respectively yields the following expressions (let N denote the numerator and D the denominator in (A1)):

$$\frac{\partial n_t}{\partial r} = \frac{1}{D^2}[[-\Omega(1-s)^2 n_{t-1}^2[1-(1-s)n_{t-1} - (1-q)(sn_{t-1} + u_{t-1}^S)]]\ [D]\ -$$

$$[\text{-}(1-s)Sn_{t-1}(1-(1-s)n_{t-1}) + (1-s)Sn_{t-1}(1-q)(sn_{t-1} + u_{t-1}^S) -$$

$$\Omega(1-s)n_{t-1}(1-(1-s)n_{t-1}) + \Omega(1-s)n_{t-1}(1-q)(sn_{t-1} + u_{t-1}^S)]\ [N]]$$

(A2)

$$= \frac{1}{D^2}[u_{t-1}^L + q(sn_{t-1} + u_{t-1}^S)][-\Omega(1-s)^3 n_{t-1}^3 S)(1-(1-s)n_{t-1}) -$$

$$\Omega(1-s)^2 n_{t-1}^2 (1-q)(sn_{t-1} + u_{t-1}^S)(1-(1-s)n_{t-1}) - \Omega(1-s)^4 n_{t-1}^4 S^2 -$$

$$\Omega(1-s)^3 n_{t-1}^3 S(1-q)(sn_{t-1} + u_{t-1}^S)] < 0,$$

$$\frac{\partial n_t}{\partial q} = \frac{1}{D^2}[[\Omega(1-s)^2 n_{t-1}^2(1-r)(sn_{t-1}+u_{t-1}^S)][D]-[-(1-(1-s)n_{t-1})(sn_{t-1}+u_{t-1}^S)$$

$$-rS(1-s)n_{t-1}(sn_{t-1}+u_{t-1}^S)+\Omega(1-s)n_{t-1}(1-r)(sn_{t-1}+u_{t-1}^S)][N]]$$

$$=\frac{1}{D^2}[sn_{t-1}+u_{t-1}^S)][-\Omega(1-s)^3 n_{t-1}^3 S2r(1-(1-s)n_{t-1})-\Omega(1-s)^2 n_{t-1}^2 r(1-(1-s)n_{t-1})^2$$

$$-\Omega(1-s)^4 n_{t-1}^4 rS^2] < 0 \quad \text{if r} > 0. \qquad \text{(A3)}$$

Appendix B: Data

Here, the data used in the calibration is presented briefly. First, we need to consider some conceptual questions and then go through the data in detail.

In a real world labor market, there exists at least three distinct states; employed, one or more groups of unemployed and out-of-the labor force (OLF). In this paper, the last group is left out to keep the model manageable and to focus attention on the central mechanisms. In a more complete model of actual labor markets, OLF dynamics should be included. The exclusion of this stock can partially be justified by arguing that these flows merely represent the exchange of workers; i.e. workers being retired and being replaced by workers directly from school, parents taking child leave etc. In addition, Blanchard and Diamond (1990) point out that the net flows to and from the labor force varies less than other flows over the business cycle. This adds a bit of complication to the calibration since labor market data includes this stock with flows to and from it. In this paper all flows from and to OLF are ignored.

As already mentioned German labor market data for the period of the mid-eighties are used. Here follows a description of the data used.

- Fraction of employed workers entering unemployment (s). Layard, Nickell and Jackman (1991), using OECD data, report a monthly inflow rate of 0.4 percent of employment. This figure is obtained by taking the number of unemployed with duration of less than one month. This excludes roughly half of those whose completed spell is less than one month. To take account of this the fact the slightly higher value 0.5 percent is used in the calibration.
- Fraction of employed job-to-job switchers ($x^{E \to E}$). Here, two possible sources of data have been found. Burda and Wyplosz (1994) report that in 1987 0.3 percent of those employed jump from job-to-job while Boeri (1999) reports that the figure in 1992 is 0.7 percent. Here, we assume that half of those hired are employed and use the figure 0.5 percent in the calibration.
- Unemployment (u). Layard, Nickell and Jackman (1991) report unemployment rates from OECD sources. The average unemployment rate for the period 1985-87 is 6.6 percent.

- Unemployed less than one year ($u^{<12\,months}$). OECD (1993) reports that in 1986 around 49 percent of those being unemployed had been so for twelve months or more.
- Probability to remain unemployed after 1, 3, 6, 9 and 12 months (y^z). Hunt (1995) reports data from the public use version of the household-based GSOEP. Using data for the time period 1983-88, she calculates Kaplan-Meier survival curves. From these figures it is clear that 90, 70, 54, 44 and 36 percent remain unemployed after one, three, six, nine and twelve months respectively. The figures are obtained by calculating escapes only to employment while keeping escapes to OLF recorded as censored. Since the model does not contain OLF dynamics, it is that figure that is relevant here.
- The outflow rate from unemployment ($x^{U \to E}$). OECD (1993) reports estimates of 7.6 percent monthly for the year 1989. It should be remembered though that this figure includes all flows from unemployment and therefore should be used with caution.
- Fraction searching-on the-job (S). Layard, Nickell and Jackman (1991), which report data for the UK from the Labour Force Study, say that around five percent of those being employed engage in on-the-job search. Since this is the only estimate available it at least gives a rough guide as to what value that can be considered reasonable.

Appendix C: Definitions

The following equations provide links between the labor market facts in Table 1 and the theoretical model.

- The fraction of employed workers switching jobs, $x^{E\rightarrow E}$, is given by:

$$x^{E\rightarrow E} = Sa \,. \tag{A4}$$

- The number of workers that at any given time have been unemployed for less than one year is given by:

$$u^{<12\,months} = sn\sum_{i=1}^{12}(1-q)^i(1-a)^i + snq\sum_{k=0}^{11}\left\{\sum_{i=0}^{k}(1-q)^i(1-a)^i(1-a^L)^{(k+1)-i}\right\}. \tag{A5}$$

- The probability to remain unemployed after z months of unemployment, y^z, is given by:

$$y^z = (1-q)^z(1-a)^z + q\sum_{k=0}^{z-1}(1-q)^k(1-a)^k(1-a^L)^{z-k} \quad . \tag{A6}$$

- The outflow rate from unemployment, $x^{U\rightarrow E}$, can be derived from the fact that the outflow from unemployment must be equal to the inflow into unemployment. It is given by:

$$x^{U\rightarrow E} = \frac{sn}{u} \,. \tag{A7}$$

Appendix D: Calibration

The objective of the calibration is to find a set of values for the unobservable magnitudes, $\{\Omega, S, r, q, a, u^S\}$, that satisfy the following equation system:

$$1 = \Omega(1-s)a\,, \tag{A8}$$

$$x^{E\to E} = Sa\,, \tag{A9}$$

$$a = \frac{sn(r(1-(1-s)n) + S(1-s)n + (1-r)(1-q)(sn+u^S))}{(1-(1-s)n)((1-r)(1-s)Sn + (1-q)(sn+u^S)) + rS(1-s)n(1-q)(sn+u^S)}\,, \tag{A10}$$

$$sn = q(sn+u^S) + a(1-q)(sn+u^S)\,, \tag{A11}$$

$$y^{1\,\text{month}} = (1-q)(1-a) + q\left(1 - \frac{(1-r)(sn+aS(1-s)n)}{1-(1-s)n+(1-s)Sn}\right), \tag{A12}$$

$$y^{12\,\text{months}} = (1-q)^{12}(1-a)^{12} + q\sum_{k=0}^{11}(1-q)^k(1-a)^k\left(1-\frac{(1-r)(sn+aS(1-s)n)}{1-(1-s)n+(1-s)Sn}\right)^{12-k} \tag{A13}$$

with the observable magnitudes, $\{s, n, x^{\mathrm{E\to E}}, y^{1\,\text{month}}, y^{12\,\text{months}}\}$, set equal to their steady state values given in Table 1.

Essentially, the equation system in (A8)-(A13) could be solved directly. However, due to the complexity of this system an iterative method is used. The algorithm used can be described by the following four steps.

- A value is set for the variable q.
- The system in (A8)-(A12) is solved for $\{\Omega, S, r, a, u^S\}$.
- The value of (A13) is calculated.
- A new value of q is chosen until convergence is achieved, i.e. (A13) is satisfied.

Essay III

Imperfect Information, Wage Formation, and the Employability of the Unemployed*

1 Introduction

A firm posting a vacancy typically receives a number of job applications from job seekers. This means that the firm has to make a decision whom to hire. Obviously, it wants to choose an applicant that can perform the tasks of the job satisfactorily. This might sound easy but the abilities of the applicants are often uncertain. A firm that chooses the wrong applicant will waste money on training the worker and incur costs to hire a replacement.[1]

In a situation with imperfect information, the employer is often unable to distinguish undesirable applicants from other applicants. One characteristic of the applicants that is easy to observe is their employment status. If employers believe that those workers that are unproductive are concentrated to the pool of unemployed workers, they may use the employment status of the applicant as a sorting criterion. An important issue is whether this will imply discrimination against fully able unemployed workers who cannot credibly show that they are indeed fully productive.

Whom the firm considers as hirable will depend crucially on the extent to which wages reflect productivity differences among workers. Assume, for example, that the firm can divide its applicants into two distinct groups each with a different expected

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[1] The following newspaper quote illustrates an extreme example of this: "US Open threatened by sabotage: employee poured acid on the greens. Estimated damage $ 3 million." (Aftonbladet June 12, 2001).

productivity, net of hiring costs etc. If the firm can set two different wages, each corresponding to the expected productivity of one of the two groups, a risk neutral firm should be indifferent between hiring from the two groups. But if the firm, for some reason, cannot differentiate wages sufficiently, it will instead be optimal to avoid hiring from one of the groups; thus discrimination will be an optimal hiring strategy.

This paper analyzes the hiring decisions of firms in a situation characterized by imperfect information. The purpose is to show that even in a situation where the firms are allowed to set their wages freely it can still be optimal for them to choose a hiring strategy that excludes some groups of workers; thus showing that discrimination is an equilibrium strategy. In addition, the aggregate and welfare properties of this equilibrium are examined.

The model is inspired by the following four key observations about the functioning of labor markets. First, a firm posting a vacancy typically receives a number of job applications from both unemployed and employed applicants. While the number of job seekers applying for a particular job varies with the cycle and the characteristics of the job, it is reasonable to assume that employers often have more than one applicant to choose from. For the U.S., Barron et al (1997) report that the average firm posting a vacancy receives between 10 and 23 applications per job offered. Behrentz (2001) reports similar figures for Sweden. Also there is ample evidence that many of these job seekers are employed. For the UK, Pissarides and Wadsworth (1994) report that around five percent of all employed workers do search for another job and Boeri (1999) shows that around fifty percent of all workers hired are job-to-job switchers.

Second, firms make significant investments in the workers they hire and, therefore, they are very concerned about keeping worker-initiated turnover low. Firms spend considerable time and money on the recruitment process. For the U.S., Barron and Bishop (1985) show that the employers in their sample spent more than two hours on average evaluating each of the applicants. In addition, substantial amounts of time and money are spent helping the newly hired worker acquire the firm-specific skills needed to do the job. In the paper mentioned above, this amounted to approximately 150 hours on average. There is also ample evidence that employers care about turnover. Survey studies indicate that managers are genuinely concerned about keeping worker-initiated turnover low; see Bewley (1999) for the U.S. and Agell and Lundborg (1999) for Sweden.

Third, it is difficult to determine the productive abilities of applicants before hiring. The productivity of a worker in a particular job depends on a lot of factors. Some of these, such as education, are relatively easy to observe whereas others, such as motivation, are almost impossible to observe prior to hiring. Instead, employers might use easily observable factors, such as employment status, as indicators of unobservable productive abilities, to sort the applicants. It seems that in many real-world situations, the important thing for the employer is to locate a worker who has sufficient skills to perform given tasks satisfactorily. This is especially relevant for jobs that are neither very low skill, so that everyone can perform them satisfactorily, or very high skill, so that it really is crucial to find an applicant with rare talents. For such jobs, the main concern for employers is to look out for those workers who are inferior, for example by having very low skill levels or by having personal characteristics that might disturb production.

Fourth, it is more likely that the pool of unemployed applicants contains workers with undesirable characteristics than that they are in the pool of employed applicants. There are, at least, two reasons for believing this; employers will be more likely to fire bad workers and workers may lose skills during unemployment.[2] The implication of this is that we would expect employers to be more wary of hiring from the pool of unemployed workers than from the pool of employed job seekers.

It might however be argued that, if the wage is sufficiently flexible, it should be possible to adjust the wage in such a way as to compensate for expected productivity differences between applicants. If a worker cannot show that he has the necessary ability, a risk neutral firm should calculate the expected productivity of such a worker by taking the expectation of the distribution of productivities and then pay him the corresponding wage. Moreover, it may be argued that the worker himself could be forced to pay all hiring and training costs in the form of a very low first period wage, or even pay a fee, or post a bond, to get the job. However, there are several arguments against this line of reasoning. First, a worker that knows he is fully able but cannot credibly show this to his present employer has very strong incentives to start looking for

[2] See Gibbons and Katz (1991). For a model based on skill loss as a result of unemployment see Eriksson (2001).

a new job if the employer pays him a very low wage. Second, in most countries the wage level is not totally flexible downwards because of factors such as minimum wage legislation, unions, fairness considerations etc. These factors may prevent wages from falling sufficiently. Third, the use of entrance fees/bonds is problematic on theoretical grounds since they would create strong incentives for the firm to cheat on the worker.[3]

In this paper, a model is formulated where workers decide whether or not to search on the job based both on wages and a stochastic job dissatisfaction factor. Firms make their hiring decisions in a situation characterized by imperfect information. The applicant pool consists of both on-the-job searchers and unemployed searchers. All workers are identical, except for a small number of unproductive workers that no firm wants to employ. These unproductive workers are found in the unemployment pool. Firms cannot always separate these unemployed workers from other applicants but firms can identify some of the unemployed applicants as being productive. Thus, firms sort their applicants into two pools: one pool of workers that the firm is certain are productive (the certain pool) and one pool of workers that the firm is uncertain about (the uncertain pool). The productivity of workers in the uncertain pool are revealed several periods after hiring. Firms set all wages unilaterally considering that worker-initiated turnover is costly since they must pay a hiring and/or training cost for every hired worker.

The paper starts by showing that it is an equilibrium hiring strategy to "discriminate", i.e. only hire workers from the certain pool. This is done by construction of an equilibrium where all firms discriminate and showing that no individual firm has an incentive to deviate by instead hiring from the uncertain pool. While it is optimal to pay a lower wage to a worker with uncertain productivity, if he is hired, the wage will not be sufficiently low to compensate the firm for the extra costs associated with hiring such a worker. The reason for this is that the wage must simultaneously discourage search among productive workers in the uncertain pool, cover the costs for replacing unproductive workers and compensate for the low net productivity of unproductive workers until they are discovered. It is impossible to find a wage that does all this. Hence, it is rational for employers to follow a discriminatory hiring strategy, i.e. to avoid hiring workers with uncertain productivity.

[3] The issue of bonding has been discussed extensively elsewhere. See for example Dickens et al (1989) and McLeod and Malcolmson (1989).

The paper then analyzes the properties of this discriminatory equilibrium by deriving the steady state solution if all firms follow their discriminatory hiring strategy. It is shown that unemployed job seekers will face a lower expected probability to find a job than employed job seekers. Given the efficiency wage mechanism, this will obviously raise wages and lead to higher equilibrium unemployment.

Finally, the paper analyzes the welfare properties of the discriminatory equilibrium. The social planner maximizes the total sum of utility in the economy given that the information constraint cannot be eliminated. It is shown that the market participants do not consider all socially relevant effects. The analysis also indicates that the market solution yields an employment level that is too low. Different policy interventions to improve welfare are also discussed.

The main point of this paper is that, even though firms are allowed to set their wages freely, it is not possible to differentiate wages so that firms become indifferent in their hiring decisions among different groups of applicants. Instead, it is optimal to discriminate in hiring. Two related papers are Gibbons and Katz (1991) and Sattinger (1998).[4] The paper by Gibbons and Katz is based on the idea that the present employer knows more about the productivity of his workers than prospective employers do. Other firms, therefore, try to infer the quality of workers from their employment history; i.e. whether workers are laid of after a plant closing or for other reasons. Obviously there is an analogy between the certain vs. uncertain pool distinction in my paper and laid off workers vs. other workers in their paper. However, a key difference is that they assume that laid off workers suffer by having to accept a lower wage rather than by not getting a job. Thus, in their paper firms do use the wage to make them indifferent among different groups of job applicants, and there is no unemployment. In my model, unemployed workers find it hard to get a job. Sattinger analyzes a situation where it is optimal for the firm to use different employment criteria for different groups. However,

[4] This paper is obviously related to the huge literature on discrimination and information imperfections. For a survey of the discrimination literature see Cain (1986). The literature on information imperfections and signaling is surveyed in Riley (2001). A related paper is Kugler and Saint-Paul (2000). In their model, firms lay off their most unproductive workers, as in Gibbons and Katz (1991), and thus firms find it more profitable to hire employed rather than unemployed workers. However, their model differs from mine in several important ways. First, they assume that the same wage must be set for all workers, making it obvious that it is more profitable to hire employed workers rather than unemployed workers. Second, while I focus on a situation where a firm needs to fill a fixed number of jobs and must choose whom to hire from a pile of applications, they consider a situation where firms always hire the workers they meet if they find it profitable to do so.

Sattinger assumes that the wage cannot be differentiated between the groups, thus avoiding the issue of why the wage cannot be used to make up for the differences in productivity. My paper thus complements Sattinger's analysis by showing that discrimination may arise without this exogenously imposed wage inflexibility.

Another related paper is Tranæs (2001). He studies the effects of raiding in labor markets in which worker's abilities differ. A firm with a vacancy can choose between hiring an unemployed worker and trying to induce an employee of another firm to switch jobs by offering a higher wage. My paper shares the idea that employers are more certain about the abilities of employed than unemployed workers, as well as the policy implication that search among the unproductive workers creates an externality affecting all other unemployed workers. However, my model differs in a number of fundamental ways. Most importantly, in my model firms worry about the incentives of their employees to look for other jobs (as in most traditional efficiency wage models) whereas firms in Tranæs' model worry about the incentives of other firms to raid their workers.

The rest of the paper is organized as follows. Section 2 presents the model and shows that it is an equilibrium hiring strategy to only hire from the certain pool. Section 3 analyzes the aggregate properties of this equilibrium. Section 4 discusses welfare and policy issues. Section 5 concludes.

2 Discrimination as an optimal hiring strategy

There are many identical firms producing one good with labor as the only input, and many workers who can be either employed or unemployed. The size of the workforce is fixed and normalized to one.

Employed workers get utility from both wages and a non-pecuniary factor measuring their job satisfaction. Every period workers compare the utility they get if they remain with the firm with the utility they would get if they switch jobs. Workers that find that it is beneficial to find a new job, start on-the-job search by submitting an application to a randomly chosen firm. Some of these workers get the jobs they apply for and therefore quit from their present employers. In addition, an exogenous fraction of the employed workers quit into unemployment and all unemployed workers submit one application to a randomly chosen firm.

The firms' set wages unilaterally taking into account that turnover is costly. The firms are free to set different wages for different workers but to prevent arrangements like bonding all firms have to pay all workers an amount at least equal to a minimum wage. Every newly hired worker has to be trained to be able to perform the tasks of the job and firms incur all these costs.

2.1 Firms' information about job applicants

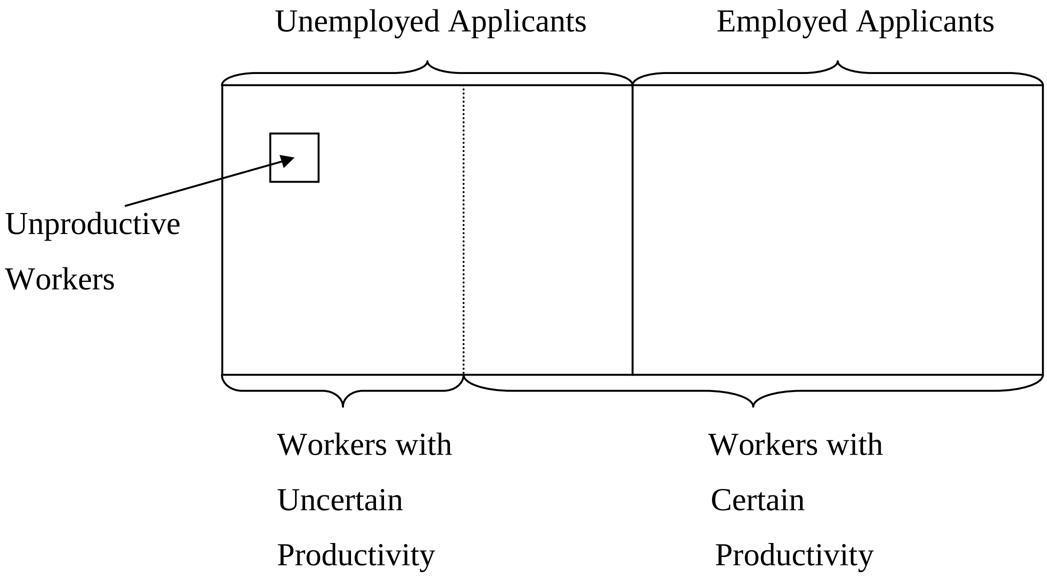
All workers are equally productive in all jobs except for a small number of really unattractive workers, Ω, which we call "unproductive". These workers produce zero output; possibly net of the costs they impose on the firms if they are hired. Firms receive the applications and can choose to hire on-the-job searchers or unemployed searchers. When choosing whom to hire, firms are not able to determine the abilities of all the applicants with certainty and thus are careful about whom they hire. Firms have access to the following information. First, they know the structure of the model and all its parameters, especially the fraction of unproductive workers in the economy. Second, they know whether or not the applicant is employed or unemployed. As we will see, no firm hires an unproductive worker in equilibrium so firms know that all employed applicants are productive. Third, firms can use other information (references etc.) to classify some of the unemployed applicants as productive. But different employers may reach different conclusions about the same worker, because different employers have access to different information.[5] For example, if an applicant includes a reference in his application, we would expect different employers to assess the value of such a reference differently. Formally, let as assume that the probability that an employer considers an unemployed worker as productive with certainty is given by ψ if he is productive and zero if he is unproductive.

Based on their information about the applicants, firms divide their applicants into two pools; those they are certain are productive (the certain pool) and those they are

[5] The reason for this assumption is that we otherwise would have a large group of productive workers that never has any chance of getting a job since employers cannot verify them as productive workers. This would be unreasonable. However, we might expect that some productive unemployed workers always are unable to credibly demonstrate their abilities.

uncertain about (the uncertain pool). The first group consists of all employed applicants and those unemployed applicants the firm knows are productive. The second group consists of all other unemployed applicants including the unproductive workers. Figure 1 illustrates the applicant pool of an individual firm.

Figure 1: The applicant pool of an individual firm.



A firm in this economy can choose to hire either from both the certain pool and the uncertain pool or to just hire from the certain pool. Thus, there are two possible hiring strategies, which we call non-discrimination and discrimination. In this section, it is shown that there exists an equilibrium where firms discriminate; i.e. where firms hire only workers with certain productivity. This is done by constructing a discriminatory equilibrium and showing that it is not profitable for a firm to deviate by hiring in a non-discriminatory way.

2.2 The sequence of events

The model takes place in discrete time and there are an infinite number of periods. The sequence of events is the same in all periods and consists of three stages. First, firms decide which wages to offer its present employees as well as those newly hired. Second, all employed workers remaining employed after exogenous quits into unemployment decide whether to seek a new job or not given the wage offers, and firms choose whom to hire from the pile of applications. Third, production takes place.

We analyze these decisions starting with the search decision made by the employed workers and then consider the wage and employment decisions made by the firms.

2.3 The workers' on-the-job search decision[6]

The workers' utility function is given by the wage divided by a job dissatisfaction factor. The dissatisfaction factor, μ, is drawn from a random distribution with cdf function $G(\mu)$, which has mean equal to one. Workers make new independent draws from this distribution every period.[7]

An employed productive worker decides whether or not to search on the job by comparing the utility from staying in the present job with the utility from changing jobs. Only the present period outcome matters, because the worker is back in the same position in the next period whether or not he gets a new job. The current-period utility from staying in the present job is equal to $w_t^i / \hat{\mu}_t$, where w_t^i is the wage offered by the firm in period t and $\hat{\mu}_t$ is the job dissatisfaction from staying in the present job in period t. The current period utility from changing jobs is equal to $\lambda \underline{w} E(1/\mu)$, where $\lambda < 1$ is what remains of the utility from the new job after moving costs and $\underline{w}$ is the first period wage offered by other firms. There are no costs of search so workers search if the expected gain from changing jobs is positive. This means that the worker will search if $\lambda \underline{w} E(1/\mu) > w_t^i / \hat{\mu}_t$. Using the distribution of the job dissatisfaction factor, the fraction of all employed workers that search on the job can be written as:

[6] It should be noted, that what is important is that the decision whether or not to search on the job is a function of the relative wage. This section tries to sketch a highly simplified micro-foundation for this assumption.

[7] This is obviously a simplification of real world behavior but a convenient way of introducing the important fact that non-pecuniary factors seem to be as important as wages in the decision of whether or not to search for a new job (see Akerlof et al (1988)). It should be possible to introduce serial correlation in the job satisfaction component without changing the basic results. However, this would severely complicate the analysis.

$$S(\frac{w_t^i}{\kappa \underline{w}}) = 1 - G(\frac{w_t^i}{\kappa \underline{w}}), \quad (1)$$

satisfying $S' < 0$ and $S'' \geq 0$ and where $\kappa = \lambda E(1/\mu)$.

2.4 Discriminating firms' wage and employment decisions

This section considers the wage setting and employment decisions of a firm, which hires only workers who are productive with certainty. The firm's objective is to maximize the present value of all future profits by choosing the optimal wage and employment levels. The firm is free to set different wages for different groups of workers but is constrained by the fact that it has to pay a minimum wage to all its workers.[8] Formally, we assume that firms have to pay all their workers a wage that is at least equal to $\underline{w}$. Firms incur hiring and training costs, h, for every newly hired worker.[9] Then discriminating firms have to set two different wages; the wage for the first period of employment and the wage for all remaining periods of employment.

Let us start by considering the optimal wage to offer the first period.[10] Since workers are unable to apply for new jobs during the first period, firms do not have an incentive to offer a high wage to keep turnover down. The only factor placing a constraint on this wage is that the firms must ensure that there exist workers who are willing to work at this wage. Here, we simply assume that the firms can get away with setting a wage equal to the minimum wage, $\underline{w}$, during this period.

Now let us consider the optimal wage for all other periods maintaining the assumption that the firm hires only productive workers. To solve for this wage, we must set up the firm's profit maximization problem. However, first we must introduce some additional notation. Let the employment level in firm i be given by n_t^i, the

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[8] This assumption can be justified by arguing that there exists a minimum wage stated in law or that some other factor places a constraint on the wage. In reality, there are a number of factors that might create a wage floor. One is obviously the existence of unions. Another is an insider-outsider argument were workers already with the firm would feel that their jobs are threatened if the hiring wage gets to low (such factors are analyzed in depth in Gottfries and Sjöström (2000)).

[9] It should be noted that it would be easy to incorporate an additional cost for worker-initiated quits. Such a cost could be justified by arguing that such quits disturb production etc.

[10] The wage the first period is not really that important because the existence of such a period is clearly an artifact of the discrete time assumption. In real world labor markets, we would expect a worker who is dissatisfied to start searching for a new job immediately after hiring implying that the optimal wage the first period would be equal to the optimal wage the second period.

production function be $f(n_t^i)$ satisfying $f'>0, f''<0$, the discount factor be β, the fraction quitting for exogenous reasons be s and the probability to get a job for an employed job seeker be a_t. Let w_t^i be the wage all subsequent periods. Hiring in period t is given by $n_t^i-(1-s)(1-S(w_t^i)a_t)n_{t-1}^i$.[11] Then the profit maximization problem can be stated as:[12]

$$\max_{w_t^i, n_t^i} \sum_{\tau=t}^{\infty} \beta^{\tau-t}[f(n_\tau^i)-(\underline{w}+h)(n_\tau^i-(1-s)(1-S(w_\tau^i)a_\tau)n_{\tau-1}^i)-w_\tau^i(1-s)(1-S(w_\tau^i)a_\tau)n_{\tau-1}^i] \qquad (2)$$

i.e. the profit every period equals production minus wage and hiring costs for newly hired workers minus wage costs for workers remaining employed from the previous period.

This problem looks like a dynamic optimization problem that requires standard dynamic programming techniques to solve. However, a closer inspection shows that the only dynamic part of the problem is the fact that if the firm hires one more worker period t this will affect the number of workers it needs to hire period t+1. Since we are primarily interested in an equation for the optimal wage, we can solve the problem quite easily by simply using the first order conditions for period t. These are:

$$-(\underline{w}+h-w_t^i)S'(w_t^i)\frac{1}{\kappa\underline{w}}a_t-(1-S(w_t^i)a_t)=0, \qquad (3)$$

$$f'(n_t^i)-(\underline{w}+h)+\beta(1-s)(1-S(w_{t+1}^i)a_{t+1})(\underline{w}+h-w_{t+1}^i)=0. \qquad (4)$$

Equation (3) implicitly defines the optimal wage as a function of variables which are given for the individual firm while equation (4) defines the employment level given the optimal wage. The optimal wage can be written as:

[11] Note, that we have simplified the notation for the S-function slightly.
[12] It is implicitly assumed that the parameter values are such that this profit level is non-negative.

$$w^i = h_1(a, \underline{w}, h) . \quad (5)$$

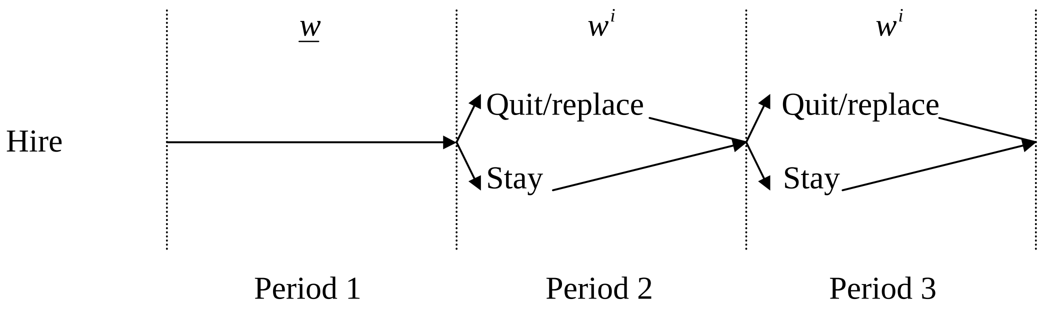
It is straightforward to show that the wage is an increasing function of a and h.[13] Note that equation (3) implies that the optimal wage will satisfy $\underline{w} + h - w^i > 0$.

Equation (5) determines the optimal wage when the firm hires only workers from the certain pool. We are now ready to begin the analysis of the whether it is more profitable to deviate by hiring from the uncertain pool, possibly at a lower wage. We do this by studying the consequences of hiring just one marginal worker from the uncertain pool given that the firm itself, and all other firms, otherwise only hires from the certain pool. However, to facilitate a comparison with the discriminatory case we first look at the consequences of always filling a job with workers from the certain pool. To keep the analysis simple, we treat the employment level of the firm as fixed in the rest of this section and focus on the optimal wages.

2.5 The profit from one job if the firm discriminates

In order to compare between the hiring of a worker from the certain pool and the uncertain pool, we consider the profit from recruiting just one worker with marginal product θ.[14] If the firm hires a worker with certain productivity, it faces the events illustrated in Figure 2.

Figure 2: The hiring of a worker with certain productivity.



[13] For reasonable parameter values it is also an increasing function of $\underline{w}$.

[14] We can interpret θ as the marginal product of the marginal worker given that all other n-1 workers are fully productive.

Let V be the discounted value of having the job filled with productive workers from period four onwards when the wage is set optimally for those periods. Then we can write the total discounted profit from hiring such a worker as:

$$\pi^H = (\theta - \underline{w} - h) + \beta[(1-s)(1-S(w^i)a)(\theta - w^i) + (s + (1-s)S(w^i)a)(\theta - \underline{w} - h)] +$$

$$\beta^2[(1-s)(1-S(w^i)a)(\theta - w^i) + (s + (1-s)S(w^i)a)(\theta - \underline{w} - h)] + \beta^3 V. \qquad (6)$$

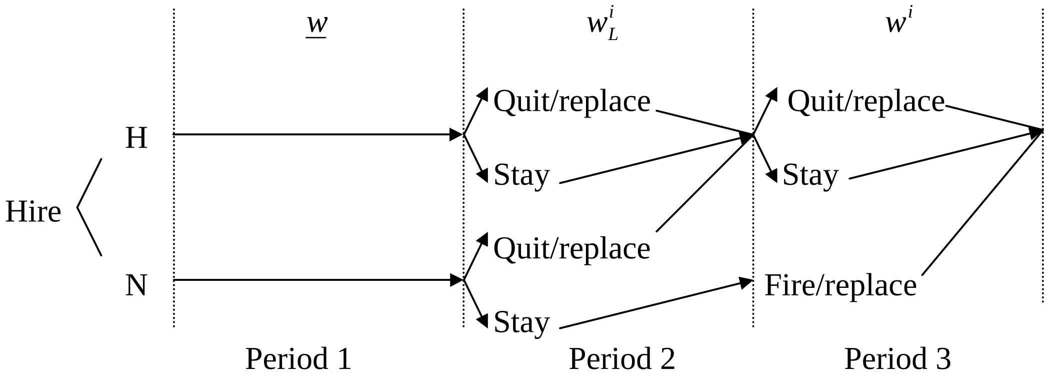
For convenience, all time subscripts have been omitted since every period is identical. We see that the profit from hiring a worker with certain productivity is the sum of several terms; the profit the first period, the profit the second period if the worker remains employed with the firm, the profit from hiring a new worker if the worker quits from the firm, the corresponding terms the third period and the sum of future profits. Equation (6), therefore, gives us an expression for all future profits, if the firm hires a worker with certain productivity today *and* continues in the future with a strategy of only hiring workers with certain productivity.

2.6 The profit from one job if the firm deviates

Now let us consider the case when the firm deviates from the strategy presented above and instead hires a worker from the uncertain pool today, while maintaining the discrimination strategy in the future; i.e. if the worker quits he is replaced by a worker with certain productivity. We assume that the firm discovers whether the worker is a productive after two full periods of employment.[15] The sequence of events is illustrated in Figure 3.

[15] What is crucial is not that the worker's type is discovered after exactly two periods, but rather that it is not discovered before the firm has a chance to use the wage to compensate itself for the fact that the expected productivity is lower for a worker from the uncertain pool; i.e. discovery cannot be before the end of period two.

Figure 3: The hiring of a worker with uncertain productivity.



The firm has to pay that worker the same minimum wage the first period, but has the possibility to pay a lower wage the second period to compensate for the risk that the worker is unproductive. Let w_L^i denote the wage offered to such a worker the second period. At the beginning of period three, the type of the worker is revealed and, henceforth, it is obviously optimal to fire unproductive workers and pay the remaining workers the wage w^i derived above.

Now consider the worker's decision whether or not to search on the job. First, consider a worker in the uncertain pool that knows he is productive but cannot demonstrate this to a firm. The fraction of such workers that will search for a new job in period two is given by equation (1) if we replace w^i with w_L^i. Second, consider a worker in the uncertain pool that knows he is unproductive. Such a worker realizes that he will be fired directly after period two. Therefore, he will have very strong incentives to apply for a new job irrespective of his level of job satisfaction. Under reasonable conditions, and this is what we assume, all such workers always use the opportunity to look for a new job.[16]

We can now write an equation for the profit from filling the job with a worker from the uncertain pool, denoted by π^L. Letting φ be the fraction of unproductive workers in the group of workers with uncertain productivity[17], this is given by:

---

[16] That is, we assume that it is not optimal to stay with the firm until the end of the period and then be fired into unemployment. Essentially, what is needed is that it is not too nice to be unemployed.

[17] I.e. the number of unproductive workers divided by the number of workers with uncertain productivity.

$$\pi^L = (1-\varphi)(\theta - \underline{w} - h) + \varphi(0 - \underline{w} - h) + \beta(1-\varphi)[(1-s)(1-S(w_L^i)a)(\theta - w_L^i) +$$

$$(s+(1-s)S(w_L^i)a)(\theta - \underline{w} - h)] + \beta\varphi[(1-s)(1-a)(0 - w_L^i) + (s+(1-s)a)(\theta - \underline{w} - h)] +$$

$$\beta^2\varphi(1-s)(1-a)(\theta - \underline{w} - h) + \beta^2(1-\varphi(1-s)(1-a))[(1-s)(1-S(w^i)a)(\theta - w^i) +$$

$$(s+(1-s)S(w^i)a)(\theta - \underline{w} - h)] + \beta^3 V. \tag{7}$$

The terms in equation (7) are in principle equivalent to the terms in equation (6), but are more complicated because we now have to keep track of two types of workers whom the employer cannot separate until the beginning of period three; those who are productive (denoted H in Figure 3) and those who are unproductive (denoted N in Figure 3). The terms are the following; the profit the first period if the worker is a H-worker, the profit the first period if the worker is a N-worker, the profit the second period if the worker is a H-worker and remains with the firm or is replaced by a H-worker, the profit the second period if the worker is a N-worker and remains with the firm or is replaced by a H-worker, the profit the third period if the worker is a N-worker, remains with the firm at the beginning of period 3 and thus is replaced by a H-worker, the profit the third period if the N-worker does not remain with the firm and finally all future profits from a H-worker.

Maximization of equation (7) with respect to the second period wage, w_L^i, yields the following first order condition, if we assume that the constraint $w_L^i \geq \underline{w}$ does not bind:[18]

$$(1-\varphi)[-(1-S(w_L^i)a) - S'(w_L^i)\frac{1}{\kappa\underline{w}}a(\underline{w} + h - w_L^i)] - \varphi(1-a) = 0\,. \tag{8}$$

The similarity between equations (3) and (8) is striking. The difference is just the last term and the fraction $(1-\varphi)$ in the first term. Equation (8) implicitly defines the

[18] It is reasonable to assume that φ is quite small and, therefore, that w_L^i is only a bit smaller than w^i so that the constraint does not bind.

second period wage for a worker with uncertain productivity as a function of what the firm perceives as parameters. This can be written as:

$$w_L^i = h_2(\varphi, a, \underline{w}, h)\,. \tag{9}$$

2.7 Comparison of the wage levels

Intuitively, it is natural to believe that the wage defined in (9) is lower than the wage defined in (5) since the existence of unproductive workers in the case where firms hire from the uncertain pool means that the firm might waste money. If the worker turns out to be unproductive, the firm will have wasted money on him in the form of costs for hiring/training and wages as well as costs to replace him. This intuition turns out to be true and the results are summarized in Proposition 1.

Proposition 1

Let the second period wage for a worker with certain productivity, w^i, be given by equation (5) and the second period wage for a worker with uncertain productivity, w_L^i, be given by equation (9). Then it can be shown that $w_L^i < w^i \quad \forall \varphi \in (0,1)$.

Proof: see the Appendix.

2.8 Comparison of the profit levels

We have seen that if there exist unproductive workers in the economy it is optimal to pay workers with uncertain productivity a wage that is lower than the one paid to other workers during the second period. The more important question, though, is if this wage is sufficiently low to compensate the firm for all the costs associated with the risk that the worker is unproductive. This question can be rephrased as asking whether the profit from filling a job with a worker with certain productivity is bigger or smaller than the profit from filling the same job with a worker with uncertain productivity. We can easily get an expression for this by subtracting equation (7) from equation (6), if we evaluate all wages at their optimal values. This after some manipulation yields the equation:

$$\pi^{Diff} = \pi^H - \pi^L = \varphi\theta + \beta(1-s)[\varphi(1-a)\theta - (w^i - w_L^i) + \varphi a(\underline{w} + h - w_L^i) -$$

$$S(w^i)a(\underline{w} + h - w^i) + (1-\varphi)S(w_L^i)a(\underline{w} + h - w_L^i)] + \tag{10}$$

$$\beta^2\varphi(1-s)^2(1-a)(1-S(w^i)a)(\underline{w} + h - w^i).$$

The profit-difference expression in (10) essentially compares the pros and cons of deviating from the main strategy. If the firm deviates, the optimal second period wage is lower but the firms' costs for expected turnover increases and there is a risk that the worker hired is unproductive, thus producing zero output and making it necessary to replace him at the beginning of the third period.

Intuitively, we might expect that it is not optimal to deviate from the main strategy because it is unlikely that there exists a wage that, at the same time, can compensate for all the differences between workers in the certain pool and workers in the uncertain pool. This intuition is confirmed in Proposition 2.

Proposition 2

Let the second period wage for a worker with certain productivity, w^i*, be given by equation (5) and the second period wage for a worker with uncertain productivity,* w_L^i*, be given by equation (9). Then it can be shown that* $\pi^{Diff}(w_L^i, w^i) > 0 \quad \forall \varphi \in (0,1)$.

Proof: see the Appendix.

We can get some intuition for the results in Proposition 2 by considering the derivative of π^L with respect to φ (note that it is only π^L in equation (10) that is a function of φ). Applying the envelope theorem, we obtain:

$$\frac{\partial \pi^L}{\partial \varphi} = -\theta - \beta(1-s)(1-a)\theta - \beta(1-s)(1-S(w_L^i))a(\underline{w} + h - w_L^i) -$$

$$\beta^2(1-s)^2(1-a)(1-S(w^i)a)(\underline{w} + h - w^i) < 0. \tag{11}$$

The first two terms in equation (11) can be interpreted as the expected loss of production from hiring a worker with uncertain productivity (unproductive workers produce zero output). The third term can be interpreted as the increase in expected costs of replacing workers quitting (productive workers will get increased incentives to search at the lower wage). The fourth term can be interpreted as costs arising from the fact that the expected cost for firing and replacing unproductive workers increase (such workers will be fired at the beginning of the third period).

To summarize the results in this section, we have shown that it is an optimal hiring strategy for an individual firm to hire only workers with certain productivity. It is never profitable to deviate from this strategy by hiring workers with uncertain productivity even though the firm can use the wage to compensate for the risk that such a worker is unproductive. The reason for this is that even though the optimal second period wage for a worker with uncertain productivity is lower than the corresponding wage for other workers, it is not sufficiently low to compensate the firm for costs associated with the risk that the worker hired is unproductive (wages and replacement costs) and to make sure that those workers who are productive do not get too eager to apply for new jobs. The first consideration tends to push the wage downwards, while the second tends to keep it high. Thus, the existence of the turnover component prevents the optimal wage from being low enough to make employers indifferent between applicants. Instead, the wage will always be so high that it is profitable to abstain from hiring workers with uncertain productivity.

It is important to note, that none of these results hinge on the assumption that there exists a first period of employment when the minimum wage is paid. Even if we let the length of that period approach zero the results would still hold. Also, the result will hold if we assume that the first period is a training period where workers only train and do not produce anything.[19] What is important, however, is that workers cannot pay up front for the job or post bonds.

[19] In other words, it is not the fact that unproductive workers produce zero output the first period that drives the results.

2.9 Numerical illustration

To gain some further intuition for the results, it is illuminating to consider a numerical example. To do that, we need to make some assumptions about the distribution of the job satisfaction factor as well as about various parameters.

To keep the simulation as simple as possible, let us assume that the job satisfaction component is drawn from a uniform distribution on the interval zero to two.[20] This means that the fraction searching on-the-job, defined in equation (1), can be written as:

$$S(\frac{w^i}{\kappa \underline{w}}) = 1 - \frac{w^i}{2\kappa \underline{w}}, \tag{12}$$

$$S(\frac{w_L^i}{\kappa \underline{w}}) = 1 - \frac{w_L^i}{2\kappa \underline{w}}, \tag{13}$$

for workers with certain and uncertain productivity respectively. Using equations (12) and (13) in the first-order conditions in equations (3) and (8), we obtain the following expressions for the optimal wage levels:

$$w^i = \frac{2\kappa(a-1)+a}{2a}\underline{w} + \frac{h}{2}, \tag{14}$$

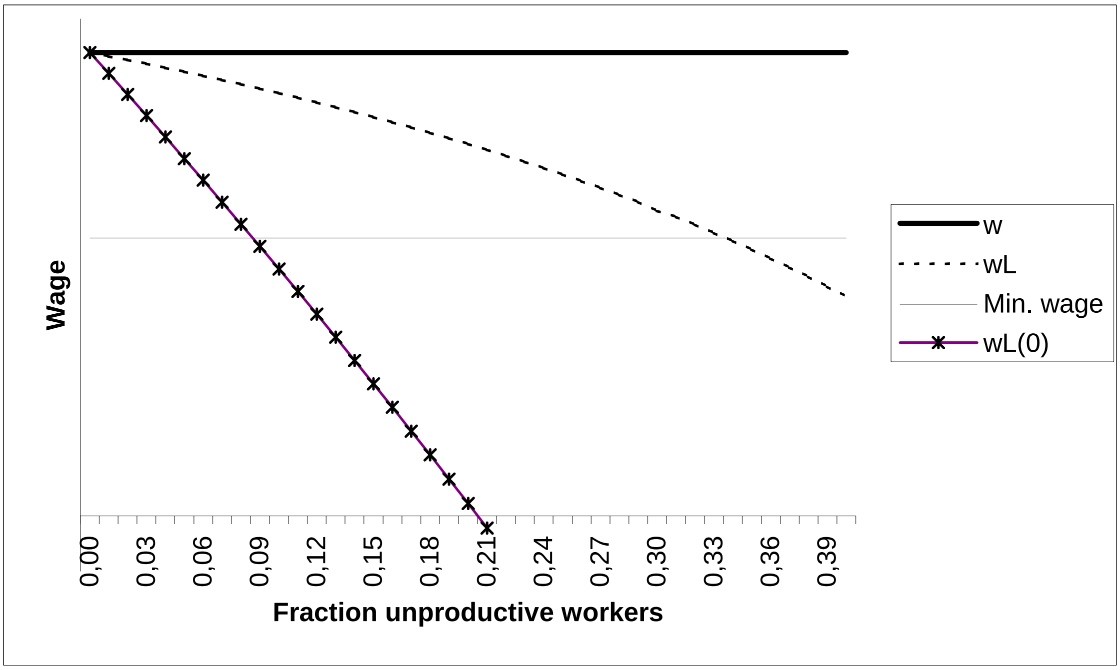
$$w_L^i = \frac{2\kappa(a-1)+a}{2a}\underline{w} + \frac{h}{2} - \frac{\varphi}{(1-\varphi)}\frac{\kappa(1-a)}{a}\underline{w}. \tag{15}$$

Note the similarity between equations (14) and (15), the only difference is the last term in (15) which as expected is a function of φ.

[20] It should be noted, that these effects probably would become even more striking if we assume a distribution for the job satisfaction component that is strictly convex. In that case, the fraction of employed workers seeking new employment would increase much more rapidly if the wage were decreased, making it even more difficult to use the wage to compensate for differences among workers.

We consider a symmetric equilibrium and choose the following values for the parameters: $a = 0.4$, $h = 3$ times the wage, $\underline{w} = 0.6$ times the wage, $\beta = 0.9975$ and $s = 0.015$.[21] Moreover, the value of κ is chosen so that 5 percent of the workers perceived by the firm as belonging to the certain pool search.[22] Let us also set $\theta = 2$.[23] Figure 4 shows the optimal wage as a function of φ.

Figure 4: The optimal wage level as a function of φ.



There are several things worth noting in Figure 4. First, we see that the optimal second period wage for a worker with uncertain productivity, w_L^i, is a declining function of φ, as we would expect from Proposition 1. Second, we see that it takes a quite extreme fraction of unproductive workers in the pool of applicants before the constraint given by the minimum wage starts to bind. This is true even if we set a higher value for the

[21] Blau and Robins (1990), find that that employed job seekers change jobs at a rate of 0.13 per week implying a value of approximately 0,4 per month, the flow from employment to unemployment is 1,5 percent per month for the U.S. (Blanchard and Diamond (1990)), the minimum wage is set at a low 60 percent of the wage, the discount rate is set to 3 percent per year, hiring/training is set to three monthly wages.

[22] As was mentioned in the introduction around 5 percent of all employed workers search in the U.K.

[23] This value of θ is chosen so that the firm makes a small profit every period except the first. This is reasonable since it must recover the investment it has made in hiring/training costs. This value is only used to calculate the curve $w_L^i(0)$ in Figure 4.

minimum wage than 60 percent of the wage. Third, if we assume the fraction of employed workers seeking a new job is constant at five percent (irrespective of the wage), we can calculate the wage that makes the profit-difference expression in (10) equal to zero. This wage, $w_L^i(0)$, falls quite rapidly with φ. The firm is not willing to set a wage given by $w_L^i(0)$ since that would mean that turnover would increase rapidly, thus generating substantial costs. Instead, it is optimal to keep the wage higher and this implies that the profit-difference expression is always positive.

3 Labor market equilibrium

We have seen that it is an equilibrium strategy to discriminate and thus only hire from the certain pool. When all firms follow such a hiring strategy, this will obviously have strong implications for the aggregate labor market equilibrium. This section analyzes the aggregate properties of our discriminatory equilibrium focusing on the steady state effects on unemployed workers.

3.1 The probability to get a job

It is important to keep in mind how firms perceive employed and unemployed workers in a discriminatory equilibrium. A rational firm knows that what is rational for the firm itself is also rational for all other firms. Since no firm will ever employ a worker with uncertain productivity, all unproductive workers will be in the pool of unemployed workers, and all employed applicants will be productive. Hence, firms will perceive employed job seekers as highly attractive to hire compared with unemployed job seekers.

Consider first the probability to get a job for an *employed* job seeker. This probability is defined as the number of vacant jobs divided by the number of workers considered as worth hiring by the firms to which they have applied in the period under consideration. Let n_t denote aggregate employment and u_t denote aggregate unemployment. Noting that the number of unemployed workers that are considered as hirable by discriminating firms is given by $\psi(u_{t-1}+sn_{t-1}-\Omega)$ we can write this probability as:[24]

$$a_t = \frac{n_t-(1-s)(1-Sa_t)n_{t-1}}{\psi(u_{t-1}+sn_{t-1}-\Omega)+(1-s)Sn_{t-1}}. \tag{16}$$

Solving equation (16) for a_t we get:

$$a_t = \frac{n_t-(1-s)n_{t-1}}{\psi(1-(1-s)n_{t-1}-\Omega)}. \tag{17}$$

An unemployed, but productive worker, has a lower chance to get a job. With probability $1-\psi$ the firm will be uncertain about his productivity and then he will not be hired. With probability ψ the firm will realize that he is productive and then he will compete with employed job applicants on equal terms. Then his chance to get a job is ψa_t which is obviously lower than a_t.

3.2 Aggregate employment: the general case

The aggregate economy consists of a large number of identical firms. The number of firms is fixed.[25] Since all firms are identical, they solve the same optimization problem and choose the same wage level. Then it must also be true that the first order conditions derived above for the individual firms also hold in equilibrium. This means that we can use those relations to find the aggregate employment level. To simplify the analysis, let us assume that the minimum wage is linked to the average wage. Formally, $\underline{w}=bw$ where $b<1$. This assumption is reasonable since in reality we would expect the minimum wage to rise over time with the wage level.

[24] The number of firms in the economy is assumed to be fixed. Aggregate employment, therefore, is just equal to the sum of the employees in those firms.
[25] This can for example be due to the fact that entry into the market requires a fixed set-up cost that is so high that no new firms enter the market.

In equilibrium, the aggregate employment level is then given by the following equations (where the discount factor is set equal to 1 and where the notation for the S-function is simplified to $S = S(1/\kappa b) = S(w/\kappa bw)$):

$$f'(n) - h(1-(1-s)(1-Sa)) - bw - (1-s)(1-Sa)(1-b)w = 0\,, \tag{18}$$

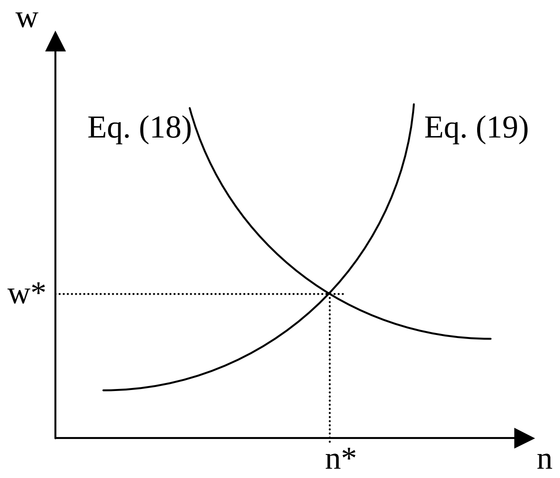
$$-(h-(1-b)w)S'\frac{1}{\kappa bw}a - (1-Sa) = 0\,, \tag{19}$$

where in a steady state the probability to get a new job for an employed searcher (equation (17)) can be written as:[26]

$$a = \frac{sn}{\psi(1-(1-s)n-\Omega)}\,. \tag{20}$$

Figure 5 illustrates how equations (18) and (19) determine equilibrium employment and wages.

Figure 5: The market equilibrium.[27]



[26] It should be noted that equation (20) can be derived from the requirement that the outflow from employment to unemployment must equal the corresponding inflow; i.e. $sn = a\psi(1-(1-s)n-\Omega)$.

[27] It can be shown that the expression in (19) defines an increasing and convex function while the expression in (18) defines a decreasing function that is concave for some parameter values.

The wage setting curve (equation (19)) is upward sloping because higher employment is associated with a higher probability to get a job for an employed searcher and this makes it optimal for firms to set a higher wage. The labor demand curve (equation (18)) is downward sloping.

In principle, it is possible to perform a comparative statics analysis using equations (18) and (19). However, this is analytically difficult and the same intuition can be grasped by looking at the special case where the training cost is linked to the wage.

3.3 Aggregate employment: a special case

If we assume that $h = kw$, where $k > 1$, the equation system in equations (18) and (19) becomes recursive. Equation (19) determines equilibrium employment while equation (19) determines the equilibrium wage. This special case implies that the wage-setting curve in Figure 5 becomes vertical, while the labor demand curve remains downward sloping. We can then solve for steady state employment explicitly and get:

$$n^{SS} = \frac{\psi(1-\Omega)}{s\left(S(\frac{1}{\kappa b}) - \frac{1}{\kappa b}(k+b-1)S'(\frac{1}{\kappa b}) \right) + (1-s)\psi}. \tag{21}$$

The comparative statics of the aggregate employment level is summarized in Proposition 3.

Proposition 3

If the aggregate employment level in steady state is given by equation (21) it can be shown that:

$$\frac{\partial n^{SS}}{\partial \Omega} < 0, \ \frac{\partial n^{SS}}{\partial \psi} > 0, \ \frac{\partial n^{ss}}{\partial k} < 0, \ \frac{\partial n^{ss}}{\partial S} < 0, \ \frac{\partial n^{ss}}{\partial (-S')} < 0.$$

Proof: see the Appendix.

Let us consider these results briefly. First, if more of the unemployed workers are unproductive this makes it easier for employed job seekers to get jobs, wages increase and employment falls. Second, if the probability that an unemployed worker can convince an employer that he is a productive worker increases this obviously has the opposite effect. Third, if hiring/training costs increase firms become anxious to reduce turnover, wages rise and employment falls. Fourth, if the fraction of employed workers looking for a new job increases (for given values of b and κ) firms respond by setting a higher wage, thereby, causing equilibrium employment to fall. Finally, if the sensitiveness of the S-function with respect to wages (for given values of b and κ) increases this leads to higher wages and lower employment.

4 Welfare and policy issues

From the analysis so far we have seen that a combination of efficiency wage considerations and information imperfections causes unemployment, and that it is an equilibrium hiring strategy for firms to sort workers according to their employment status. This means that unemployed workers will have a hard time finding a job.

A natural question to ask is whether the market solution is efficient or not. This question is important because it is only meaningful to discuss policy if we can show that there are efficiency gains to be made by changing the market outcome.[28] To answer this question, this section focuses on three issues. First, we clarify exactly who is unemployed in this model. Second, we ask whether the market solution yields too low employment by comparing it to the socially optimal solution, given that the information constraints cannot be eliminated. Third, we ask how policy can be used to improve welfare.

4.1 The composition of unemployment

The reason why we have unemployment is clearly that wages are higher than what is consistent with market clearing. The efficiency wage constraint makes it optimal for firms to keep wages high and this obviously makes it impossible for an unemployed worker to offer to work at a lower wage. No firm would be willing to accept such an

[28] Obviously, it can still be interesting to discuss distributional issues. However, such issues are not discussed in this paper.

offer.[29] In addition, we have the minimum wage that prevents firms from forcing their employees to accept a very low wage the first period of employment. This means that all unemployment in the model must be considered as involuntarily.

Now consider the composition of unemployment. We can divide all workers remaining unemployed *after* hiring has taken place in a given period into three distinct groups. First, we have a group of unemployed workers who are truly unproductive. Second, we have a group of fully productive workers that have been rejected by a firm because they could not be distinguished from the unproductive workers. Third, we have a group of fully productive workers who were recognized by a firm as productive but, since there were more applicants than jobs, could not find work. One difference between these three groups is that, after all job searchers have submitted their applications, only those unemployed workers whom an employer considered as belonging to the certain pool had a chance to get a job. This means that unemployed workers belonging to the first two groups really did not have any chance of finding a job during the period, while the last group had the same chance as employed applicants.

4.2 The social vs. the market solution

Consider a social planner who maximizes the sum of all individual utilities. One important issue that faces the social planner is to determine which employment level that is socially optimal.[30] To formulate the welfare function, we need to use the utility functions of workers derived in Section 2. We can divide the workers into four distinct groups and derive a measure of utility for each of these groups.[31]

- First, we have a group of workers whose job satisfaction is so high that they do not find it worthwhile to search for new jobs. The number of such workers is

[29] This assumes that it is not possible for workers to commit to some kind of contract that prevents the worker from switching jobs. However, such contracts are hardly feasible in reality.

[30] Another issue that might face the planner is to determine the optimal wage. In this paper, we focus on employment. This can be justified by arguing that the most important function of the wage is to distribute the surplus between workers and firms. To avoid discussing distributional issues, we therefore assume that the wage is given by what the market generates.

[31] Assume that the job dissatisfaction factor can take on all values between m and M , where $0<m<M$.

equal to $(1-s)(1-S)n$ and their average utility level is equal to $\int_{m}^{1/\kappa b}(w/\mu^{i})dG(\mu^{i})=w\int_{m}^{1/\kappa b}(1/\mu^{i})dG(\mu^{i})=w\Delta_1$,

where $\Delta_1 \equiv \int_{m}^{1/\kappa b}(1/\mu^{i})dG(\mu^{i})>1$.

- Second, we have a group of workers whose job dissatisfaction factor is high enough to make it worthwhile to search for jobs but that do not get any jobs. The number of such workers is equal to $(1-s)S(1-a)n$ and they each get a utility level equal to $\int_{1/\kappa b}^{M}(w/\mu^{i})dG(\mu^{i})=w\int_{1/\kappa b}^{M}(1/\mu^{i})dG(\mu^{i})=w\Delta_2$,

  where $\Delta_2 \equiv \int_{1/\kappa b}^{M}(1/\mu^{i})dG(\mu^{i})<1$.

- Third, we have a group of workers that either search on the job or are unemployed, and that do get a new job. The number of such workers is equal to $(1-s)San+sn$ and they each get a utility level equal to[32] $\int_{m}^{M}(\lambda\underline{w}/\mu^{i})dG(\mu^{i})=\lambda\underline{w}\int_{m}^{M}(1/\mu^{i})dG(\mu^{i})=\lambda bwE(\frac{1}{\mu^{i}})=b\kappa w$,

  where $\kappa=\lambda E(\frac{1}{\mu^{i}})$.

- Fourth, we have a group of workers that are unemployed and do not get a new job. For simplicity, we let these workers get a utility level of zero.[33]

Let us assume that the economy, in addition to the workers, includes a group of risk neutral capitalists who do not work but that receive all profits.[34] Their utility is set equal to their income. The total welfare, W, in the economy is then given by:[35]

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[32] For simplicity, it is assumed that unemployed workers who do find a job also incur the moving cost.

[33] Nothing changes if we assume that unemployed workers receive positive utility.

$$W = (1-s)(1-S)nw\Delta_1 + (1-s)S(1-a)nw\Delta_2 + [(1-(1-s)(1-Sa)]n\kappa bw +$$

$$f(n) - (1-s)(1-Sa)nw - (1-(1-s)(1-Sa))n(bw+h), \qquad (22)$$

where $a(n; s, \psi) = \dfrac{sn}{\psi(1-(1-s)n-\Omega)}$.

Let us briefly consider each of the components of the welfare function. The first three terms consist of the utility of workers belonging to each of the groups identified above. The next three terms consist of the utility received by capitalists; i.e. profits. Given that the information constraint cannot be eliminated, the probability to get a job for an on-the-job searcher is given by equation (20).

There are two things worth noting about the way we have formulated the welfare function that will help us understand the results later. First, the non-pecuniary gains from switching jobs have an important impact on the way total welfare is calculated. If job switching did not imply a gain in the non-pecuniary component of utility, all terms involving wages would cancel out in the welfare function and only two terms would remain; production minus hiring/training costs.[36] Second, the average value of the non-pecuniary factor *after* job switching has taken place will differ from the average of the distribution of the non-pecuniary factor. Only workers with a bad draw will search and since everyone who receives a new job gets the average value, all such workers will gain in utility. Thus, the average job dissatisfaction *after* job switching will be lower than the average of the distribution of the non-pecuniary factor.

The issue we are interested in is whether the employment level generated by the market is too low or not. One way to answer this question is to look at the derivative $\partial W / \partial n$ evaluated at the market solution. Given that W is single-peaked, the socially optimal employment level is higher than the market solution if this derivative is positive. The derivative evaluated at the market solution is given by:

[34] Remember that firms in this economy can yield positive profits. The assumption that there exist capitalists that do not work are similar to what is used in Fredriksson and Holmlund (2001).
[35] We assume that the parameters/functions are chosen so that W has a well-defined unique maximum.
[36] This would correspond to the case often analyzed in the matching literature, e.g. Pissarides (2000), where the sole function of wages is to divide the surplus between workers and firms. Thus, in that case wages would not enter the welfare analysis.

$$\frac{\partial W}{\partial n} = (1-s)(1-S)w\Delta_1 + (1-s)S(1-a)w\Delta_2 + (1-(1-s)(1-Sa))\kappa bw +$$

$$(1-s)Swn(1-\Delta_2-(1-\kappa)b)\frac{\partial a}{\partial n} - (1-s)Shn\frac{\partial a}{\partial n}, \qquad (23)$$

where a is defined by equation (20), where $\partial a/\partial n$ is the partial derivative of a with respect to n, which is always positive, and where the wage and employment levels are evaluated at the values from the market solution.

Let us consider the terms in equation (23). The first three terms reflect the fact that workers who are employed receive higher utility (in terms of wages and job satisfaction) than unemployed workers. These terms imply that a higher employment level is desirable. The last two terms reflect the fact that higher employment results in more turnover. If employment increases, this will increase the probability that on-the-job searchers get the jobs they apply for, since a is an increasing function of n, and this increase in turnover will have two effects.[37] It will increase the utility of the workers since more job switching creates utility gains for workers; i.e. higher job satisfaction. This implies that higher employment is desirable. However, it will also divert more resources towards covering hiring/training costs. This term implies that lower employment is desirable.

From this discussion it is apparent that it is impossible to determine the sign of equation (23) analytically. However, it is intuitively reasonable to expect higher employment to be optimal, since the utility gains unemployed workers get if they find employment should outweigh the negative effects of an increase in turnover, unless the hiring cost is very high and the difference in utility between being employed and unemployed is very small. One way to test this intuition is to perform numerical simulations. This means that we must choose a distribution for the job dissatisfaction factor and set values for the parameters. It is natural to use similar assumptions as we used in the simulation in Section 2; i.e. a uniform distribution on the interval zero to two for the dissatisfaction component, a Cobb-Douglas production function, h=3, $\underline{w}$=0.6

[37] It can be shown that $(1-\Delta_2-(1-\kappa)b)>0$. The effects of a marginal increase in turnover can be interpreted as follows. On-the-job searchers that find a new job, on average, get a utility gain of $\kappa bw-w\Delta_2$, which is always positive because otherwise they would not search. Capitalists that lose an employee meanwhile face a profit decrease of $h+bw-w$.

times the wage, $s = 0.015$, $S = 0.05$, ψ=0.5 and $\Omega = 0.01$. Using these assumptions it can be shown that the expression in equation (23) is positive and that the socially optimal employment level is significantly higher than what the market generates. For these figures, the market yields an unemployment rate of around 13 percent while the socially optimal unemployment rate is around 5 percent.

4.3 Can welfare be improved with policy interventions?

Given that the socially optimal employment level is higher than what the market generates, the social planner should order all firms in the economy to increase employment.[38] However, in a real world economy there exists no social planner that can force firms to hire more workers. Instead, what is needed is some kind of scheme that persuades firms that it is in their best interest to increase employment. The key to achieving higher employment is to induce firms to view turnover a bit less unfavorably. One way of achieving this is a subsidy that covers some part of the hiring/training cost. Such a policy would induce firms to set a lower wage, thus in equilibrium, generating higher employment. To succeed with such a policy, the planner should calculate the optimal size of this subsidy using equations (18) and (23). A policy involving subsidies would probably increase employment but it is important to keep in mind that it also might create incentives for firms to try to cheat the system and that the financing of the subsidies might create other distortions.

Another way to increase welfare is to find ways to lessen the information constraints. In the model, all unemployed workers seek employment by submitting job applications to a randomly chosen firm. This means that even those workers who know they are unproductive apply for jobs. Employers respond to this fact by avoiding hiring all unemployed workers whom they are not sure are productive. Therefore, those workers who are unproductive impose an externality on all other unemployed workers who risk being rejected by employers because they cannot credibly be distinguished from unproductive workers. The severity of the problem depends on how difficult it is

[38] It should be noted that the welfare analysis has been performed under the assumption that it is possible to increase employment without having to force firms to employ workers from the uncertain pool. Formally, this can be achieved as long as $n^{Planner} - n^{SS} < \psi(u^{SS} + sn^{SS} - \Omega) - sn^{SS}$; i.e. if the difference between the socially optimal employment level and the market equilibrium is not too big. If the socially optimal employment level requires hiring from the uncertain pool, the best policy option is to try to lessen the information constraint.

for employers to identify a worker as productive. There are two methods that can be used to mitigate this externality; to remove unproductive workers from active search (to decrease Ω), or to enable fully productive unemployed workers to credibly demonstrate their abilities (to increase ψ).

Starting with the first alternative, it should be noted that the economy does not lose anything in terms of welfare from removing the unproductive workers from active search. In the model, the only reason these workers do apply for jobs is that they are forced to do so. In reality, we expect unproductive workers to search because they are required to search to receive unemployment benefits. However, given the potentially strong negative externalities these workers create, it can be argued that it would be welfare improving if such workers were identified, removed from active job search and, if possible, rehabilitated in some way. The success of this method depends crucially on the ability of public agencies to identify unproductive workers. An important implication of this discussion is that it is beneficial for society to remove some job searchers from the applicant pool. This contradicts the conventional wisdom that it is always beneficial to keep up the search intensity of all unemployed workers.

The second alternative might be a more feasible way to improve welfare. If society in some way can help unemployed workers to showcase their abilities, this would improve welfare. The key is to provide employers with credible information about the people who apply for jobs. This can be achieved either by enabling employers to share information about their previous employees more effectively or by devising some scheme where public agencies certify the skills of workers. The usefulness of this approach hinges on the requirement that employers must perceive the information as credible. One way to achieve this would be if the agency could give the firm some kind of guarantee that it would pay all costs incurred by a firm if a worker turns out to be unproductive; i.e. use some sort of trial employment scheme.

5 Conclusions

This paper has considered hiring in a situation characterized by imperfect information. Firms make significant investment in their employees at the time of hiring and this makes them very concerned with keeping worker-initiated turnover low. There exist a small number of unproductive workers in the economy that firms cannot detect. Instead, firms use all information they have available prior to hiring to sort their applicants into two groups; one group consisting of workers the firm is certain are productive and one group the firm is uncertain about.

It is shown that it is an equilibrium hiring strategy to only hire from the certain pool even though wages can be used to compensate the firm for the differences between the groups. The optimal wage is lower for workers in the uncertain pool than for workers in the certain pool but not low enough to make firms indifferent in their hiring decisions. This is because the wage at the same time must prevent search among those workers who really are productive and compensate the firm for the possibility that the searcher is unproductive.

If all firms follow their equilibrium strategies, all unproductive workers will end up in the unemployment pool and firms will treat all employed applicants as fully productive. This means that firms will consider employment status as an important signal for productivity. As a consequence, the expected probability to find a job is higher for employed job seekers than for unemployed job seekers. Due to the efficiency wage considerations in wage setting this gives rise to higher unemployment.[39]

The welfare analysis shows that the firms in the economy do not consider all socially relevant effects in their wage setting decisions. Thus, the private solution seems to yield a too low employment level leaving room for policy to improve welfare.

The main contribution of this paper is that it shows that flexible wages do not necessarily prevent discrimination against groups of workers. This means that we cannot simply assume that flexible wages always will make a firm indifferent between different groups of applicants unless we are willing to allow for implausible arrangements like job fees etc. Instead, it is possible that the wage that the firm considers as optimal for a particular group, taking into account factors like turnover consequences, is so high that it is less profitable to hire from that group than from some other group of applicants.

[39] This result is similar to the results in Eriksson and Gottfries (2000).

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Appendix: Proofs of Propositions 1-3

Proof of Proposition 1

We divide this proof into two parts. First, we show that $w_L^i = w^i$ when $\varphi = 0$. Second, we show that $\partial w_L^i / \partial \varphi < 0 \;\; \forall \varphi \in (0, \overline{\varphi})$ where $\overline{\varphi}$ is the value where the constraint starts to bind.

First, consider the case when $\varphi = 0$. Then the first order conditions in equations (3) and (8) become identical and this obviously implies that $w^i = w_L^i$.

$\because \;\; w_L^i = w^i$ if $\varphi = 0$.

Second, let us consider the case when φ>0. Implicit differentiation of (8) with respect to φ yields us:

$$(1 - S(w_L^i)a) + S'(w_L^i)\frac{1}{\kappa \underline{w}} a(\underline{w} + h - w_L^i) - (1-a) + (1-\varphi)S'(w_L^i)\frac{1}{\kappa \underline{w}} a \frac{\partial w_L^i}{\partial \varphi} - $$
$$(1-\varphi)S''(w_L^i)\frac{1}{(\kappa \underline{w})^2} a(\underline{w} + h - w_L^i)\frac{\partial w_L^i}{\partial \varphi} + (1-\varphi)S'(w_L^i)\frac{1}{\kappa \underline{w}} a \frac{\partial w_L^i}{\partial \varphi} = 0. \qquad \text{(A1)}$$

Equation (A1) can be rewritten as:

$$\frac{\partial w_L^i}{\partial \varphi} = \frac{(1 - S(w_L^i)a) + S'(w_L^i)\frac{1}{\kappa \underline{w}} a(\underline{w} + h - w_L^i) - (1-a)}{-(1-\varphi)S'(w_L^i)\frac{1}{\kappa \underline{w}} a + (1-\varphi)S''(w_L^i)\frac{1}{(\kappa \underline{w})^2} a(\underline{w} + h - w_L^i) - (1-\varphi)S'(w_L^i)\frac{1}{\kappa \underline{w}} a}. \qquad \text{(A2)}$$

Now consider the numerator in (A2). This expression is negative if:

$$(1 - S(w_L^i)a) + S'(w_L^i)\frac{1}{\kappa \underline{w}} a(\underline{w} + h - w_L^i) - (1-a) < 0. \qquad \text{(A3)}$$

If we multiply with $-(1-\varphi)$, (A3) can be rewritten as:

$$(1-\varphi)[-(1-S(w_L^i)a)-S'(w_L^i)\frac{1}{\kappa \underline{w}}a(\underline{w}+h-w_L^i)]-\varphi(1-a)+(1-a)>0\,. \qquad \text{(A4)}$$

But from equation (8) we now that:

$$(1-\varphi)[-(1-S(w_L^i)a)-S'(w_L^i)\frac{1}{\kappa \underline{w}}a(\underline{w}+h-w_L^i)]-\varphi(1-a)=0\,. \qquad \text{(A5)}$$

Then since $(1-a)$ is clearly positive we can conclude that equation (A4) is satisfied. Now consider the denominator in (A2). Since we have assumed that the S-function is decreasing and convex this expression is clearly positive.

$$\because \ \frac{\partial w_L^i}{\partial \varphi}<0\,.$$

Now consider the case when the minimum wage constraint does bind. Then it must be that $w_L^i = \underline{w}$ irrespectively of the value of φ. The result still holds as long as the constraint does not bind when $\varphi = 0$, but that case is hardly relevant since the constraint would then bind for all workers.

Combining these two results we see that $w_L^i < w^i \quad \forall \varphi \in (0,1)$.

QED.

Proof of Proposition 2

We divide this proof into two parts. First, we show that $\pi^{Diff} = 0$ when $\varphi = 0$. Second, we show that $\partial \pi^{Diff} / \partial \varphi > 0 \quad \forall \varphi \in (0,1)$.

First consider the case when $\varphi = 0$. From the proof of Proposition 1 it follows that $w_L^i = w^i$. Using these two facts in equation (10) we immediately see that $\pi^{Diff} = 0$.

$\because\ \pi^{\mathrm{Diff}} = 0$ if $\varphi = 0$.

Second, consider the case when $\varphi > 0$. Implicit differentiation of equation (10) with respect to φ yields:

$$\frac{\partial \pi^{Diff}}{\partial \varphi} = (1+\beta(1-s)(1-a))\theta + \beta(1-s)(1-S(w_L^i))a(\underline{w}+h-w_L^i) +$$

$$\beta^2(1-s)^2(1-a)(1-S(w^i)a)(\underline{w}+h-w^i) + \qquad \text{(A6)}$$

$$\beta(1-s)\left[1-\varphi a+(1-\varphi)S'(w_L^i)\frac{1}{\kappa\underline{w}}a(\underline{w}+h-w_L^i)-(1-\varphi)S(w_L^i)a\right]\frac{\partial w_L^i}{\partial \varphi}.$$

If we compare the terms within the brackets in A6 with the first order condition in (8), we see that they are identical (the envelope theorem). This means that it must be that:

$$\frac{\partial \pi^{Diff}}{\partial \varphi} = (1+\beta(1-s)(1-a))\theta + \beta(1-s)(1-S(w_L^i))a(\underline{w}+h-w_L^i) +$$

$$\beta^2(1-s)^2(1-a)(1-S(w^i)a)\,(\underline{w}+h-w^i). \qquad \text{(A7)}$$

Looking at (A7) we see that it clearly is positive since it follows from the first order conditions in (3) and (8) that $\underline{w}+h-w^i > 0$ and $\underline{w}+h-w_L^i > 0$.

Now consider the unlikely case when the wage constraint does bind. Then we have that $w_L^i = \underline{w}$. The result above hold since the derivative then would be given by:

$$\frac{\partial \pi^{Diff}}{\partial \varphi} = (1+\beta(1-s)(1-a))\theta + \beta(1-s)(1-S(\underline{w}))ah +$$

$$\beta^2(1-s)^2(1-a)(1-S(w^i)a)(\underline{w}+h-w^i), \qquad \text{(A8)}$$

which is also clearly positive.

$$\because \ \frac{\partial \pi^{Diff}}{\partial \varphi} > 0 \quad \forall \varphi \in (0,1).$$

Combining these two results we see that $\pi^{Diff} > 0 \quad \forall \varphi \in (0,1)$.

QED.

Proof of Proposition 3

Differentiation of equation (21) with respect to the parameters yields:

$$\frac{\partial n^{SS}}{\partial \Omega} = \frac{-\psi\left\{s\left(S(\frac{1}{\kappa b}) - \frac{1}{\kappa b}(k+b-1)S'(\frac{1}{\kappa b})\right) + (1-s)\psi\right\}}{\left(s\left(S(\frac{1}{\kappa b}) - \frac{1}{\kappa b}(k+b-1)S'(\frac{1}{\kappa b})\right) + (1-s)\psi\right)^2} < 0, \qquad \text{(A9)}$$

$$\frac{\partial n^{SS}}{\partial \psi} = \frac{(1-\Omega)s\left(S(\frac{1}{\kappa b}) - \frac{1}{\kappa b}(k+b-1)S'(\frac{1}{\kappa b})\right)}{\left(s\left(S(\frac{1}{\kappa b}) - \frac{1}{\kappa b}(k+b-1)S'(\frac{1}{\kappa b})\right) + (1-s)\psi\right)^2} > 0, \qquad \text{(A10)}$$

$$\frac{\partial n^{SS}}{\partial k} = \frac{s\frac{1}{\kappa b}S'(\frac{1}{\kappa b})\psi(1-\Omega)}{\left(s\left(S(\frac{1}{\kappa b}) - \frac{1}{\kappa b}(k+b-1)S'(\frac{1}{\kappa b})\right) + (1-s)\psi\right)^2} < 0, \qquad \text{(A11)}$$

$$\frac{\partial n^{SS}}{\partial S} = \frac{-s\psi(1-\Omega)}{\left(s\left(S(\frac{1}{\kappa b}) - \frac{1}{\kappa b}(k+b-1)S'(\frac{1}{\kappa b})\right) + (1-s)\psi\right)^2} < 0, \tag{A12}$$

$$\frac{\partial n^{SS}}{\partial(-S')} = \frac{-s\frac{1}{\kappa b}(k+b-1)\psi(1-\Omega)}{\left(s\left(S(\frac{1}{\kappa b}) - \frac{1}{\kappa b}(k+b-1)S'(\frac{1}{\kappa b})\right) + (1-s)\psi\right)^2} < 0. \tag{A13}$$

QED.

Essay IV

Competition between Employed and Unemployed Job Applicants: Swedish Evidence*

1 Introduction

During the 1990s Sweden suffered a severe economic crises. The unemployment rate quickly reached a very high level and it took several years before it started to fall back to more normal levels. In continental Europe, unemployment started to rise in the late seventies and has since remained very high. Irrespective of what economic disturbances that caused the initial rise in unemployment, the question why the adjustment back to equilibrium has taken so long must be explained before we can claim to understand the dynamics of unemployment.

A number of explanations for the persistence of unemployment have been proposed.[1] These explanations are often based on the idea that some factor in the wage formation process prevents wages from falling, thereby, keeping the unemployment rate high. One such explanation starts by noting that a firm often has a choice between hiring employed and unemployed applicants. If firms perceive employed applicants as more attractive to hire than unemployed applicants, wages will not fall despite the high unemployment rate. Instead, competition among firms over already employed workers will keep wages high.

In principle, there are two reasons why unemployment might be perceived as a negative worker characteristic. The first explanation is based on a selection argument. It assumes that the most unproductive workers in the economy are concentrated to the

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[1] See, for example, the discussion in Bean (1994).

pool of unemployed workers, e.g. because firms generally lay off their least productive workers in bad times. If firms cannot distinguish these workers from other fully productive unemployed workers, unemployment becomes a signal for low productivity.[2] Firms might then find it optimal to avoid hiring unemployed workers. The second explanation is based on duration effects. It assumes that workers lose human capital, e.g. productive or social skills, during unemployment. If firms perceive that many unemployed workers have suffered such a loss of skills, it might be optimal to avoid hiring them, especially if this is combined with an inability among firms to identify which workers that have lost skills. Both of these stories share the idea that unemployment signals low productivity and should be important in labor markets where firms have an imperfect ability to observe the productive abilities of their applicants. Since this is a reasonable assumption for real world labor markets, we might expect such signals to significantly affect the hiring strategies used by firms.

It can be shown, that if firms discriminate against unemployed workers in hiring this can have profound effects for the aggregate economy. Eriksson and Gottfries (2000) analyze the macroeconomic implications of such behavior. An efficiency wage model is formulated where firms use the wage to try to keep turnover low and where firms find it unprofitable to hire unemployed workers for a fraction of the available jobs. It is shown that this, in the aggregate, will lead to higher equilibrium unemployment and a slower adjustment back to equilibrium after a negative shock to the economy. The explanation for these effects is that since firms use the wage to control turnover they will be reluctant to lower it rapidly fearing a rise in turnover; which is costly for the firm. Numerical simulations indicate that these effects are substantial and have the potential to explain the observed persistence of unemployment.

Economic theory thus indicates that it can be rational for an individual firm to prefer to hire employed applicants rather than to hire unemployed applicants. Moreover, this might be an important explanation for the European unemployment experience. However, to be certain that such discrimination is a feature characterizing European labor markets we have to verify it empirically. The purpose of this paper is,

[2] The term signal is used throughout the paper and should be interpreted in a wide sense. Employment status is viewed as a signal for productivity by firms but obviously differs from the more narrow use of the word signal as something that the sender chooses.

therefore, to empirically investigate whether unemployed applicants have a lower probability to find a job than employed applicants.

Anyone wishing to investigate how employment status affects an applicant's chance to get a job faces a number of difficulties. First, data is needed about the search behavior and search outcomes for both employed and unemployed job applicants. Data about employed search is often difficult to obtain because on-the-job search and job-to-job switches are not recorded in official registers. Second, controls for differences in search intensity among workers are needed because it is possible that there are systematical differences in search intensity between employed and unemployed applicants. Third, data about all other relevant characteristics of the searchers are needed to isolate the effect from employment status from other factors that employers take into account when they make hiring decisions. The last complication is often encountered in studies of discrimination and is very difficult to solve because it is rare for the researcher to have access to the same data as the firms use when they make hiring decisions.

This paper uses data from the Applicant Database (Sökandebanken), which is kept by the Swedish Employment Office (AMS). All workers, both employed and unemployed, looking for a new job are invited to submit details about their education, work experience, other skills as well as details about the type of jobs they want to find.[3] Employers can then search in this database for applicants that they find interesting and contact them for interviews etc. All such contacts are registered. The data covers all applicants remaining active searchers in April 2001 who agreed to participate in this research project.

This dataset makes it possible to study how the probability to get contacted by an employer, and the number of contacts received, depends on the characteristics of the applicants; e.g. their employment status. This dataset also allows us to overcome many of the above-mentioned problems. First, we have data about the search activities of a lot of employed workers; almost half of the workers in the sample search on the job. Second, the search intensity is the same for all workers in the database; to search just means to submit the required information to the database. Third, since the employer only observes what is in the database, we can be certain that we have records of all

[3] This dataset has previously been used in only one other paper. Edin and Lagerström (2002) use it to study discrimination based on gender or ethnicity.

information that the employer uses when he chooses whom to contact. This means that we do not need to worry that the employer has access to more information than us. Thus, if we include properly defined control variables for all other characteristics, we can truly claim that we have obtained estimates measuring the effect from being unemployed on the chance to get contacted by an employer. The major disadvantage of using this dataset is that we do not know whom the employer finally decides to hire. However, for an applicant to get hired he must be contacted by an employer. Therefore, if we find that the probability to get contacted by an employer is lower for unemployed workers, this will also be strong evidence that the hiring probability is lower for unemployed workers. It is also worth keeping in mind that what we measure is just discrimination in the contact decisions. Since it is also possible that employers view employment as a negative characteristic when they decide whom of the contacted workers to hire, it may very well be the case that discrimination in hiring is even more severe than what we can measure with our data.[4]

We estimate two types of models in the paper. First, we estimate models for the probability to get contacted by an employer. This means that we have a binary dependent variable. We insert control variables for education, work experience, other skills, regional and occupational dummies as well as dummy variables for the current labor market status of the applicant. The results of these regressions indicate that an unemployed worker faces a lower probability to get contacted by an employer than an employed applicant. For an otherwise identical searcher, being unemployed reduces the contact probability by 3 percentage points. For the "typical" searcher, this corresponds to a decrease in the probability to get contacted from 45 percent to 42 percent; i.e. a 7 percent decrease.[5] Second, we estimate models for the number of contacts received by the applicants. This means that we have a dependent variable that can only take on non-negative integer values. The results of the regressions show that an unemployed worker

[4] The hiring of a worker often involves several steps. For example, a firm identifies a few candidates in the Applicant Database they find interesting and decides to contact them, these workers are asked to send in applications, the firm chooses to interview a couple of these workers, and finally hires one of them. This means that the firm may be: (i) less likely to contact unemployed workers, (ii) given that the firm contacts unemployed workers be less likely to choose to interview unemployed workers and (iii) given that the firm chooses to interview unemployed workers be less likely to hire them. Thus, total discrimination may be a product of these three components.

[5] The "typical" searcher is a 26-35 year old Swedish man with secondary education and at least five years labor market experience who has a driving license, good computer skills, good language skills in Swedish and English and that searches for technical work (Amsyk 3) in Stockholm.

gets around 0.13 fewer contacts over the sample period than an employed worker. For the "typical" searcher, this corresponds to a decrease in the number of contacts received from 1.10 to 0.97; i.e. a 12 percent decrease. All results are statistically significant at conventional levels and appear stable over different specifications and estimation methods.

Both of these results indicate that firms prefer to contact employed applicants rather than unemployed applicants even when we control for all other observable characteristics. Thus, it seems to be the case that unemployment *per se* is seen as a signal of negative unobservable characteristics. These results give clear support to the theoretical claims in Eriksson and Gottfries (2000).

Due to the difficulties that arise when one tries to identify labor market discrimination based on employment status, there exist few studies that use standard econometric techniques to analyze this issue. Instead, most of the existing literature uses surveys or interviews. Examples using Swedish data are Agell and Lundborg (1999), Klingvall (1998) and Behrentz and Delander (1996). All of these studies find evidence in favor of the view that some firms view unemployment as a negative characteristic. Similar results for other countries can be found in Bewley (1999) for the US and Atkinson, Giles and Meager (1996) for the UK. However, even though these studies support the view that labor market status is used as a hiring criterion, it is difficult to draw conclusions about the relative probability to find employment from such studies. One might also question whether employers that do use unemployment as a hiring criterion are willing to admit to that in an interview or a survey. Such bias might result in an underestimation of the true extent of discrimination. Our data have the advantage that we observe what employers *actually do* rather than what they *claim they do*.

There are some econometric studies using foreign data. An example is Blau and Robins (1990). They use data from the Employment Opportunity Pilot Project (EOPP), a US dataset collected in 1979-80. They find that unemployed workers do get fewer job offers than employed applicants even after controlling for other differences.[6] Belzil

[6] However, Belzil (1996) points out that it is hard to know how much of this result that is explained by individual unobserved heterogeneity.

(1996) finds similar results using Canadian data.[7] However, since these studies use data about applicants who are interviewed etc., they are open to the criticism that firms observe characteristics that are unobservable to the researcher. We have not found any comparable studies for Sweden.

The rest of the paper is organized as follows. Section 2 sketches a simple informal model of a labor market where employment status is used as a signal of worker productivity. In Section 3 we present the dataset used in the estimation and in Section 4 we define the variables, discuss the estimation strategy and present the results. Section 5 concludes.

2 A theoretical framework

Before going into the empirical analysis, it is useful to briefly consider how we would expect an employer, who has access to a database filled with applicants, to behave; i.e. which factors should influence whom he chooses to contact.

The discussion in this section is very informal and its sole purpose is to guide us in the empirical analysis below. A formal analysis of hiring under uncertainty can be found in Eriksson (2002).

2.1 Factors that should determine whom the firm contacts

The problem facing the employer is to choose whom of all the applicants he should contact. His choice will usually be limited to those searchers that have stated that they are interested in a job in some specific occupation at some specific location.[8] His objective is to find, and ultimately hire, the applicant he believes is best suited for the job. In many real world hiring situations, this means an applicant that is able to perform the tasks of the job satisfactorily; i.e. the employer do not want to risk hiring someone who is unable to do the job properly, especially if firms normally have to pay substantial hiring/training costs. Obviously, the employer does not have to hire all those

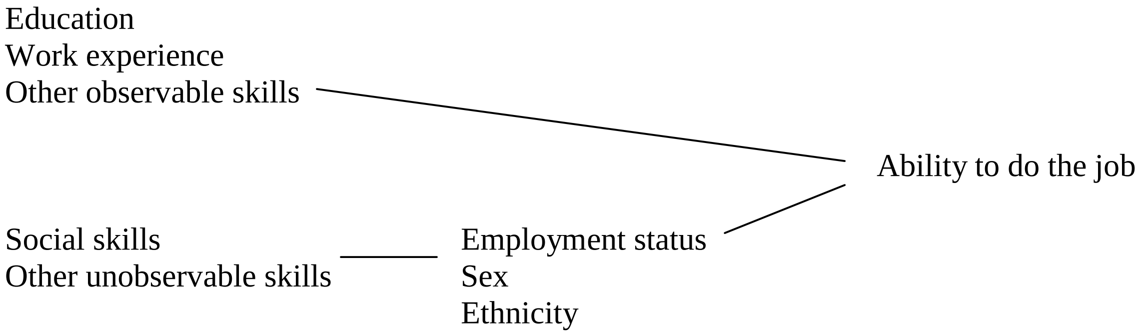
[7] There exist a few more studies but they tend to focus on youths. Andrews et al (2001) find that employed search is slightly more effective for UK youths aged 15-18. In contrast, Holzer (1987) finds that unemployed search is more effective using a sample of US youths. Belzil (1996) finds that mature workers are more likely to be stigmatized by unemployment than youths.

[8] Of course, it is possible for firms to ignore such requirements and contact workers anyway. However, in most cases we would expect such action to be pointless.

he decides to contact. Thus, one may argue that he does not risk much by contacting an applicant he is unsure of. However, since it takes time to interview and evaluate workers, we should not expect him to contact a worker he believes is not worth hiring.

A crucial factor that determines whom the employer considers as hirable is the information set he has available when he chooses whom to contact. If the information available to the employer were totally illuminating about the abilities of all the applicants, this would be easy. However, this is highly unlikely since there are a lot of factors that determine the productivity of a worker. Therefore, the employer has to make his choice in a situation characterized by imperfect information. In such a situation, there are essentially two types of factors that we expect will affect whom the employer decides to contact. First, all observable factors that directly affect the productive abilities of the applicants. Examples of such factors are education, work experience, other skills etc. Second, all factors that are signals for other unobservable factors that affect the productivity of the applicant. Examples of unobservable factors are ability to cooperate, motivation and other social skills. Examples of signals are the employment status of the applicant, sex and ethnicity.[9] None of the these signals should directly affect the productivity of the workers, but the employer may feel that these factors are signals of something unobservable that does affect productivity. Figure 1 illustrates how these different types of information should affect the contact decision. The lines represent real or perceived correlations.

Figure 1: Factors that affect the contact decision of the firm.



[9] Obviously, factors such as education and experience also might be viewed as signals for unobservable characteristics. However, there is a fundamental difference between these factors and factors like employment status. Employment status is only meaningful as a screening criterion if the employer believes it is correlated with some other factor that do affect productivity, while education and experience are meaningful as screening criterions by directly affecting productivity. Therefore, we use the distinction between observable productive factors and signals.

2.2 Employment status as a signal for productivity

Now let us consider how one of these signals, the employment status of the applicant, might affect the contact decision. Let us make the following assumptions: i) A (small) fraction of all workers that are unemployed are really unattractive, either because these workers have always been low productivity workers or because these workers have lost important skills during unemployment[10], ii) The employer is unable to with certainty distinguish these workers from many other unemployed applicants, iii) The wage can not be adjusted in such a way as to make the employer indifferent between applicants with different characteristics and iv) Only the current period profit matters; i.e. whom the firm hires now does not affect the profit in future periods. Instead, every job is associated with a given wage. The profit from hiring a worker is then given by: $\pi_t^i = \theta_t^i - w_t$, where θ_t^i is the perceived productivity net of training costs for applicant i in the Applicant Database, w_t is the wage for the vacant job. The value of θ_t^i will be affected by both observable characteristics that directly affects the productivity of the worker and by the signal employment status.

How do we expect a rational employer to act? Well, he should use information about the employment status of the applicants in his hiring decisions because unemployment signals low productivity, but for two reasons this is not the only factor that determines his hiring strategy. First, different jobs differ in their characteristics and, therefore, in the skills needed. Second, there seldom exist two applicants, even in a large database of applicants, that are identical with respect to all other characteristics except in their employment status. Therefore, for some hiring decisions the employment status will be crucial, but for others it will not. However, for two individuals, identical in all respects except their employment status, firms will be more likely to hire the employed applicant. This means that, on average, the probability to get a job is a_t^E for an employed applicant and $a_t^U = \phi a_t^E$, $\phi < 1$, for an unemployed applicant.

[10] Implicitly, it is assumed that all employed workers are fully productive. In reality, we would expect some employed workers to have low productivity as well. However, it is still reasonable to believe that the least productive workers are concentrated to the pool of unemployed workers.

2.3 Implications for the empirical analysis

From the discussion in this section we can conclude that the probability to get contacted by an employer should be a function of the workers' requirements about the job, observable factors that directly affect the productivity of the worker and signals that firms believe are correlated with unobservable factors that also affect productivity (the same is true for the number of contacts received). The probability to get contacted by an employer, denoted by a, is given by:

$$a = f(\textit{requirements about the job}, \textit{observable productive characteristics}, \textit{signals}). \quad (1)$$

3 Data

This paper uses data from the Applicant Database (Sökandebanken), which is kept by the Swedish Employment Office (AMS) since the fall of 1997. All workers, both employed and unemployed, that want to find a new job are invited to submit their personal details to the database. This can be done either from home via the Internet or at the Employment Office. The applicant is required to submit details about education, work experience, language skills and a personal letter as well as information about which type of job he/she is interested in.[11] Employers that are registered with the Employment Office can then use the database to locate workers they find interesting and contact them for interviews etc. Most such contacts are registered in the database.[12]

[11] The information is submitted using specially constructed forms that must be filled out by the applicants. This means that there are no missing values. In the personal letter, the applicant is free to write whatever he or she wants. This means that it can contain both a duplication of information that also has been filled out in the other forms and other kinds of personal information. It is difficult for us to know how much this information affects employers in their contact decisions. We do not try to grade the quality of the personal letters because such a measure would be highly subjective. However, it should be kept in mind that employers might use the quality of the personal letter as a signal for unobservable characteristics. Another peculiarity of the dataset is that people are allowed to hide personal information like name and sex. This generates information that can be used to study discrimination based on sex or ethnicity (see Edin and Lagerström (2002)). This feature of the data is not used in this paper and does not in any way affect our results.

[12] It is possible that some employers contact applicants using other methods that do not get recorded, e.g. if a worker includes a phone number in the personal letter. However, according to the Employment Office most contacts are made within the system of mailboxes.

In this section we discuss the data used in the empirical investigation. We describe how the data was obtained, give summary statistics and discuss the representativity of the data.

3.1 The characteristics of the sample

In the spring of 2001, the Applicant Database contained approximately 50 000 individuals with a monthly inflow of around 11 000 new applicants. All applicants that logged into the system between March 1 and March 12, 2001 were asked if they wanted to participate in a research study investigating the recruitment behavior of firms.[13] Around 50 percent of those asked agreed, giving us a sample of 8666 individuals. Because we did not want to include youths in secondary school in the sample we excluded all individuals aged below 20.[14] That gives us the sample used in this study consisting of 8043 individuals.[15] [16] These people have been in the database for an average time of approximately 35 weeks. Tables 1 and 2 give some descriptive statistics about the people in the sample and the jobs they hope to find.

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[13] This was required by the Employment Office. The data used were collected for use in Edin and Lagerström (2002). The system registers if and when the applicants log into the system. Since all workers included in our empirical investigation logged in during this time, only active searchers should be included in the sample.

[14] Most of the applicants aged below 20 look for work during the summer break or temporary work on school holidays etc. Therefore, it seems natural to exclude them in our empirical investigation.

[15] More than 10 000 applicants agreed to participate in the study. However, some searchers did not submit all required information in the forms and, as a consequence, their information were not made available to firms. Since firms could not contact these searchers, it is natural to exclude them in the empirical investigation.

[16] It should be noted that our sample is a stock-flow sample; i.e. our sample includes both new applicants that registered their details during the period 1-12 March and applicants that logged into their already existing account in that time period. Stock-flow sampling sometimes can cause problems. However, given that we insert properly defined control variables for all factors that affect the contact probability it should not affect our results.

Table 1: Descriptive statistics about the characteristics of the applicants in the sample.

	All	Employed	Unemployed
Highest level of completed education:			
Primary	0.072	0.050	0.116
Secondary	0.489	0.512	0.534
University	0.439	0.438	0.350
Work experience:			
None	0.146	0.048	0.214
Some (less than 5 years)	0.421	0.446	0.402
Long (five years or more)	0.433	0.506	0.384
Other skills:			
Managerial experience	0.343	0.418	0.271
Distance work experience	0.124	0.139	0.109
Research experience	0.054	0.058	0.044
Driving license	0.788	0.830	0.730
Good computer skills	0.738	0.756	0.689
Good language skills - Swedish	0.969	0.976	0.956
Good language skills - English	0.561	0.580	0.495
Good language skills – G-F-S	0.197	0.201	0.177
Age:			
Mean (years)	33.79	34.10	34.00
Age 20-25	0.289	0.251	0.281
Age 26-35	0.331	0.356	0.291
Age 36-50	0.279	0.300	0.291
Age 51-	0.101	0.093	0.137
Sex:			
Male	0.513	0.505	0.553
Female	0.487	0.495	0.447
Ethnicity:			
Foreign name	0.134	0.122	0.150
Labor market status:			
Employed	0.49		
Unemployed	0.38		
University student	0.08		
In other training	0.04		
On child leave	0.01		

Note: Our measure of labor market experience only includes work in those occupations the worker wants to find a job. This explains why some of those who are employed are classified as having no work experience. G-F-S denotes language skills in German, French or Spanish. The column labelled all includes all searchers including students etc.

Table 2: Descriptive statistics about the jobs the applicants in the sample want to find.

	All	Employed	Unemployed
Desired region:			
Stockholm	0.293	0.312	0.264
Uppsala	0.088	0.086	0.084
Södermanland	0.078	0.071	0.077
Östergötland	0.080	0.078	0.080
Jönköping	0.059	0.061	0.055
Kronoberg	0.046	0.049	0.042
Kalmar	0.048	0.049	0.046
Gotland	0.020	0.021	0.017
Blekinge	0.046	0.048	0.041
Skåne	0.187	0.188	0.193
Halland	0.075	0.083	0.066
Västra Götaland	0.181	0.197	0.151
Värmland	0.049	0.048	0.050
Örebro	0.066	0.059	0.069
Västmanland	0.074	0.066	0.077
Dalarna	0.051	0.048	0.059
Gävleborg	0.055	0.053	0.059
Västernorrland	0.042	0.036	0.049
Jämtland	0.021	0.021	0.021
Västerbotten	0.041	0.038	0.043
Norrbotten	0.031	0.031	0.028
Desired occupation:			
Managerial work (Amsyk 1)	0.030	0.040	0.020
Work requiring higher education (specialists) (Amsyk 2)	0.279	0.297	0.217
Technicians and other work requiring shorter university education (Amsyk 3)	0.290	0.326	0.245
Office and customer service work (Amsyk 4)	0.248	0.265	0.242
Service, health care and sales work (Amsyk 5)	0.190	0.197	0.194
Agriculture, garden, forest or fishing work (Amsyk 6)	0.021	0.020	0.021
Craft work in construction and manufacturing (Amsyk 7)	0.116	0.121	0.122
Process and machine operator work, transport work etc. (Amsyk 8)	0.100	0.103	0.113
Unskilled work that do not require training (Amsyk 9)	0.105	0.085	0.129

Note: It is possible for the workers to search for jobs in several regions and/or occupations. This explains why the fractions do not sum to one. The column labelled all includes all searchers including students etc.

From Tables 1 and 2 there are several things worth noting. First, the people in the sample tend to be quite young and well educated. The average age is just around 34 years and almost 44 percent have a university degree. Moreover, many of the applicants have a lot of other potentially useful skills. Second, there are almost as many women as men in the database and it includes a non-negligible number of workers with foreign names.[17] Third, we have more employed people than unemployed people in the sample. This is obviously one of the most attractive features of the dataset for the purpose of studying competition between employed and unemployed workers. Fourth, we see that a substantial fraction of the workers seek employment in the areas surrounding the three biggest metropolitan areas and that they are quite diversified with respect to the types of work they seek.

Finally, turning to the number of offers received the 8043 workers in our sample have received 7179 contacts from employers during their time in the database. Table 3 gives some summary statistics about the fraction receiving at least one offer and the number of offers received, both for all workers and for four employment status subgroups.

Table 3: Descriptive statistics about the contacts received divided into employment status subgroups.

Employment status	Fraction receiving at least one contact	Average number of contacts
All	0.341	0.893
Employed	0.407	1.156
Unemployed	0.281	0.638
University student	0.252	0.569
In other training	0.298	0.754

Table 4 presents the distribution of the number of contacts received for all workers, unemployed workers and employed workers respectively.

[17] The Applicant Database does not contain information about the ethnical origin of people. However, since employers often easily can see the name of the applicant from the information submitted, we might expect some employers to use this as a basis for discrimination. Therefore, all workers in the Applicant Database agreeing to participate in the study were asked whether they believed other people perceived their name as foreign.

Table 4: Descriptive statistics about the distribution of contacts received divided into employment status subgroups, percent.

	0	1	2	3	4	5	6	7	8	9	>9
All	65.9	17.4	6.7	3.1	1.2	1.0	0.8	0.8	0.3	0.5	0.2
Unemployed	71.9	15.2	5.4	2.3	1.8	1.2	0.8	0.5	0.2	0.2	0.5
Employed	59.4	19.6	8.2	3.8	2.2	1.4	1.3	1.1	0.4	0.6	2.0

From Tables 3 and 4 we see that employed workers receive many more contacts than workers in any of the other states. An employed worker receives, on average, almost twice as many contacts as an unemployed worker. Obviously, we cannot conclude from these tables that it is unemployment in itself that leads to this outcome, since we expect that the groups differ systematically in a number of other ways as well. Some of these other differences are apparent from the second and third columns of Table 1, where we present the characteristics of employed and unemployed searchers respectively. There we clearly see that unemployed searchers have fewer skills than employed searchers. To get an estimate of the extent of discrimination, we need to control for all these other differences; which is what we do in the next section. However, the shear size of the differences in Table 3 is striking. We also see that people currently participating in some sort of education receive quite few contacts. This could be due to the fact that employers want to find people that can take new jobs directly or that employers do not use the Applicant Database to fill positions suitable for people straight out of universities.

3.2 Is the dataset representative?

An important issue for any dataset is whether the data is representative for the entire economy. In our case, we have essentially two types of selection to discuss. First, since the individuals themselves choose whether or not to submit their data to the Applicant Database we might wonder whether people that choose to do so differ from the average job searcher. Second, since we only have data for those who agreed to participate in the study, we must ask whether those that agreed differ systematically from those that refused.

It is difficult to know the extent of these potential selection problems. One possibility is to compare the characteristics of our data to other datasets. However, since there is very little information about the search activities of employed applicants this is difficult. To get a rough idea about whether our data differs from other datasets, we can compare it to data from the Swedish public employment offices. Carling et al (1996), use such data to study the effects of unemployment benefits. Comparing these two datasets, the most striking difference is the high proportion of university graduates in our sample. In addition, our applicants are a little older and have more work experience.

4 Estimation

We want to investigate whether the probability to get contacted by an employer, and the number of contacts received, is affected by the current employment status of the applicant. As we have seen from Table 1, employed and unemployed workers differ systematically in a number of other dimensions as well. Thus, we need to define proper control variables for all these other factors; the characteristics of the desired job, observable productive characteristics and other signals than employment status. In this section, we define the variables, present the econometric specification and discuss the results.

4.1 Variables

The control variables used correspond to those presented in Tables 1 and 2. Here, we will try to give some intuition for how we have chosen to construct these variables.

First, let us consider the requirements workers have about the jobs they want to find. In principle, there are two types of requirements; desired occupation and desired location.[18] It is natural to expect that labor market conditions differ between different occupational groups as well as between different regions. To control for such effects, we use dummy variables for occupation and location. For desired occupation, we use

[18] Obviously, the personal letter can contain other requirements for the desired job. However, it can be argued that such more qualitative factors are more likely to be discussed after a contact has been established rather than affecting whom the firm chooses to contact.

dummy variables based on the nine-group classification system used by the Employment Office.[19] For desired location, we use dummy variables for counties.

Second, we have factors that are directly related to the productivity of the applicant. We expect these factors to both explain much of the variation in contact rates between applicants as well as, potentially, contain systematic differences between employed and unemployed applicants. As a consequence, we must insert proper controls for these characteristics. The two most important observable characteristics that directly affect the productivity of the worker are education and labor market experience. To control for education, we include dummy variables for the highest completed level of education; primary, secondary or university. To control for experience, we use dummy variables for three lengths of experience; none, some ($0 < t < 5$ years) and long (≥ 5 years).[20] Even though education and experience are probably the two most important observable skills, the data also contains a number of other factors that are easily observable to firms. To control for these effects, we use dummy variables for managerial experience, experience of distance work, research experience, driving skills, good computer skills and good language skills in Swedish, English, German, French or Spanish.

Third, we have those factors that employers might use as signals for other unobservable characteristics. These include age, sex, ethnicity and employment status. For age, we divide the workers into five groups; 20-25, 26-35, 36-50, 51- years old.[21] For sex and ethnicity, we use naturally defined dummy variables. For employment status, we divide the applicants into five groups; employed, unemployed, university students, in other training and on child leave. We include the last three groups to make sure that those classified as employed or unemployed really are just that and not students.

[19] This classification follows the Swedish standard for classifying occupations.

[20] It can be argued that the number of years of experience is the relevant variable. However, such information is impossible to obtain from the dataset. In addition, we only have data on labor market experience in those occupations the searcher wants to find a job.

[21] In principle, we could insert age as a continuous variable. However, we have chosen not to do so because there is hard to find a theoretical argument why for example a 35 year old should be judged differently by employers than a 34 year old. In addition, the results do not change if we introduce age as a continuous variable.

4.2 The probability to receive a contact

We estimate a model for the probability that a searcher in the Applicant Database receives at least one contact, during his time in the database, as a function of our independent variables; i.e. an empirical specification corresponding to equation (1). This is a typical example of binary choice where the dependent variable can take on only two values; the value 1 if the event occurs and the value 0 if it does not occur. We use the linear probability model (LPM) and estimate it using ordinary least squares. The empirical specification is given by:

$$P(Y=1)=\alpha+\phi' t+\beta' S+\delta' X+\gamma' Z+\phi' T+\varepsilon, \qquad (2)$$

where S denotes the current employment status of the applicant, X denotes the observable productive characteristics of the applicant, Z denotes the characteristics of the desired job and T denotes signals other than employment status. A vector t, consisting of the variables time and time squared, is included in the specification because searchers have been in the database for different lengths of time and this probably affect the number of contacts they have received.

Estimation of the specification in (2) yields the results presented in Table 5.

Table 5: Estimates of the probability to receive a contact

	(1)	(2)	(3)	(4)
Labor market status (S) (ref. employed):				
Unemployed	-0.063	-0.048	-0.040	-0.031
	(0.010)	(0.010)	(0.010)	(0.010)
University student	-0.036	-0.047	-0.050	-0.057
	(0.017)	(0.018)	(0.018)	(0.018)
In other training	-0.020	-0.012	-0.017	-0.009
	(0.023)	(0.023)	(0.023)	(0.023)
On child leave	0.044	0.041	0.044	0.050
	(0.050)	(0.049)	(0.049)	(0.050)
Observable productive characteristics (X):				
Highest level of completed education (ref. primary):				
Secondary		0.065	0.050	0.020
		(0.016)	(0.015)	(0.016)
University		0.110	0.088	0.052
		(0.016)	(0.017)	(0.018)
Work experience (ref. some):				
None		-0.052	-0.035	-0.029
		(0.013)	(0.013)	(0.013)
Long		0.003	-0.0004	0.024
		(0.010)	(0.010)	(0.012)
Other skills:				
Managerial experience				0.052
				(0.011)
Distance work experience				0.025
				(0.015)
Research experience				0.005
				(0.022)
Driving licence				0.005
				(0.012)
Good computer skills				0.011
				(0.011)
Good language skills – Swedish				0.013
				(0.025)
Good language skills – English				0.032
				(0.010)
Good language skills – G-F-S				0.032
				(0.013)
Characteristics of the desired job (Z):				
Dummies for desired region	No	No	Yes	Yes
Dummies for desired occupation	No	No	Yes	Yes

	(1)	(2)	(3)	(4)
Other signals (T):				
Age (ref. age 20-25):				
Age 26-35				-0.029
				(0.012)
Age 36-50				-0.075
				(0.014)
Age 51-				-0.094
				(0.020)
Ethnicity:				
Foreign name				-0.015
				(0.013)
Sex:				
Female				-0.046
				(0.010)
Other variables:				
Weeks in the database	0.011	0.010	0.010	0.010
	(0.0003)	(0.0003)	(0.0003)	(0.0003)
$(\text{Weeks in the database})^2$	-0.00004	-0.00004	-0.00004	-0.00004
	(0.000002)	(0.000002)	(0.000002)	(0.000002)
Constant	0.119	0.048	0.010	0.030
	(0.009)	(0.017)	(0.017)	(0.031)
Number of observations	8043	8043	8043	8043
R^2	0.237	0.243	0.270	0.281

Note: The reference category is an employed man with a Swedish sounding name having primary education, some labor market experience and looking for unskilled work in Stockholm. All specifications are estimated using ordinary least squares. Robust standard errors are in parentheses.

In column 4 we see the parameter estimates for the full specification. The results indicate that unemployment is considered as a negative worker characteristic. The probability to get contacted by an employer is approximately 3 percentage points lower for an unemployed applicant than for an employed applicant and this effect is statistically significant at conventional levels. To get a feeling for the size of this effect, we can calculate contact probabilities for a "typical" applicant.[22] Such a searcher has a 45 percent probability to get contacted if he is employed, and a 42 percent probability to get contacted if he is unemployed. Thus, the contact probability is reduced by around 7 percent. These results support the theoretical proposition that firms view

[22] The "typical" searcher is a 26-35 year old Swedish man with secondary education and at least five years labor market experience who has a driving license, good computer skills, good language skills in Swedish and English and that searches for technical work (Amsyk 3) in Stockholm.

unemployment as a signal of some unobservable negative worker characteristic and, ceteris paribus, prefer to contact an employed applicant rather than an unemployed applicant.

Several other things are worth noting. First, searchers currently enrolled in university education also face a lower probability than employed searchers to get contacted by an employer. This might reflect the fact that firms want workers that are available for work soon or that firms do not use this search channel to recruit for entry-level positions suitable for university graduates. Second, education and labor market experience have the expected signs. A higher level of completed education, or more labor market experience, has a clear positive effect on the probability to get contacted. Third, we see that other applicant characteristics functioning as signals, like age and sex, also have quite strong effects. Women and old people face a significantly lower probability to get contacted.

In Section 3, we saw that employed workers, on average, have a much higher probability to get contacted by an employer. It is obvious from the results of the estimation that a large proportion of this difference reflects systematic differences between employed and unemployed applicants. To get a feeling for what these differences are, it is illuminating to consider columns 1 to 3 in Table 5, where we start with only labor market status variables as regressors and then successively introduce other variables that might contain systematic differences between employed and unemployed applicants (the constant and the time variables are included in all regressions).

In the first column, we regress the probability to get contacted by an employer only on the employment status variables. An unemployed worker faces a 6.3 percentage points lower probability to get contacted than an employed worker. In the second column, we include variables corresponding to such observable productive characteristics that are usually included in discrimination studies. The probability difference now falls to 4.8 percent implying that some of the difference in search outcome between employed and unemployed applicants is explained by the fact that the unemployed applicants have less education and less labor market experience. In the third column, we introduce the variables corresponding to the requirements applicants have on the jobs they hope to find. We see that unemployed workers now face a 4.0

percentage points lower probability to get contacted. The difference between the results in columns 2 and 3 must reflect the fact that unemployed applicants seem to search for the "wrong" kinds of jobs in the "wrong" regions. In column 4, all variables are included. It should be noted that many of these variables are not normally available in studies of discrimination.

To summarize the results from Table 5, we can conclude that unemployed workers seem to have a lower chance than employed workers to get contacted by an employer. Some of this difference is explained by the fact that unemployed workers have less education and less labor market experience and by differences in the type of job they wish to find. However, even after we control for these variables a non-negligible negative effect remains from being unemployed, thus, indicating that unemployment *per se* is considered as a negative signal.

An interesting question is if the disadvantage unemployed searchers face differ between different subgroups of unemployed applicants. We might for example ask whether unemployed women face a bigger disadvantage than unemployed men do. To investigate this, we introduce an interaction term between the female and unemployed variables in specification (2). This new variable turns out to be statistically insignificant and thus we must conclude that firms consider unemployment as an equally strong negative signal for men and women.

An important issue for any empirical analysis is whether the results are sensitive to the choice of statistical model. For the LPM model, we have tried a number of different specifications with very similar results. However, the properties of the LPM model have been criticized in the literature.[23] To ensure that our results are not specific to the use of this particular model, we have also estimated the equivalent of equation (2) using the Probit model. This yields very similar results; the slope coefficient for the unemployment variable now becomes equal to 0.033.[24] Thus, our results appear stable with respect to changes in model specification.[25]

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[23] Amemiya (1981), points out two weaknesses characterizing the LPM model. First, there is nothing in the model that constrains dependent variable to lie between 0 and 1 as a probability should. Second, this model is heteroscedastic. However, using estimation methods that corrects for heteroscedasticity can solve this problem.

[24] Estimates from the LPM and the Probit models are not directly comparable. However, it is easy to calculate the marginal effect corresponding to the coefficient estimate from the Probit model. Performing that calculation yields the value 0.033.

[25] Similar results are obtained if we use the Logit model.

4.3 The number of contacts received

In our estimation of the probability to get contacted by an employer, we did not use all the information we have available. We also know the number of contacts our applicants have received during their time in the Applicant Database. This means that we can take the analysis a bit further by asking: do unemployed workers get fewer contacts as well?

We want to estimate a model for the number of contacts received by the searchers in the Applicant Database corresponding to equation (1). The dependent variable is then equal to the number of contacts received. Hence, it can take on only non-negative integer values. We estimate the following specification with ordinary least squares:

$$Y = \alpha + \phi' t + \beta' S + \delta' X + \gamma' Z + \phi' T + \varepsilon, \qquad (3)$$

where Y now denotes the number of contacts. All the explanatory variables are defined as in specification (2). The results of the estimation are presented in Table 6.

Table 6: Estimates of the number of contacts received

	(1)	(2)
Labor market status (S) (ref. employed):		
Unemployed	-0.127	-0.212
	(0.041)	(0.105)
University student	-0.247	-0.360
	(0.073)	(0.205)
In other training	-0.008	0.092
	(0.120)	(0.364)
On child leave	-0.029	-0.299
	(0.135)	(0.349)
Observable productive characteristics (X):		
Highest level of completed education (ref. primary):		
Secondary	-0.132	-0.040
	(0.059)	(0.210)
University	-0.027	0.081
	(0.068)	(0.226)
Work experience (ref. some):		
None	0.027	0.045
	(0.048)	(0.164)
Long	0.141	0.351
	(0.061)	(0.158)
Other skills:		
Managerial experience	0.174	0.172
	(0.057)	(0.134)
Distance work experience	0.147	0.146
	(0.094)	(0.190)
Research experience	0.124	0.138
	(0.136)	(0.270)
Driving licence	-0.037	-0.088
	(0.056)	(0.157)
Good computer skills	0.002	0.019
	(0.037)	(0.101)
Good language skills – Swedish	0.034	0.110
	(0.079)	(0.232)
Good language skills – English	0.161	0.292
	(0.044)	(0.112)
Good language skills – G-F-S	0.237	0.525
	(0.074)	(0.176)
Characteristics of the desired job (Z):		
Dummies for desired region	Yes	Yes
Dummies for desired occupation	Yes	Yes

	(1)	(2)
Other signals (T):		
Age (ref. age 20-25):		
Age 26-35	-0.270	-0.542
	(0.062)	(0.162)
Age 36-50	-0.397	-0.638
	(0.075)	(0.207)
Age 51-	-0.547	-0.917
	(0.090)	(0.236)
Ethnicity:		
Foreign name	-0.010	0.041
	(0.071)	(0.203)
Sex:		
Female	-0.208	-0.337
	(0.047)	(0.128)
Other variables:		
Weeks in the database	0.028	0.034
	(0.002)	(0.004)
$(\text{Weeks in the database})^2$	-0.00004	-0.00007
	(0.00002)	(0.00003)
Constant	-0.050	0.455
	(0.113)	(0.393)
Numbers of observations	8043	2743
R^2	0.256	0.193

Note: The reference category is an employed man with Swedish sounding name having primary education, some labor market experience and looking for unskilled work in Stockholm. All specifications are estimated using ordinary least squares. Robust standard errors are in parentheses.

In column 1, we have the results of the regression for the full sample. We see that the results confirm what we saw in Table 5. Unemployed job seekers face a significantly worse outcome than employed job seekers. On average, an otherwise identical searcher gets contacted 0.13 times less if he is unemployed. As we did with the contact probability, we can calculate the effects for the "typical" searcher. Such a searcher receives 1.10 contacts if he is employed and 0.97 contacts if he is unemployed. Thus, the contact probability is reduced by around 12 percent.

It is possible that applicants that do get at least one offer differ in some important way from those applicants that do not get any offers. To see if this is true, we run a regression including only those applicants that have received at least one contact. The results of that regression are presented in column 2. We see that the difference is even bigger; an unemployed worker receives approximately 0.21 fewer contacts than an employed applicant.

To summarize, it seems that workers that are unemployed receive significantly fewer contacts than employed searchers. The probability to get contacted is lower for an unemployed worker and, even if a person gets contacted, he gets fewer offers if he is unemployed. This is important because it might take several contacts before the applicant actually gets hired. A potential problem with using ordinary least squares to estimate equation (3) is that the distribution of contacts received is not symmetrical. As is emphasized by Greene (1997), the preponderance of zeros and small values as well as the discrete nature of the dependent variable make other model assumptions potentially more suitable. To see if the statistical model chosen affects the results, we have estimated the model using two models that are often proposed in the literature; the Poisson model and the Negative Binomial model. Estimation of the equivalent of equation (3) for the whole sample, using both of these models, yields very similar estimates for the unemployment variable. The result that unemployed workers receive fewer contacts than employed searchers, therefore, seems very stable over different model assumptions.

5 Concluding remarks

Firms hiring new workers are often not able to perfectly observe the productive abilities of their applicants. Instead, employers try to infer the productivity of job seekers by using whatever information they have available. Such information often includes signals; i.e. factors that firms believe are correlated with unobservable factors that affect productivity. One example of such a signal is the employment status of the applicant. If employers use employment status as a hiring criterion, an unemployed job seeker should face a lower probability to get contacted by a firm than an employed job seeker. The purpose of this paper has been to empirically investigate whether this theoretical implication is valid.

Using Swedish data from the Applicant Database, we have seen that an unemployed job seeker seems to face a lower probability to get contacted by a firm, and receives fewer contacts, than an employed job seeker. These effects remain even after we control for all other factors that the firm can observe prior to its contact decision. Thus, the results of the empirical analysis give support to the proposition that firms view employment status as an important signal for productivity and that firms therefore, ceteris paribus, often prefer to contact employed applicants rather than unemployed applicants.

The results in this study clearly indicate that unemployed job seekers are at a disadvantage compared to employed job seekers in our sample from the Applicant Database. An important issue is whether the same is true for the whole labor market. Obviously, only further empirical analysis can answer such a question. However, *a priori* it is difficult to think of any particular reason why firms using the Applicant Database should be more prone to view unemployment as a negative worker characteristic than employers using other search channels.

Another important issue that should be addressed is what are the aggregate implications for the economy of the effects we have identified. From the analysis in Eriksson and Gottfries (2000), it is clear that in an economy where firms perceive unemployed applicants as less hirable than employed applicants there will be wage pressure and higher unemployment. Obviously, it is difficult to know if the effects found in this study are big enough to generate substantial effects for the aggregate economy, especially since we only measure discrimination in the contact decision. However, at the very least our study indicates that such effects might be an important factor that affects the dynamics of unemployment.

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