Unemployment and Search Externalities in a model with Heterogeneous Jobs and Workers*

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Abstract

In this paper a matching model with low and high skilled workers and simple and complex jobs is presented. Badly matched workers continue search on the job. I show that the degree to which low skilled workers are harmed by high skilled workers who are willing to temporarily accept simple jobs depends on the relative productivity of high and low skilled workers on simple jobs and on the quit rate of high skilled workers. Under certain conditions, low skilled workers can even benefit from job competition by high skilled workers. With this framework, a number of explanations for the high and persistent unemployment rates of lower educated workers in the 90's is evaluated: i) an increased number of high skilled workers, ii) skill biased technical change, iii) lower firing costs for low skilled workers, iv) a general slowdown of the economy.

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1 Introduction

Due to the seminal work of Diamond (1982), Pissarides (1990,1994), Hosios (1990) and Mortensen and Pissarides (1994) we know that optimal search effort at the micro level can generate inefficient outcomes at the macro level. This literature has shown that there is no reason to expect that the market outcome is efficient because individual workers and firms do not take the effects of the bargained wage on aggregate labor market tightness into account. The inefficiency is caused by the fact that wages are determined after the firm and worker meet. In general, an additional job searcher makes firms with vacancies better off but he worsens the position of the other job seekers.

This paper describes an economy with simple and complex jobs and low and high skilled labor. All workers can apply for simple jobs but only high skilled workers can apply for complex jobs. When there are search frictions and both the unemployed low and high skilled workers compete for simple jobs, there are two additional externalities which have to be taken into account. The first one stems from the fact that high skilled workers have a positive quit probability on simple jobs (since they continue searching for a higher paying complex job). Firms will anticipate this and they will restore profitability by opening less simple job vacancies in equilibrium. The low skilled workers (who never quit) are therefore also punished for the quits of the high skilled workers. The other externality stems from the fact that the productivity on simple jobs depends on the skill of the worker. When high skilled workers are sufficiently more productive than low skilled workers (at simple jobs), the equilibrium supply of vacancies will depend positively on the fraction of high skilled workers searching for simple jobs. The low skilled workers also benefit from this larger supply of vacancies. Under certain conditions, this effect dominates the two other externalities. In that case, the low skilled workers will be better off when an additional high skilled worker starts searching (even when the matching function exhibits constant returns to scale).

The model is related to the Pissarides (1994) model which has heterogeneity on one side of the market (good and bad jobs) and allows for on the job search. Pissarides showed that some workers can get locked in at bad jobs as their wages increase with job tenure. In some respects the model in this paper is simpler than the Pissarides (1994) model since it does not consider tenure effects. It does however allow for heterogeneity in the work force. Things remain tractable because a different strategic underpinning of the usual Nash

Bargaining solution (as in for example Pissarides (1990)) is applied. As Abbring (1999) shows, the traditional intertemporal surplus sharing solution can be either supported by an infinitely large risk of breakdown (relative to the discount rate) or by precommitment to search during disagreement. The first one is unattractive since it is not clear why the production environment (with a finite job destruction rate) would be so different from the bargaining environment. The second underpinning assumes precommitment to search but when search is unobservable as in Wolinsky (1987), workers can only precommit to search when employers actually realize that there are better partners out there in the market place. I therefore only allow high skilled workers who bargain with simple vacancy suppliers to credibly threaten to continue searching for complex jobs.

Saint Paul (1996), also analyzes an equilibrium search model with different job and worker types. The main differences between his model and the model presented here is that I assume free entry of vacancies and restrict the complex job vacancies to be occupied by high skilled workers only. This approach leads to completely different conclusions.

The model of Albrecht and Vroman (1998) is also related to this model. The wage bargaining process in the Albrecht and Vroman model is however different than in the model of this paper and the overqualified high skilled workers are not allowed to search on the job. Moreover, in their model, high skilled workers always earn higher wages than low skilled workers at simple jobs because they have a better outside option. In this model, high skilled workers also have a better bargaining position but they do not necessarily earn higher wages because employers anticipate their higher quit rate which reduces the match surplus.

The problem of matching heterogeneous workers with heterogeneous jobs is also a central issue in the assignment literature, see Sattinger (1995), Shimer and Smith (2000) and Teulings and Gautier (2000) for assignment models with search frictions. Although the model in this paper only takes account of two job and worker types, it does not require an absolute advantage of the high skilled workers on simple jobs and most importantly, it allows for on the job search.[1] Finally, Hosios (1985) describes a similar externality as is highlighted in this paper in a non-matching search context.

The second aim of this paper is to relate the outcomes of the model to the relatively high and persistent unemployment rates for low skilled workers

[1] Most labor market transitions in OECD countries reflect job to job movements.

in many OECD countries as reported in Table 1. There is no shortage of explanations for this fact. I focus on four popular ones. First, since the levels of completed education have increased, low skilled workers may suffer from an increasing number of high skilled workers who search for simple jobs. Second, skill biased technical change decreases the relative profitability of simple jobs and increases the relative profitability of complex jobs. Third, firing rates at simple jobs are in general higher since simple jobs require relatively little specific (sunk) investments. Fourth, a general slowdown of the economy leads to both higher low and high skilled unemployment rates. In a calibrated version of the model, I analyze the effects of shocks, which are consistent with those stories, on the magnitude, expected duration and the composition of unemployment and on the wages of high and low skilled workers. Moreover, the model can be used to analyze the social and public benefits of training because it derives explicit expressions for the asset values of high and low skilled workers. The difference between them is a more relevant measure for the returns to schooling than wage differentials at a point in time.

The paper is organized as follows. Section 2 presents the model and shows how equilibrium wages are calculated for low skilled workers, high skilled workers at simple jobs and high skilled workers at complex jobs. Section 3 derives the equilibrium vacancy stocks and the output value at a simple job for which employers are indifferent between high and low skilled workers. Section 4 gives some simulation results of a calibrated version of the model and section 5 concludes.

2 An equilibrium search model with job competition

Consider an economy with two types of jobs, complex and simple. Complex vacancies can only be filled by high skilled workers while simple job vacancies can be filled by both high and low skilled workers. This seems to be consistent with what we observe in the real world where everybody can occupy a hamburger flipping job while only very skilled workers can become a rocket engineer at NASA.[2] Assume that the type of vacancy which is opened has to

[2] Many other assumptions are made in the literature. As discussed in the introduction, in Saint Paul (1996) and some of the assignment liteature it is assumed that low skilled

be determined ex ante. Thus it is not possible for a firm to open a general vacancy and decide upon the job type after the first worker has shown up. Furthermore, assume that workers and vacancies meet according to a CRS matching function which is increasing in the relevant amount of searchers and vacancies. Figure 1 captures the basic structure of the model. The pools of unemployed (U) and simple employment (S) consist of two types of workers, high skilled (H) and low skilled (L). The complex jobs (C) can by assumption only be occupied by high skilled workers. The arrows give the possible flows between the different states.

Assume that complex jobs produce output y_c while simple jobs occupied by a low skilled worker produce output $y_s = \psi y_c$, where $0 < \psi < 1$, and simple jobs occupied by a high skilled worker produce output μy_s where $0 < \mu < 1/\psi$. Thus, the output at complex jobs is always higher than the output at simple jobs.

There is no a priori reason to expect μ to be larger or smaller than one. One can imagine that high skilled workers perform worse on simple repeating activities (university professors are not better garbage men than high school drop outs) but for some types of simple jobs, high skilled workers can have a higher productivity than low skilled workers. Examples include waiters who speak many languages or nurses with a lot of medical knowledge. It turns out that μ plays an important role in determining the equilibrium stocks of vacancies and unemployment in equilibrium. Perhaps surprisingly, low skilled workers benefit from high skilled workers who have a high productivity at simple jobs.

I will use the following information structure. Workers do know whether a vacancy is for a simple or a complex job but simple vacancy suppliers cannot ex ante exclude one type of worker from searching. The motivation behind this assumption is that it does not seem to be very difficult for a firm to make clear whether a vacancy is simple or complex (e.g. on internet or in a newspaper advertisement) but that is difficult to exclude certain groups from reading this advertisement.

The number of contacts between simple jobs and unemployed workers is given by:

workers can be employed at all jobs. Kremer (1993) assumes an O-ring production structure where total production is determined by many related tasks and where high skilled workers have a smaller probability of making a (costly) mistake.

$$x_s = x_s(v_s, u_h + u_l) \tag{1}$$

where v_s refers to a simple job vacancy, u_l and u_h are low and high skilled unemployment, and x_s is a CRS matching function, which is increasing in both its arguments, and concave. Since only high skilled workers apply for complex jobs, the number of contacts between complex jobs and workers is given by:

$$x_c = x_c(v_c, u_h + e_{sh}) \tag{2}$$

where v_c refers to complex job vacancies, and e_{sh} stands for the number of high skilled workers occupying simple jobs. Note that it is implicitly assumed that employed and unemployed high skilled workers search equally efficiently for complex jobs and also that high and low skilled workers search equally efficiently for simple jobs. In addition, I normalize the total labour force to one. It is also convenient to define the variables θ_s and θ_c which represent the ratio of vacancies and searchers on each side of the market for simple and complex jobs respectively,

$$\theta_s = \frac{v_s}{u_l + u_h} \text{ and } \theta_c = \frac{v_c}{u_h + e_{sh}}$$

Under the CRS assumption, the rate at which low and high skilled vacancies are filled can be written as:

$$q_s(\theta_s) \equiv \frac{x_s}{v_s} = x_s(1, \theta_s^{-1}) \tag{3}$$

$$q_c(\theta_c) \equiv \frac{x_c}{v_c} = x_c(1, \theta_c^{-1}) \tag{4}$$

The rates at which low and high skilled unemployed workers find simple jobs is: $p_s = x_s/(u_h + u_l) = \theta_s q_s(\theta_s)$. The rate at which high skilled workers find complex jobs is: $p_c = x_c/(u_h + e_{sh}) = \theta_c q_c(\theta_c)$. Note that given the properties of the matching technology, q_s and q_c are decreasing in vacancies and increasing in the number of job seekers: $q_s'(\theta_s) \leq 0$ and $q_c'(\theta_c) \leq 0$, while $\theta_s q_s(\theta s)$ and $\theta_c q_c(\theta_c)$ are increasing in vacancies and decreasing in the amount of job seekers.

In addition, wages have to be specified. Because of the search frictions, each match has quasi rents. Given those rents, the market wage is not unique because there are many divisions possible that satisfy individual rationality.

In the literature it is common practice to let wages be determined by an axiomatic Nash bargaining solution, see Diamond (1982), Pissarides (1990), and Binmore et al. (1986). Bargaining with two or more worker and job types can get very complex however when the threat points of both parties depend on all possible labour market states and the probabilities to enter each of those states. To keep the model both tractable and consistent, assume further that:

1. *Employers observe the skill of a worker at the moment the bargaining starts.*
2. *All firms are single worker firms.*
3. *Search intensities are fixed.*
4. *Wages continuously satisfy the Nash sharing rule.*
5. *Search is not observable.*[3]
6. *The equilibrium wage is renegotiation proof.* [4]

The standard approach to solve equilibrium search models of this type is to attach a continuous time asset value to every possible worker and job state.

The following notation is introduced. The expected income stream for unemployed low skilled workers and unemployed high skilled workers will be denoted by (rW_{UL}) and (rW_{UH}) respectively. Furthermore, there are 3 possible employment (rW_{Ej}) job (rW_{Fj}) and disagreement-while-bargaining (rW_{Dj}) states with $j \in \{SL, SH, C\}$, where SL, SH, and C represent a simple job with a low skilled worker, a simple job with a high skilled worker and a complex job with a high skilled worker respectively. The asset values for low and high skilled unemployed workers are equal to their unemployment income (b) plus the rate at which simple vacancies meet workers times the expected wealth improvement when the worker is employed.

$$rW_{UL} = b + p_s[W_{ESL} - W_{UL}] \tag{5}$$

[3] Abbring (1999) and Wolinsky (1987) show that this guarantees that workers and firms will not continue searching for similar partners during the bargaining.

[4] This assures that wages at complex jobs are independent of the workers previous labor market state. The intuition is the following. If an employed worker would use his simple-job-wage as threat point in the bargaining, firms would initially agree but then re-open the bargaining at the moment the worker actually quits. In the new bargaining, the worker's outside option is similar to the outside option of an unemployed worker.

$$rW_{UH} = b + p_s[W_{ESH} - W_{UH}] + p_c[W_{EC} - W_{UH}] \tag{6}$$

The expected income flows for employed workers can be expressed in a similar way.

$$rW_{ESL} = w_{sl} - s_s[W_{ESL} - W_{UL}] \tag{7}$$

$$rW_{ESH} = w_{sh} + p_c[W_{EC} - W_{ESH}] - s_s[W_{ESH} - W_{UH}] \tag{8}$$

$$rW_{EC} = w_c - s_c[W_{EC} - W_{UH}] \tag{9}$$

where w_{sl}, w_{sh}, and w_c denote the wages for low skilled workers at simple jobs, high skilled workers at simple jobs and high skilled workers at complex jobs respectively. Simple and complex job destruction rates, s_s and s_c, are exogenous, independent of the hiring rate and follow a Poisson process. When such a shock arrives, all production potential of the match will be destroyed. Gautier et al. (1999) show for the Netherlands that in general, s_s is larger than s_c. Further note that the only job to job movement that will take place is that of a high skilled worker on a simple job (e_{sh}) who climbs the job ladder and moves to a complex job (e_c). The asset values of the different matches from the employer's point of view are then given by:

$$rW_{FSL} = y_s - w_{sl} - s_s[W_{FSL} - W_{VS}] \tag{10}$$

$$rW_{FSH} = \mu y_s - w_{sh} - (s_s + p_c)[W_{FSH} - W_{VS}] \tag{11}$$

$$rW_{FC} = y_c - w_c - s_c[W_{FC} - W_{VC}] \tag{12}$$

Finally, the 3 different worker disagreement payoffs in the bargaining state, rW_{Dj}, for each of the 3 match types needs to be defined. Remember that the only possible search during bargaining is by a high skilled worker who looks for complex vacancies while he bargains with a simple vacancy supplier and that vacancies have the same probability of being destroyed during the bargaining as existing jobs.

$$rW_{DSL} = b + s_s[W_{UL} - W_{DSL}] \tag{13}$$

$$rW_{DSH} = b + p_c[W_{EC} - W_{DSH}] + s_s[W_{UH} - W_{DSH}] \tag{14}$$

$$rW_{DC} = b + s_c[W_{UH} - W_{DC}] \tag{15}$$

These asset values implicitly determine the reservation productivity and the supply of complex and simple jobs.

The model can be closed by assuming that vacancies are opened until the expected income stream is zero. Let c_s and c_c be the flow costs for respectively simple and complex vacancies. Think of them as advertisement costs. Then,

$$rW_{VS} = \frac{x_s}{v_s(u_l + u_h)}(u_l W_{FSL} + u_h W_{FSH} - W_{VS}) - c_s = 0 \tag{16}$$

The expected income stream of a simple vacancy is equal to the probability that the vacancy meets a particular worker times the expected rents of a match with this worker. It does not only depend on the stock of unemployed workers but also on the composition of unemployment. The larger the output at simple jobs produced by a high skilled worker relative to a low skilled worker (μ) is, the more employers prefer high skilled workers on simple jobs. Given the renegotion proofness argument, employers with complex vacancies are indifferent with respect to the previous labor market state of the high skilled worker and supply vacancies according to:

$$rW_{VC} = \frac{x_c}{v_c}[W_{FC} - W_{VC}] - c_c = 0 \tag{17}$$

For each match, the Nash bargaining solution is the w_i that maximizes the weighted match surplus:

$$(W_{Ej} - W_{Di})^{\beta}(W_{Fi})^{1-\beta} \tag{18}$$

All wages can then be derived from:

$$[W_{Ej} - W_{Di}] = \beta[W_{Ej} + W_{Fi} - W_{Di}] \tag{19}$$

Before deriving explicit expressions for the wages, assume that unemployment benefits, b, are a fixed fraction υ of y_s ($0 < \upsilon < 1$). This guarantees that each contact between a worker and a vacancy results in a match (except of course between a low skilled worker and a complex vacancy). In most OECD countries such a relation either exists formally or informally..

For low skilled workers on simple jobs this implies that: $w_{sl} = b+\beta(y_s-b)$. Since $b = \upsilon y_s$ and $0 < \upsilon < 1$, it follows that

$$w_{sl} = ((1-\beta)\upsilon + \beta)\, y_s \tag{20}$$

Similarly,

$$w_{sh} = b + \beta(\mu y_s - b) = ((1-\beta)\upsilon + \beta\mu)\, y_s \tag{21}$$

and

$$w_c = b + \beta(y_c - b) = \left((1-\beta)\upsilon + \frac{\beta}{\psi}\right) y_s \tag{22}$$

Because of the renegotion proofness assumption, all high skilled workers earn the same wage at complex jobs, independent of their previous wage. Also note that $w_{sh} > w_{sl}$ if $\mu > 1$. If $\mu = 1$, the total match surplus is smaller when a simple job is occupied by a high skilled worker because of his positive quit probability. The high skilled workers are able to bargain the same wage however because they have a stronger bargaining position (since they can credibly threaten to continue searching for a complex job while bargaining with a simple vacancy supplier). This exactly compensates for the smaller match surplus. It implies that employers with simple vacancies prefer to meet low skilled workers when $\mu = 1$. I return to this issue in the next section.

Finally, it is easy to show that given the assumptions of the model, the reservation wage rules are always met. This follows from the conditions that $rW_{ESL} > rW_{UL}$ and $rW_{ESH} > rW_{UH}$. First note that the sharing rule implies that $w_{sl} > b$, therefore from (7) it follows that $rW_{ESL} > b - s_s[W_{ESL} - W_{UL}]$. Also note that since it follows from (5) that $b = rW_{UL} - p_s[rW_{ESL} - rW_{UL}]$, it must also hold that $rW_{ESL} > rW_{UL}$. Using similar arguments, it can easily be derived that $rW_{ESH} > rW_{UH}$ and $rW_{EC} > rW_{UH}$.

3 Vacancy supply and search externalities

Diamond (1982) and Pissarides (1990) showed that parties on the same side of the market create in general negative search externalities and parties on different sides of the market create positive search externalities for each other. In this model it can be shown that, depending on the relative output of high and low skilled workers on simple jobs, high skilled workers who also search for simple jobs, can generate both positive and negative search externalities. First, assume the following standard functional forms for the matching functions, x_s and x_c.

$$x_s = \lambda_s {v_s}^{\alpha} (u_l + u_h)^{1-\alpha} \tag{23}$$

$$x_c = \lambda_c {v_c}^{\alpha} (u_h + e_{sh})^{1-\alpha} \tag{24}$$

Employers with simple vacancies are indifferent between a high and a low skilled worker when the higher productivity of a high skilled worker on a simple job exactly compensates for his higher quit probability. Call the value of μ for which this holds: μ^*. We can derive μ^* from the condition that $W_{FSH} = W_{FSL}$, hence (10) and (11) imply that:

$$\mu^* = \upsilon + \frac{(r + s_c + p_c)(1 - \upsilon)}{s_s + r} \tag{25}$$

In the special case that $s_s = s_c$ this reduces to:

$$\mu^* = 1 + \frac{p_c(1 - \upsilon)}{s_s + r} \tag{26}$$

The higher the probability for a high skilled worker to find a complex job, the higher his productivity on simple jobs must be to compensate employers for the shorter expected match duration. Before deriving the equilibrium vacancy stock, it is convenient to derive explicit solutions for the asset values of filled jobs. This can easily be done by rewriting (10), (11) and (12) as:

$$W_{FSL} = \frac{(1 - \beta)(1 - \upsilon)y_s}{r + s_s} \tag{27}$$

$$W_{FSH} = \frac{(1 - \beta)(\mu - \upsilon)y_s}{r + s_s + p_c} \tag{28}$$

$$W_{FC} = \frac{(1 - \beta)(\psi^{-1} - \upsilon)y_s}{r + s_c} \tag{29}$$

The supply of complex vacancies can then be derived straightforwardly from(17), (24) and (29):

$$v_c = (u_h + e_{sh}) \left(\frac{\lambda_c W_{FC}}{c_c} \right)^{\frac{1}{1-\alpha}} \tag{30}$$

and θ_c is simply equal to:

$$\theta_c = \left(\frac{\lambda_c W_{FC}}{c_c} \right)^{\frac{1}{1-\alpha}} \tag{31}$$

Note that θ_c is independent of u_h and increasing in y_c.The supply of complex job vacancies depends positively on the efficiency of the matching process, the expected employer's share of the match surplus and the amount of complex job searchers (employed and unemployed). It depends negatively on the flow costs of keeping the vacancy open, the interest on alternative investments and the probability that the match ends. The supply of simple vacancies can be derived in a similar way from, (23) (27), and (28):

$$v_s = \left(\frac{\lambda_s (u_l W_{FSL} + u_h W_{FSH})}{c_s (u_l + u_h)^{\alpha}} \right)^{\frac{1}{1-\alpha}} \tag{32}$$

Besides the factors mentioned above, the supply of simple vacancies also depends on the composition of unemployment. At the moment the vacancy is opened, employers do not know whether they will meet a low or a high skilled worker. But they do know the aggregate composition of unemployment and therefore they can calculate the probability of meeting each of the worker types.

Now the rate of simple vacancies to simple job seekers θ_s can be derived from (27), (28) and (32) :

$$\theta_s = \left(\frac{\lambda_s (u_l W_{FSL} + u_h W_{FSH})}{c_s (u_l + u_h)} \right)^{\frac{1}{1-\alpha}} \tag{33}$$

$$= \left(\frac{y_s \lambda_s}{u_l + u_h} \left(\frac{u_l (1-\beta)(1-\upsilon)}{c_s (r + s_s)} + \frac{u_h (1-\beta)(\mu - \upsilon)}{c_s (r + s_s + p_{c)}} \right) \right)^{\frac{1}{1-\alpha}}$$

where:

$$p_c = \lambda_c (\theta_c)^{\alpha} \tag{34}$$

Again, θ_s depends on the composition of unemployment. When $\mu < \mu^*$, firms with simple vacancies prefer low skilled workers because high skilled workers do not produce enough to compensate the employers for their positive quit probability to a complex job (which forces employers to incur new search costs). When high skilled workers produce sufficiently more than low skilled workers on simple jobs ($\mu > \mu^*$), they not only create the standard negative congestion externality but also impose a positive search externality on low skilled workers (which can, as shown later, even dominate). This counter-intuitive result stems from the fact that the more high skilled workers search for simple jobs, the more attractive it is for employers to open up simple vacancies. This can be summarized in the following proposition.

Proposition 1 *When $\mu > \upsilon \wedge \mu < (>) \ \mu^*$, the ratio of simple vacancies to simple job searchers is decreasing (increasing) in the amount of high skilled* *job searchers, u_h, and in the fraction of unemployed workers who are high skilled, $u_h/(u_l + u_h)$.*

Proof. First note that when $\mu < \upsilon$, simple jobs occupied by high skilled workers are not profitable and the labor market will be completely segmented. The second part of the proposition follows simply from differentiating θ_s in equation (33) with respect to u_h and from the definition of μ^*.

The negative externality arises because the low skilled workers are punished exactly as much as the high skilled workers for the fact that high skilled workers have a quit probability, $p_c > 0$. The positive externality arises when the low skilled workers benefit from the larger supply of simple vacancies caused by the higher productivity of high skilled workers at simple jobs. The nature of the positive externality is similar to the one in Ortega's (2000) migration paper where foreign workers face higher search costs and therefore receive lower wages.[5] This stimulates vacancy supply and the native workers also benefit from that.

Also note that, when $d\theta_s/du_h > 0$, $dp_s/du_h = (\partial p_s/\partial\theta_s)(d\theta_s/du_h) = \alpha\lambda_s\theta_s^{\alpha-1}(d\theta_s/du_h) > 0$. Thus $\mu > \mu^*$ implies that the rate at which low skilled unemployed job seekers find simple vacancies increases when there are more unemployed high skilled workers. This result depends crucially on the CRS production technology. When there are decreasing returns at the macro level, low skilled workers will suffer more from job competition by high skilled workers.[6]

The relation between the probability of finding a job for a low skilled worker and the relative productivity of high skilled workers on simple jobs is depicted in Figure 2 which shows that the relationship between p_s and μ is discontinuous and non-monotonic. As long as $\mu < \upsilon$, W_{FSH} is negative. Employers only hire low skilled workers at simple jobs and p_s is independent of μ. When $\mu > \upsilon$, there is a regime switch and W_{FSH} becomes positive. High skilled workers are also hired for simple jobs and the labor market is no longer segregated. On the trajectory between υ and μ^*, the negative search externality of high skilled workers (caused by their positive quit probability) dominates. When μ exceeds μ^*, the positive externality dominates and the low skilled workers start to benefit from the higher productivity of high skilled workers.

[5] I thank one of the referees for pointing out this paper to me.

[6] Note however that CRS is necessary to generate a balanced growth path.

Finally, it is interesting to see from a welfare point of view what happens when high skilled workers do not search for simple jobs. Note from (30) and (32) that both v_s and v_c are increasing in u_h. When high skilled workers only search for complex jobs, fewer simple jobs are supplied (according to (32), v_s can be decreasing in (u_h/u_s) when $\mu < \mu^*$, it is however always increasing in u_h), overall production goes down and high skilled unemployment rises more than low skilled unemployment falls. Hence, the fact that high skilled workers (temporarily) occupy simple jobs is not inefficient as long as $\mu > \upsilon$, in the sense that total production and employment would be lower if they would only look for complex jobs. This result does partly depend on the assumption that the search intensity of high skilled workers is independent of their labour market state. In Pissarides (1994), steep wage-tenure profiles prevent high skilled workers at simple jobs from continuing search for complex jobs.

3.1 Steady state conditions

The model can be closed by writing down the 3 steady state equilibrium flow conditions for the different worker states which in turn determine the employment and unemployment rates. In the steady state, the inflow into each state has to be equal to the outflow.[7]

$$p_s u_h = (p_c + s_s) e_{sh} \tag{35}$$

$$p_s u_l = s_s e_{sl} \tag{36}$$

$$p_c(u_h + e_{sh}) = s_c e_c \tag{37}$$

In steady state equilibrium, the unemployment rate for low skilled workers is higher than the unemployment rate for high skilled workers. From (36) it follows that in the steady state: $e_{sl}/u_l = p_s/s_s$ and from (35) and (37) it follows that $(e_{sh} + e_c)/u_h = p_s/(p_c + s_s) + p_c(p_s + p_c + s_s)/s_c(p_c + s_s)$. The difference between low and high skilled employment rates is easy to calculate when $s_s = s_c$. In that case we get: $e_{sl}/u_l - (e_{sh} + e_c)/u_h = -p_c/s_s$. In the likely case that simple jobs are destroyed sooner, the difference in unemployment rates between high and low skilled workers will be larger. The intuition is simple. The rate at which unemployed high skilled workers meet simple vacancies is exactly the same as for low skilled workers (this

[7] Since all out of steady state differential equations are stable, it is easy to see that a steady state exists.

follows from the matching function) but they also meet a positive amount of complex vacancies (by assumption: $p_c > 0$ and $s_c < 1$). Therefore, they are more likely to be employed.

4 Why are unemployment rates for low skilled workers so much higher?

In this section, some simulations are carried out to mimic certain shocks which have been put forward in the literature to explain the relative decrease in the labor market position of low skilled workers in Europe and North America. Examples include skill biased technical change, an increase in the general level of education, an increase in the replacement ratio and an increase in the job destruction rate of simple jobs.

4.1 Baseline parameter values

The exogenous variables of the model are set at the following values.

$\alpha = 0.5$, $\beta = 0.5$, $\upsilon = 0.4$, $\frac{e_{sl}+u_l}{u_h+e_{sh}+e_c} = \frac{l}{h} = 0.5$, $y_c = 1$, $\psi = 0.5$,
$\mu = 1$, $r = 0.10$, $s_s = 0.18$, $s_c = 0.05$,

Unemployment and vacancies are assumed to have equal weights in the matching function (actual estimates of α lie between 0.4 and 0.7). β is set equal to α so that the Hosios-Pissarides efficiency condition is met and the particular search externalities of this paper can be analyzed isolated. The values of λ_s, λ_c, and the flow costs of keeping a vacancy open were chosen arbitrarily in a way that the unemployment rates for high and low skilled workers are in the same order of magnitude as in the typical OECD country of Table 1. The benefit level is set at 0.4 $y_{sl} = 0.2$. In the baseline projection, high skilled workers are assumed to be equally productive at simple jobs as low skilled workers ($\mu = 1$). This implies that high skilled workers earn the same wage at simple jobs as low skilled workers, which is in line with evidence of Gautier et al. (1998a) for the Netherlands. It also implies that high skilled workers impose a negative externality on low skilled workers. The interest rate on alternative investments is set at 0.10 per year while the outflow rates for simple and complex jobs are respectively set at 0.05 and 0.18 per year.

4.2 Simulations

The results of the simulations are presented in Table 2 . Examining the base case shows that the low skilled unemployment rate is 12.9% and the high skilled unemployment rate is 4.7% in equilibrium. Those values are in the same order of magnitude as the unemployment rates of the OECD countries in the end of the eighties, presented in Table 1. The aggregate equilibrium unemployment rate in the baseline case is 7.4% and 25% of the simple jobs are occupied by high skilled workers. The expected unemployment duration for a low skilled worker in the baseline projection is 0.83 years, while for a high skilled worker it is 0.71 years.[8] The wage dispersion that the model generates is also in the same order of magnitude as the wage dispersion in most OECD countries. It is approximated by $w_c/w_{sl} = 1.71$.[9]. It is of course more relevant to compare the asset values of the states of unemployment and employment. Those values can be derived straightforwardly from equations (5)-(9). It turns out that $rW_{UH}/rW_{UL} = 2.5$, which is larger than w_c/w_{sl}. The main reason is that the asset equation also captures expected unemployment duration over the whole career of the worker and high skilled workers experience fewer and shorter unemployment spells.

The critical value of μ^* is 1.18 in the base run. This means that when high skilled workers produce more than 1.18 times as much as low skilled workers on simple jobs, employers actually prefer high skilled workers at those simple jobs (their higher productivity outweighs their higher quit rate) and they open more simple vacancies when u_h/u_l increases. Finally, an allocation measure ($\frac{Y_{tot}}{Y_{\max}}$) is presented. It is calculated as the rate of actual output over the output that would have been generated in a frictionless world where all high skilled workers occupy a complex job and all low skilled workers occupy a simple job.

Next we turn to the simulations. In some cases, the results can also be derived analytically. In those cases I start with describing the relevant mechanisms before turning to the simulation outcomes.

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[8]Abbring et al. (1998) report that the expected probability to find a job within 6 months is 0.54 in the Netherlands and 0.69 in the US. while the probability to enter employment within one year is 0.72 in the Netherlands and 0.78 in the US.

[9]According to the OECD employment outlook (1990,1993,1998), it is quite close to the wage dispersion (measured as the ratio of the mean gross wage before taxes of workers with a university degree and workers with a lower secondary education) in Canada '95 (1.76), Denmark '95 (1.62), Germany '95 (1.79), the Netherlands '89 (1.57) and Spain '89 (1.76). But it is much less than in the US '92 (2.4).

4.2.1 The case where $\mu > \mu^*$

When the output of high skilled workers at simple jobs is sufficiently high, ($\mu = 1.25 > \mu^*$), low skilled workers benefit from high skilled workers looking for simple jobs. All else equal, the low skilled unemployment rate drops by 0.8 percentage points to 12.1%, the high skilled unemployment rate also falls slightly and more high skilled workers occupy simple jobs. In the Netherlands, it has been argued that the high unemployment rates for low skilled workers can be explained by the fact that high skilled workers take simple jobs. This is a counter example which shows that the fact that some high skilled workers occupy simple jobs is not sufficient to explain the relatively high unemployment rates for low skilled workers.

Since the expected rents of simple jobs increase, more vacancies will be opened, till the point where the expected rents of an additional vacancy are zero. The aggregate unemployment rate falls to 6.9% and both the expected low and high skilled unemployment duration decrease. Also note that part of the higher rents of simple jobs are appropriated by high skilled workers who receive a higher wage at simple jobs than their low skilled colleagues. Finally, we see that total output rises and a more efficient allocation is reached.

4.2.2 A general slow down of the economy,

Next, consider the case where output at complex jobs, (y_c), falls to 0.75 and where output at simple jobs remains a fixed fraction $\psi = 0.5$ of the output at complex jobs. This fall can be either thought of as a negative demand or a negative technology shock. In the new equilibrium, the expected rents of both job types will be lower, therefore the aggregate unemployment rate will increase. The low skilled workers are particularly harmed by this shock because they face increased competition from the high skilled workers and since $\mu < \mu^*$, simple vacancy supply will be decreasing in the fraction of high skilled unemployed job seekers. Moreover, wages will be lower for all workers and aggregate output falls as well. Since relatively more high skilled workers occupy simple jobs, a less efficient allocation is reached.

The responses of the key variables in this model seem to be consistent with what happened to some of the OECD countries in Table 1 which experienced a slow down in (or even negative) GDP growth. Canada and the UK experienced a fall in their GDP between 1989 and 1992.[10] At the same time

[10] To mimic the actual unemployment increase in those countries, we need a 50% reduc-

both the unemployment rate for high skilled workers and for low skilled workers rose but the low skilled unemployment rate rose much sharper. For the US, and Denmark which experienced only around 1% growth a year between 1989-92, a similar pattern arose. High skilled unemployment rose moderately and low skilled unemployment rose sharply.

4.2.3 Changes in the relative profitability of simple and complex jobs

When people talk about skill biased technical change, they usually think about a relative shift in the demand for skills. This is simulated by a fall in $\psi = \frac{ys}{yc}$ from 0.5 to 0.25, while fixing y_c at 1. It makes simple jobs both absolutely and relatively less attractive and also lowers the simple wage and the level of unemployment benefits (both are directly linked to the productivity at simple jobs). According to (32) , (33) and (34) v_s falls and p_s goes down as well. Accordingly, both e_{sl} and e_{sh} fall and u_l and u_h increase. The supply of v_c will not change however because the total amount of searchers for complex jobs does not change (there is just a substitution from employed to unemployed job seekers). This also follows from (31), which shows that θ_c does not change in response to changes in u_h and y_s. In the simulations we see that the low skilled unemployment rate rises enormously to 20.0% while the unemployment rate for high skilled workers rises moderately to 16.3%. A smaller fraction of the high skilled workers occupies simple jobs and total unemployment rises to 20.0%. Wage dispersion increases and since unemployment benefits are linked to output at simple jobs, the bargaining position for both high and low skilled workers weakens and as a consequence, the wage rate at both simple and complex jobs falls.

In the American literature, e.g. Bound and Johnson (1992), skill biased technical change has been mentioned as the major reason for the increased wage dispersion in the US. This could easily be simulated by letting ψ fall and y_c rise simultaneously. In that case, high skilled unemployment will however not move in the same direction as low skilled unemployment. Hence, viewing skill biased technical change as the process where both the profitability of complex jobs increases and the profitability of simple jobs falls does not seem to be consistent with the observation that low and high skilled unemployment move in the same direction.[11] Skill biased technical change is

tion in y_c. This would have resulted in $U_l = 16.2\%$, $U_h = 10.2\%$ and $U^{tot} = 10.4\%$.

[11] Van Ours and Ridder (1995) give time series evidence that low and high skilled un-

therefore probably not the whole story. Recent evidence does suggest that skill biased technical change took place in the last decades, see e.g., Berman et al. (1998), and Kahn and Lim.

4.2.4 An increase in the job destruction rate for simple jobs

There is abundant evidence that low skilled workers face a higher probability of loosing their job. Abbring et al. (1999), and Gautier et al. (1999) show for example that the displacement and layoff probabilities are higher for low skilled workers, both in the Netherlands and in the US. It is possible that the recent trend towards a more flexible production structure increased turbulence and shortened the simple job durations in particular. Simple jobs are particularly vulnerable to this process because those jobs typically require little sunk and firm specific investments. Caballero et al. (1995) show with firm level data that most employment adjustment costs are to a large extent fixed (firms either fully adjust their work force to their desired level or do not adjust at all).

Since complex jobs require more (fixed) training costs they are likely to survive longer. Mortensen and Pissarides (1995) argue that when firms face the choice to either destroy a job or adjust it against some fixed cost, simple jobs will be destroyed more often in response to technical shocks than complex jobs because the quasi rents are lower.

Could it be the case that the recent deterioration of the position of low skilled workers is caused by an increase in the job destruction rate of simple jobs? I simulate this possibility by an increase in the yearly exogenous job destruction rate for simple jobs (s_s) to 0.25. As expected, this reduces the asset value of a simple job and therefore the low skilled unemployment rate increases while the high skilled unemployment rate remains unchanged. The reason that the low skilled workers suffer more from this shock is that most simple jobs are occupied by low skilled workers. In the simulations, wage dispersion does not increase when the simple job destruction rate increases. Except for the UK and Canada, where wage dispersion did increase, the unemployment, output and wage patterns generated by this shock are consistent with what happened in the beginning of the 90's in many OECD countries.

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employment is strongly correlated (although low skilled unemployment fluctuates more strongly).

4.2.5 An increase in the replacement ratio

In this model, unemployment benefits are linked to simple job output and by the nature of the wage bargaining process, there also exists a direct link to wages earned at simple jobs. Wages at complex jobs also increase when unemployment benefits rise because it improves the outside option of workers. When the productivity at simple jobs increases, both wages and employment benefits increase as well. The simulations show that wages at complex jobs also increase because benefits are an argument in the disagreement payoffs of the high skilled workers. As a consequence, both high and low skilled unemployment (and unemployment duration) increase but low skilled unemployment increases much more. It is however important to keep in mind that this model is not very well suited to do welfare analysis with unemployment benefits because the agents in this model are risk neutral and an important motivation for the introduction of an unemployment system is risk aversion.

4.2.6 The effects of schooling

An important feature of the model is that the composition of jobs adjusts in the long run to the composition of workers. When a larger share of the labor force receives training and becomes high skilled it is easier for employers to find high skilled workers and they respond by opening more complex vacancies. In Acemoglu (1998), a related adjustment mechanism is presented. He argues that the increase in the fraction of high skilled workers has stimulated technology investments in the high skilled sector.

The most straightforward way to model the benefits of schooling is by increasing the fraction of skilled workers. The effects of schooling depend on the initial value of μ. In the first simulation $\mu = 1 < \mu^*$ while in the second simulation $\mu = 1.25 > \mu^*$.

When $\mu < \mu^*$, the unemployment rate for low skilled workers increases. The mechanism is the following. In the new equilibrium, u_h/u_l will be higher. Therefore, the simple vacancy suppliers face a smaller probability to find a low skilled worker (who they prefer when $\mu = 1 < \mu^*$). The supply of simple vacancies will therefore fall and although total unemployment falls, the low skilled unemployment rate will increase. This is consistent with the fact that in the last 20 years, both the average level of education and the low skilled unemployment rate increased (even though low skilled labor became scarcer). At the same time, it becomes much easier to find high skilled workers and therefore more complex vacancies are opened.

Because the efficiency parameter of the matching function for the complex sector is set at a lower level than for the simple sector, the unemployment rate for high skilled workers increases by 0.5 % points in the simulations. Total unemployment is however a weighted average of the low and high skilled unemployment rates. As a larger proportion of the unemployed is high skilled, the weight for this group increases and total unemployment falls. Also note that in the new equilibrium, a larger fraction of the simple jobs is occupied by high skilled workers.

When the productivity of a high skilled worker at a simple job is sufficiently high, the public benefits of schooling are more favorable according to the last row of Table 2. The main reason for this is that the expected benefits of opening a simple vacancy are increasing in u_h/u_l when $\mu > \mu^*$. As a result, both the unemployment rates for high and low skilled workers fall and more skilled workers occupy simple jobs than in the case where $\mu < \mu^*$. In addition, we see that total unemployment falls. Besides the trained workers, employers benefit from government subsidized general schooling since they extract part of the rents. The position of the other low skilled workers depends on the value of μ. When $\mu > \mu^*$ they are better of but when $\mu < \mu^*$ they are worse of. If firms would have the option to invest in general capital (train low skilled workers so that they become high skilled) they would only choose to do so if $\mu > \mu^*$. In the previous example where $\mu = 1.25$, the incentives for firms to do so are small. Only if the costs of training are lower than or equal to: $(W_{FSH} - W_{FSL}) = 0.005 = 0.008w_c$ it is beneficial for them to do so. The reason is of course well known in the literature. Firms are reluctant to invest in general capital because a large share of the rents will be appropriated by the worker, not only in the form of higher wages but also by a larger chance to find a better job.

5 Discussion

Many OECD countries experienced increasing unemployment rates in the beginning of the 90's. In turned out that the bulk of the burden of unemployment was carried by low skilled workers. During this period, some countries experienced an increase in wage dispersion while other countries experienced a decrease in wage dispersion. Those phenomena cannot be explained by a simple homogeneous worker/ homogeneous job story. This paper therefore discusses an equilibrium search model with both different worker and job types. In this model, the productivity of a high skilled worker on a simple job turns out to be a key variable. It is shown that, in general, low skilled workers benefit from an increased productivity of high skilled workers on simple jobs and that they suffer from a high quit rate of high skilled workers at simple jobs. How sensitive are those results for the specific assumptions which were made? One important assumption was that firms with simple vacancies cannot ex ante restrict the worker type with the lowest expected profit stream from searching. If firms could (partly) concentrate their search effort in certain segments, e.g. by advertising in newspapers which are mainly read by (un)skilled workers, the magnitude of the externalities of this model will be smaller but the signs remain the same. The second assumption that is crucial for the results is constant returns to scale. This assumption has the pleasant property that doubling the size of the labor force does not increase the unemployment rate which is consistent with the fact that large countries do not have systematically higher nor systematically lower unemployment rates than small countries. Still within certain industries or regions, production is likely to be characterized by decreasing returns. In that case, lower educated workers will for given productivity levels suffer more from competing high skilled workers.

6 References:

Abbring J.H. (1999), Commitment and wage bargaining in job matching models with costly search, discussion paper Tinbergen Institute Amsterdam.

Abbring J.H., G.J. Van den Berg, P.A. Gautier, G Van Lomwel, J.C. Van Ours and C. Ruhm (2000), Displaced workers in the United States and the Netherlands, in P. Kuhn, editor, *Losing Work, Moving on: Worker Displacement in International Perspective*, W. E. Upjohn Institute for Employment Research, Kalamazoo, MI Forthcoming.

Acemoglu D. (1998), Why do new technologies complement skills? Directed technical change and wage inequality, *Quarterly Journal of Economics* 113 (4) 1055-1089.

ALBRECHT J. AND S. VROMAN (2000), A matching model with endogenous skill requirements, mimeo, Georgetown University, Washington, DC 20057.

BERMAN E., J. BOUND, S. MACHIN (1998), Implications of skill-biased technological change: international evidence, *Quarterly Journal of Economics*, 113 (4), 1245-1279.

BINMORE K.G., A. RUBINSTEIN AND A. WOLINSKY (1986), The Nash Bargaining solution in economic modelling, *Rand Journal of Economics*, 17, 176-188.

BOUND, J. AND G. JOHNSON (1992), Changes in the structure of wages in the 1980's: an evaluation of alternative explanations, *American Economic Review*, 82, 371-92.

CABALLERO R.J., E.M.R.A. ENGEL AND J. HALTIWANGER (1995), Aggregate employment dynamics: building from microeconomic evidence, *NBER Working Paper* No. 5042.

DIAMOND P.A. (1982), Wage determination and efficiency in search equilibrium, *Review of Economic Studies*, 49, pp.217-227.

GAUTIER P.A., G.J.VAN DEN BERG, J.C. VAN OURS AND G. RIDDER (1998), Worker turnover at the firm level and crowding out of lower educated workers, Mimeo Free University Amsterdam.

GAUTIER P.A., G.J.VAN DEN BERG, J.C. VAN OURS AND G. RIDDER (1999), Separations at the firm level, forthcoming in J. Haltiwanger, J. Lane, J. Theeuwes and K. Troske ed. "The Creation and Analysis of Matched Employer-Employee Data". North Holland.

HOSIOS, A.J. (1985), Unemployment and Recruitment with Heterogeneous Labor, *Journal of Labor Economics* 3 : 175-87.

HOSIOS, A.J. (1990), On the Efficiency of Matching and Related Models of Search and Unemployment, *Review of Economic Studies 57,* 279-298.

KAHN J.A. AND J. LIM (1998), Skilled labor-augmenting technical progress in U.S. manufacturing, *Quarterly Journal of Economics* 113, 1281-1308.

KREMER M. (1993), The O-Ring theory of economic development, *Quarterly Journal of Economics*, CVIII, 551-576.

MORTENSEN D. AND C.A. PISSARIDES (1994) Job Creation and Destruction in the Theory of Unemployment, *Review of Economic Studies*, 61, 397-415

MORTENSEN D. AND C.A. PISSARIDES (1995) Technological Progress, Job Creation and Job Destruction, *CEPR discussion paper* no. 264.

OECD (1990) *Employment Outlook*, Paris.

OECD (1993) *Employment Outlook*, Paris.

OECD (1998) *Employment Outlook*, Paris.

OECD (1998) *Education at a glance*, Paris.

ORTEGA J. (2000) Pareto-improving immigration in an economy with equilibrium unemployment, *Economic Journal*, 110, 92-112

OURS J.C. VAN AND G. RIDDER (1995) Job matching and job competition: Are lower educated workers at the back of job queues?, *European Economic Review*, 39, 1717-31.

PISSARIDES C.A. (1990) *Equilibrium Unemployment Theory*, Basil Blackwell, Londen.

PISSARIDES C.A. (1994) Search Unemployment with on the job search, *Review of Economic Studies*, 61, 457-475.

SAINT PAUL G. (1996) *Dual labor markets: A macroeconomic perspective* MIT Press.

SATTINGER M. (1995) Search and the efficient assignment of workers to jobs, *International Economic Review*, 36, 283-302.

SHIMER R. AND L. SMITH (2000) Assortative matching and search, *Econometrica*, 68, 343-370.

TEULINGS C.N. AND P.A. GAUTIER (2000) The right for the job, TI working paper 38/3.

WOLINSKY A. (1987), "Matching, search, and bargaining", *Journal of Economic Theory*, 42, 311-333.

7 Appendix

A Data and definitions

The data are based on the OECD "education at a glance" publications 1992-97 and on the OECD employment outlook. The OECD figures were derived from national labor force surveys. The unemployed are defined in accordance with the ILO guidelines on labor statistics as persons who are without work, actively seeking employment and currently available to start work. The total unemployment rate is defined as the number of unemployed as percentage of the total labor force. Persons aged under 25 have been excluded from the statistics.

The relative earnings from employment are defined as the mean earnings of persons at a given level of educational attainment divided by the mean earnings of persons with upper secondary school attainment. The ratio is multiplied by 100. The earnings data are based on annual earnings (except for Spain where monthly earnings were used) before taxes. Persons who work less than 15 hours a week were excluded. The observed differences in relative earnings across countries do not only reflect differences in hourly wage rates but also differences in coverage, number of hours worked per year.

B Figures

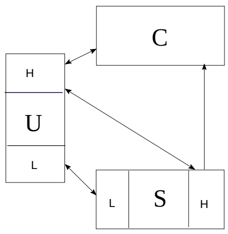

Figure 1: Labor market flows

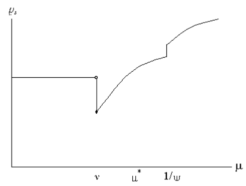

Figure 2: Employment probabilities of low skilled workers and the relative productivity of high skilled workers at simple jobs.

C Tables

Table 1: Unemployment and wages in OECD countries

	yr	Unempl. by educ.				Wage disp.		GDP.	
		Low	High	Univ	Tot	Low	Univ	$	% change
Cananda	89	10.3	5.0	2.2	6.7	92	175	569	
	92	20.9	10.3	6.5	11.9	66	164	562	-1.2
	95	13.0	7.5	4.6	8.3	87	156	615	9.3
US	89	8.5	3.3	2.2	4.4	64	190	5412	
	92	17.9	5.7	3.0	8.2	66	170	5600	3.5
	95	10.0	3.6	2.5	4.7	68	174	6150	9.8
Denmark	89	12.1	4.0	3.4	8.3	85	145	127	
	92	23.0	7.2	7.8	13.6	86	146	131	3.7
	95	14.6	5.3	4.3	10.0	83	133	143	8.7
France	89	11.8	3.4	3.0	8.1	...	...	1168	
	92	18.0	5.6	6.8	11.3	87	174	1221	4.6
	95	14.0	5.9	7.5	9.7	80	175	1263	3.4
Germany	89	13.8	3.9	2.6	13.9	...	...	1536	
	92	10.2	4.6	4.3	6.1	88	170	1724	12.2
	95	13.3	5.2	4.7	8.1	88	158	1787	3.7
Netherlands	89	13.6	4.6	5.0	6.5	86	178	275	
	92	8.8	4.9	5.2	5.8	84	132	296	7.8
	95	7.7	4.1	4.1	5.6	85	153	312	5.4
Spain	89	15.6	11.3	10.7	12.9	...	..	453	
	92	23.7	16.7	17.5	21.1	78	138	507	11.8
	95	20.6	16.6	13.8	19.0	...	...	562	3.9
UK	89	10.0	2.7	2.4	6.4	84	163	974	
	92	21.2	3.8	3.8	10.2	80	171	951	-2.3
	95	12.2	4.1	3.5	7.4	73	153	1034	8.0

Note: Source OECD, education at a glance and employment outlook. Lower education refers to less than secondary, higher education refers to higher non-university degrees. The cells on higher education for the Netherlands are based on CBS (EBB) figures Wage earnings are relative to earnings at the upper secondary level (=100). GDP is measured in billion US dollars deflated by 1990 prices.

Table 2: The effects of job competition - numerical simulations

		U_l^{rate}	U_h^{rate}	U^{tot}	$\frac{e_{sh}}{S}$	U_l^{dur}	U_h^{dur}	w_{sl}	w_{sh}	w_c	μ^*	$\frac{Y_{tot}}{Y_{\max}}$
	Base case	12.9	4.7	7.4	24.7	0.83	0.71	0.35	0.35	0.60	1.18	0.88
1	$\mu = 1.25$	12.1	4.4	6.9	25.1	0.76	0.65	0.35	0.41	0.60	1.18	0.89
2	$y_c = 0.75$	14.2	5.7	8.6	29.3	0.93	0.81	0.26	0.26	0.45	1.06	0.86
3	$\frac{y_{sl}}{yc} = 0.25$	20.0	6.3	10.8	21.3	1.37	1.03	0.18	0.18	0.55	1.24	0.85
4	$s_s = 0.25$	15.2	4.9	8.3	25.1	0.76	0.65	0.35	0.35	0.60	1.02	0.87
5	$\upsilon = 0.6$	18.1	5.8	9.2	29.3	1.04	0.87	0.40	0.40	0.65	1.08	0.84
6	$\frac{l}{h} = 0.25$	15.0	5.2	7.2	39.3	1.00	0.82	0.35	0.35	0.60	1.18	0.88
	$\mu = 1.25$	13.7	4.8	6.5	39.3	0.86	0.73	0.35	0.41	0.60	1.18	0.89