# Discrimination and Employment Protection[1]

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**Abstract**

We study a search model with firing cost. We show that there exists an equilibrium with discriminatory hiring standards of worker only differing in an observable characteristic determining their type. Even though the firm can observe the workers' expected productivity at the hiring stage, it still may condition its hiring standard on group belonging, due to feedback effects of other firm' hiring standards. The model predicts higher unemployment rates, stricter hiring standards, longer tenure for discriminated workers and a positive relation between employment protection and relative unemployment rates for discriminated workers.

**Key words**: Discrimination, Employment Protection, Hiring Standards

**JEL codes**: J70, J60

# 1 Introduction

Can discrimination of a group of workers persist if there are profit maximizing employers with no "taste for discrimination"? In Becker's model, employers with prejudices push the wage down for one group of workers, and other employers without prejudices benefit from hiring this group at a lower wage. In the long run, entry of employers without prejudices increases the demand for the disadvantaged group, and the wage gap disappears.

We offer a novel argument for discriminatory outcomes of equally productive groups of workers. The argument builds on three key assumptions. First, there is uncertainty at the time of hiring about the productivity of a match which may be low due to job-specific productivity shocks, or due to whether the worker satisfies the job requirements. Second, laying off the workers is costly to the firm. The most important example of such costs are legal restrictions, in the form of Employment Protection Legislation which in many countries severely restrict the firms' possibility to lay off workers. Third, employer and employee share the benefits from the match being of high productivity. In the model, this is captured by letting the wage be increasing in the output of the job.

Worker turnover is commonly perceived as a cost to the firm. While this is of course true in case of a high productivity match, it need not hold in case of a low productivity match. The cost for the firm depends on the cost of firing the worker and the likelihood that the worker leaves voluntarily. Consider an economy with two types of workers, Green and Red. Assume that firms hire Red workers only if their observable match-specific quality is considerably higher than that of Green workers. Irrespective of which type of worker is hired, the match may turn out to be of low productivity. In this situation a Green worker is more likely to find a better (higher paid) job elsewhere and quits to the benefit of both, the worker and the firm. However, a Red worker in a low productivity match is less likely to find a new job, as firms are less inclined to hire Red workers. Consequently, the risk is higher that a Red worker in a low productivity match stays long with the firm. This makes it less attractive to hire Reds in the first place, consistent with our initial assumption.

In our main wage-bargaining specification, outside options only serve as constraints. As a consequence, wages for Green and Red workers are identical for a given productivity, and profits are always increasing in the job-finding rate. When outside options are the threat points in the bargaining a higher job-finding rate implies higher outside options, and hence higher wages given productivity. Discriminatory hiring-standards then exists if the direct positive effect, on profits, of a higher quitting rate in case of a low productivity match is larger than the negative effect of higher wages. In numerical simulations we find that high unemployment benefits and high minimum wages make the existence of discriminatory equilibria more likely.

In addition to offering an novel theoretical argument for equilibrium discrimination, our model provides several predictions: Discriminated workers are more likely to be unemployed, face more demanding hiring standards, and have longer tenure. At the aggregate level, the model implies a positive relation between employment protection and the relative unemployment rate of discriminated workers.

Various papers have derived equilibrium discrimination with ex-ante identical groups in the absence of preferences for discrimination using different approaches. One strand of this literature is based on investment in human capital. The idea is that discrimination against one group of workers reduces their incentive to invest in human capital. This in turn makes the employers' initial perception of productive differences self-fulfilling. (See e.g., Arrow, 1973; Lundberg and Startz, 1983; Coate and Loury, 1993; Mailath, Samuelson and Shaked, 2000). Another approach puts forward the idea that interviewers (mentors) find it easier to assess (to mentor) workers from their own group. (Cornell and Welch; 1996, Athey, Avery and Zemsky; 2000). As in this paper, Rosén (1997) and Masters (2006) derive within a search framework equilibrium discrimination as the result of the interaction between the firms' hiring policies. In contrast to Rosén (1997) and Masters (2006), our paper assumes symmetric information, and the combination of on-the-job search and firing costs is the source of discriminatory outcome.[1]

There is a large number of papers that analyse the effects of employment pro-

[1] Lang et al. (2005) show within an urn-ball model that wages and utility of the discriminated group are substantially lower with an arbitrary small taste for discrimination. Other papers that considers search and taste-based discrimination include Black (1995), Bulows and Eckstein (2002) and Rosén (2003).

tection on economic variables, such as unemployment, wages, employment fluctuations and investments in human capital (e.g., Addison and Teixeira, 2003; Bentolila and Bertola, 1990; Garibaldi and Violante, 2005; Hopenhayn and Rogerson, 1993, Saint-Paul; 1996). This literature does, however, not examine the possible interactions between firing costs and labour market discrimination.

Our model is related to Mortensen and Pissarides (1994) who also consider a sequential search model where the productivity of a specific match is uncertain. Since we do not focus on the dynamics we simplify the Mortensen-Pissarides model by assuming that the productivity is uncertain at the hiring stage but constant over the lifetime of the match. (Technically, the idiosyncratic shock takes place only once and immediately after the hiring.) Our model also shares features with Saint-Paul (1995), notably the existence of multiple equilibria and a positive relationship between firms' profit and the likelihood that the worker leaves in case of a bad match.

The paper is organized as follows: The model is presented in section 2. The discriminatory equilibrium outcome is analyzed in section 3. Section 4 considers alternative modelling assumptions and empirical implications. Section 5 concludes.

# 2 The model

We consider a sequential search model of the Diamond-Mortensen-Pissarides type with wages set by bargain or a minimum wage[2]. There are two types of workers in the economy, $n_G$ Greens and $n_R$ Reds, where $n_G + n_R = 1$. Workers are ex-ante equally productive, and there is no other difference between the types, than some observable characteristic that determines the type, e.g. the color of the skin. However, we will show that there exist equilibria with discrimination, i.e. that one type receives better treatment than the other. The discrimination equilibrium outcome may obtain if there exists restrictions on the firms' possibility to lay off workers, in particular legal restrictions in the form of Employment Protection Legislation EPL.

There are three key assumptions in the paper. First, we assume that there

[2] Diamond (1982), Mortensen (1982), and Pissarides (1985).

is uncertainty about the match-specific productivity. When an employer decides whether to hire a specific applicant, the employer clearly has a lot information about him or her, making it possible to assess the likelihood that the applicant will do a good job. However, it is impossible to foresee perfectly how the employee will perform in the job. There is considerable uncertainty as to both how well the employee fits in with the job requirements, and to how she/he fits in with the colleagues. Furthermore, the productivity of the match may also change over time. For example, the job requirements may change, implying that a previously well qualified worker becomes less productive.

Specifically, we assume that when a firm has hired a worker, a random draw determines whether the match is of high or low productivity, with output $y^H > y^L > 0$, respectively. Let $\gamma$ be the probability that the match is of high productivity. One interpretation of $\gamma$ is that a match is of high productivity iff the job stays productive and the worker fits into the job. Then $\gamma$ is the product of the probability that the worker fits in and the job stays productive. The parameter $\gamma$ is i.i.d. over matches and to keep the model transparent, may take only two values: $\overline{\gamma}$ with probability $\eta$ and $\underline{\gamma}$ with probability $1 - \eta$. Denote the mean of $\gamma$ by $\gamma^M$. We assume that $\gamma$ is observable to the firm at the time when the hiring decision is taken. If $\gamma$ is sufficiently low, the firm may choose not to hire the worker.

Second, we assume that it is costly for firms to lay off a worker who wants to remain in the job. In many countries, such costs come in the form of Employment Protection Legislation EPL. For illustrative purposes, we consider the extreme case where it is impossible to lay off a worker who does not want to leave voluntarily.

Third, we assume that the employer and the employee share the benefits from the match being of high productivity. In the model, this is captured by the assumption that the wage is increasing in the output in the job. Outside our specific model, the employee could also benefit from a better match if this increases the probability of a promotion. One implication of this assumption is that workers in a low productivity match will search for a new job, while workers in a high productivity match have nothing to gain from searching, and thus will not search. Firms want to get rid of workers who are in a low productivity match. However, we as noted above we assume that the EPL is sufficiently strict that the firm cannot lay off the worker involuntarily.

Workers leave the market at an exogenous rate $s$, and new workers enter as unemployed at the same rate. All unemployed workers and workers in bad matches search for jobs, with the same exogenous intensity. The matching between vacancies and workers is random and described by a Cobb-Douglas matching function

$$X = A(u + \varepsilon(1-u))^{\lambda} v^{1-\lambda}, \qquad 0 < \lambda < 1, \tag{1}$$

where $X$ is the number of matches taking place as a function of the vacancy rate $v$ and the rate of job applicants $u + \varepsilon(1-u)$, where $u$ is the unemployment rate and $\varepsilon$ is the fraction of employed workers who are in bad matches and thus search. The parameter $A$ indicates the efficiency or speed of the matching process. The rate at which a vacancy is matched to a job seeker is $q = X/v$, labour market tightness is $\theta = v/(u + \varepsilon(1-u))$ (the ratio of vacancies to job-seekers) and the rate at which a job-seeker is matched to a vacancy is $\phi = \theta q$.

There is free entry of jobs in the market, and firms may open a vacancy by incurring a cost $K > 0$. These costs could e.g. be thought of as investment in relevant physical capital, and are once-for all costs. The flow cost of maintaining a vacancy is $c$.

## 2.1 Asset Values

Unemployed workers have a flow payoff $z$ when unemployed. The asset value of an unemployed worker of type $i$, $i = G, R.$:

$$(r + s)U_i = z + \phi p_i(EW_i - U_i),$$

where $r$ is discount rate, $p_i$ is the probability that the worker is hired given a match, and $W_i$ the asset value of worker of type $i$ at the point of hiring, before observing whether the match is of high or low productivity, but after observing $\gamma$. $W_i(\gamma)$ is given by

$$W_i(\gamma) = \gamma W_i^H + (1-\gamma)W_i^L. \tag{2}$$

After observing the productivity of the match, the asset values of an employed worker of type $i$ with high and low productivity respectively are

$$(r+s)W_i^H = w^H, \tag{3}$$

$$(r+s)W_i^L = w^L + \phi p_i(EW_i - W_i^L). \tag{4}$$

Workers in a match of high productivity do not search, while workers in a low productivity match continue to search, and are matched to a new job at the rate $\phi$. Due to Employment Protection Legislation EPL, the firm is not allowed, or find it too costly, to lay off the worker even if the match is of low productivity. Rewriting (4) gives

$$W_i^L = \frac{w^L + \phi p_i EW_i}{r+s+\phi p_i}. \tag{5}$$

A firms hire a worker from group $i$ if and only if the probability that the match is of high productivity is greater than or equal to $\gamma_i^C$. Inserting (3) and (5) into (2), taking expectations and solving for $EW_i$ gives us the expected value of the worker of being hired by the firm, given the hiring strategy $\gamma_i^C$

$$EW_i = \frac{E(\gamma \left| \gamma \geq \gamma_i^C \right.) \frac{w^H(r+s+\phi p_i)}{r+s} + (1 - E(\gamma \left| \gamma \geq \gamma_i^C \right.))w^L}{r+s+E(\gamma \left| \gamma \geq \gamma_i^C \right.)\, \phi p_i}.$$

For a firm using the cutoff value $\gamma_i^C$, the expected value from hiring a worker of type $i$, before the value of $\gamma$ is realized, is

$$\widetilde{J}_i = E(\gamma \left| \gamma \geq \gamma_i^C \right.)\, J_i^H + (1 - E(\gamma \left| \gamma \geq \gamma_i^C \right.))J_i^L. \tag{6}$$

The asset values of a job with a worker of type $i$, depending on whether the match is of high or low productivity, are

$$rJ_i^H = y^H - w_i^H + s(V - J_i^H),$$

or

$$J_i^H = \frac{y^H - w_i^H + sV}{r+s}. \tag{7}$$

$$rJ_i^L = y^L - w^L + (\phi p_i + s)(V - J_i^L),$$

or

$$J_i^L = \frac{y^L - w^L + (\phi p_i + s)V}{r + s + \phi p_i}. \tag{8}$$

Inserting (7) and (8) into (6), gives us

$$\widetilde{J}_i = \frac{E(\gamma \,|\, \gamma \geq \gamma_i^C)}{r+s}(y^H - w_i^H + sV) + \frac{(1 - E(\gamma \,|\, \gamma \geq \gamma_i^C))}{r + s + \phi p_i}\left(y^L - w^L + (\phi p_i + s)V\right). \tag{9}$$

The expected value to the firm of hiring a worker from group $i$, where the probability of being high productive is $\gamma$ and the probability that another firm will hire the worker if he or she continues to search is $p_i$, is

$$J_i(\gamma, p_i) = \frac{\gamma}{r+s}(y^H - w_i^H + sV) + \frac{(1-\gamma)}{r + s + \phi p_i}\left(y^L - w^L + (\phi p + s)V\right). \tag{10}$$

The asset value of a vacancy is

$$rV = -c + q\left(\alpha_G p_G(\widetilde{J}_G - V) + \alpha_R p_R(\widetilde{J}_R - V)\right), \tag{11}$$

where $\alpha_i$ is the ratio of job seekers of type $i$ out of all job seekers, and $\widetilde{J}_i$ is the expected value to the firm of a job that is filled with a worker of type $i$. Rewriting (11) gives

$$V = \frac{-c + q\left(\alpha_G p_G \widetilde{J}_G + \alpha_R p_R \widetilde{J}_R\right)}{r + q\left(\alpha_G p_G + \alpha_R p_R\right)}. \tag{12}$$

To ensure that firms want to get rid of workers in a low productivity match, we assume that

$$y^L - w^L < rK. \tag{13}$$

As we assume that the EPL is sufficiently strict to prevent any involuntary layoffs, the outside options are not the relevant threat points in a dispute over the wage. We assume that during a dispute in the wage negotiations, no production takes place while the firm does not pay any wages to the worker, implying that the threat points of both players are zero. Allowing for continuous renegotiation of the wage, and letting $\beta \in (0,1)$ denote the bargaining power of the worker, the wage in a match with high productivity is the same for both worker types, given by

$$w^H = \beta y^H. \tag{14}$$

The wage in a match with low productivity is equal to the minimum wage $w^L$. The crucial assumption here is that if the match has low productivity, the firm is prevented from reducing the wage down to a value that makes the match profitable for the firm. Clearly, if the firm has this option of reducing the wage, EPL would not bite. We take $w^L$ as exogenous; it could be given by some national law or from a collective agreement imposing a minimum wage.

## 2.2 Steady state conditions

Let $\varepsilon_i$ denote the share of employed workers of type $i$ in jobs with low match quality. For both types $i$, the outflow from jobs with bad matches must equal the inflow to jobs with bad matches

$$n_i \varepsilon_i (s + p_i \phi)(1 - u_i) = vqp_i(1 - E(\gamma \,|\gamma \geq \gamma_i^c))\alpha_i. \tag{15}$$

Similarly, the outflow from good matches equals inflow to good matches

$$n_i(1 - \varepsilon_i)s(1 - u_i) = vqp_i E(\gamma \,|\gamma \geq \gamma_i^c)\, \alpha_i.$$

Using the above two equations gives us

$$E(\gamma \,|\gamma \geq \gamma_i^c)\, \varepsilon_i (s + p_i \phi) = s(1 - E(\gamma \,|\gamma \geq \gamma_i^c))(1 - \varepsilon_i),$$

or

$$\varepsilon_i = \frac{s(1 - E(\gamma\,|\gamma \geq \gamma_i^c))}{s + E(\gamma\,|\gamma \geq \gamma_i^c)\; p_i\phi}. \tag{16}$$

As the outflow from unemployment equals inflow to unemployment, we must have

$$n_i u_i(p_i\phi + s) = sn_i.$$

Solving for the rate of unemployment

$$u_i = \frac{s}{p_i\phi + s}. \tag{17}$$

The job seekers consist of the unemployed as well as the employed in bad matches. The fraction of all job seekers that are of type $i$, $\alpha_i$, is defined by

$$\alpha_i = \frac{n_i(u_i + (1 - u_i)\varepsilon_i)}{n_G(u_G + (1 - u_G)\varepsilon_G) + n_R(u_R + (1 - u_R)\varepsilon_R)}. \tag{18}$$

while labour market tightness is given by

$$\theta = \frac{v}{n_G(u_G + (1 - u_G)\varepsilon_G) + n_R(u_R + (1 - u_R)\varepsilon_R)}. \tag{19}$$

## 2.3 Equilibrium

We consider an equilibrium where all firms use the same strategies; below, we will show that this is indeed the case.

**Definition 1** Equilibrium is defied by

1. Free entry

$$V = K.$$

With $V$ given by (12).

2. Firms hire a worker of type $i$ iff it is profitable.

$$J_i(\gamma, p_i) \geqq V \text{ for } \gamma \geqq \gamma_i^C \qquad J_i(\gamma, p_i) < V \text{ for } \gamma < \gamma_i^C$$

with $J_i(\gamma, p_i)$ given by (10), where $p_i = 1$ if $\gamma_i^C = \underline{\gamma}$ and $p_i = \eta$ if $\gamma_i^C = \overline{\gamma}$.

3. Workers' choice of whether to search on the job or not is maximizing their utility. In our setting this implies that workers search iff $y = y^L$.

4. Workers only accept a job if this is optimal. This is satisfied as workers always gain from employment and thus accept all job offer.

5. The steady state conditions, (15), (16), (17), (18) and (19), are all fulfilled.

# 3 Discriminatory equilibrium

In this section we establish existence of a discriminatory equilibrium, where all Greens are hired, but where Reds are hired only if $\gamma = \overline{\gamma}$. Formally, all firms use the same cutoff strategies where $\gamma_G^C = \underline{\gamma}$, while $\gamma_R^C = \overline{\gamma}$. We show that there exists parameter values such that this discriminatory equilibrium exists. Subsequently all asset values are expressed given these hiring rules.

A discriminatory equilibrium implies that it is not profitable to hire a Red with $\gamma = \underline{\gamma}$, given that other firms only hire Reds if $\gamma = \overline{\gamma}$, implying that $p_R = \eta$. This requires that the expected profits for the firm of hiring such a worker is less or equal $V$, i.e.

$$J(\underline{\gamma}, \eta) < V.$$

Given the wage setting equation (14), the expected profits from hiring a worker only depends on the probability that the match has high output,$\gamma$, and the probability that the worker of this type is hired when being matched with another firm. Thus, we may omit the subscript indicating worker type Using (10),

$$J(\underline{\gamma}, \eta) = \frac{\underline{\gamma}}{r+s}((1-\beta)y^H + sV) + \frac{(1-\underline{\gamma})}{(r+s+\phi\eta)}\left(y^L - w^L + (\phi\eta + s)V\right) < V. \quad (20)$$

In addition, the existence of a discriminatory equilibrium requires that it is profitable to hire a Green with $\gamma = \underline{\gamma}$, given that all other firms always hire Greens, implying that $p_G = 1$.

$$J(\underline{\gamma}, 1) > V.$$

Using (10),

$$J(\underline{\gamma},1)=\frac{\underline{\gamma}}{r+s}((1-\beta)y^H+sV)+\frac{(1-\underline{\gamma})}{r+s+\phi}\left(y^L-w^L+(\phi+s)V\right)>V. \quad (21)$$

Define the value of a vacancy, given $\gamma_G=\underline{\gamma}$ and $\gamma_R=\overline{\gamma}$ in all firms as a function of $\theta$; $V(\theta)=V(\theta,\gamma_G=\underline{\gamma},\gamma_R=\overline{\gamma})$. To prove the existence of discriminatory equilibria we make two assumptions:

**Assumption 1:** $V(\theta)>0$ for $\theta=0$.

Assumption 1 says that the value of vacancy is positive when $\theta=0$ with the given hiring rules $\gamma_G=\underline{\gamma}$ and $\gamma_R=\overline{\gamma}$. Note that the hiring rules do however not need to be optimal at $\theta=0$. It is only required that $V(0)>0$, with the given hiring rule.

**Lemma 1** *Assumption 1 is satisfied if*

$$n_G(\gamma^M(1-\beta)y^H+(1-\gamma^M)(y^L-w^L))+n_R\eta(\overline{\gamma}(1-\beta)y^H+(1-\overline{\gamma})(y^L-w^L))>0. \quad (22)$$

**P roof.** See Appendix 1. ■

Also note that for any $\underline{\gamma}\geq 0$ there exist values of $y^H$ such that (22) is satisfied.

Since the value of a vacancy $V$ is increasing in $\phi$, $V$ may be increasing in $\theta$ over some intervals. However there always exists an interval $\left[\theta^0,\theta^1\right]$ where $V$ is decreasing in $\theta$ and $V<0$ for $\theta>\theta^1$.

**Lemma 2** *There exists values $\theta^0$ and $\theta^1$ such that $\frac{dV}{d\theta}<0$ for $\theta\in\left(\theta^0,\theta^1\right]$, $\frac{dV}{d\theta}\leq 0$ for $\theta=\theta^0, V(\theta^1)=0$ and $V(\theta)<0$ for $\theta>\theta^1$.*

**P roof.** $V$ is continuous in $\theta$, $V(0)>0$, and $\lim\limits_{\theta\to\infty}V=-c/r$. Hence, there exists values $\widehat{\theta}^0$ and $\theta^1$ such that $\frac{dV}{d\theta}<0$ for $\theta\in\left(\widehat{\theta}^0,\theta^1\right]$, $\frac{dV}{d\theta}\leq 0$ for $\theta=\widehat{\theta}^0, V(\theta^1)=0$ and $V(\theta)<0$ for $\theta>\theta^1$. Define $\theta^0$ to be the smallest non-negative value of $\widehat{\theta}^0$. ■

As part of the existence proof we want to show that there exist values $\overline{\theta}$ and $\underline{\theta}$, such that when $\underline{\theta}\leq\theta<\overline{\theta}$ it is profitable to hire Green workers, i.e. $J(\underline{\gamma},p=$

$1) - V \geq 0$ and at the same time not profitable to hire Red, i.e. $J(\underline{\gamma}, p = \eta) - V < 0$. As a first step we show that the profitability of a hiring a worker is increasing in $\theta$, and $\underline{\gamma}$ on the interval where $V$ is decreasing in $\theta$.

Using (10) we can define $J(\underline{\gamma}, p)$ as a function of $\theta$; $\hat{J}(\theta, \underline{\gamma}, p)$, where

$$\hat{J}(\theta, \underline{\gamma}, p) = \frac{\underline{\gamma}}{r+s}(y^H - w_i^H + sV(\theta)) + \frac{(1-\underline{\gamma})}{r+s+\phi(\theta)p}\left(y^L - w^L + (\phi(\theta)p + s)V(\theta)\right). \tag{23}$$

Denote $\hat{J}(\theta, \underline{\gamma}, 1)$ by $\hat{J}_G(\theta, \underline{\gamma})$ and denote $\hat{J}(\theta, \underline{\gamma}, \eta)$ by $\hat{J}_R(\theta, \underline{\gamma})$. Using (12) and (9) we can similarly define $V$ as a function of $\theta$ and $\underline{\gamma}$; $\hat{V}(\theta, \underline{\gamma})$. The expression for $\hat{V}(\theta, \underline{\gamma})$ is given in the proof of the next Lemma.

**Lemma 3** *a)* $\hat{J}_i(\theta, \underline{\gamma}) - \hat{V}(\theta, \underline{\gamma})$ *is strictly increasing in* $\theta$ *on* $\left[\theta^0, \theta^1\right]$, $\quad i = G, R$.

*b)* $\hat{J}_i(\theta, \underline{\gamma}) - \hat{V}(\theta, \underline{\gamma})$ *is strictly increasing in* $\underline{\gamma}$ *on* $\left[\theta^0, \theta^1\right]$, $\quad i = G, R$.

**P roof.** See Appendix 2 ■

A prerequisite for an equilibrium with the proposed hiring strategies is that the probability of low productivity, $\underline{\gamma}$, takes intermediate values. For sufficiently high values of $\underline{\gamma}$ both types will be hired for $\gamma = \underline{\gamma}$ as it will be profitable to hire Red workers with $\gamma = \underline{\gamma}$ even when $p_R = \eta$. For sufficiently low level $\underline{\gamma}$ neither Green nor Reed are hired when $\gamma = \underline{\gamma}$ as it will not be profitable to hire a Green worker with $\gamma = \underline{\gamma}$ even if $p_G = 1$. Thus, $\underline{\gamma}$ has to take intermediate values to make it profitable to hire Green but not Red.

**Assumption 2:** $\underline{\gamma} \in \left[\underline{\gamma}^0, \underline{\gamma}^1\right]$.

The bounds $\underline{\gamma}^0$ and $\underline{\gamma}^1$ are defined in the Lemma below.

**Lemma 4** *a)There exist a unique* $\underline{\gamma}^0$*, for which* $\hat{J}_G(\theta^1, \underline{\gamma}^0) - \hat{V}(\theta^1, \underline{\gamma}^0) = 0$ *and a unique* $\underline{\gamma}^1$ *for which* $\hat{J}_G(\theta^0, \underline{\gamma}^1) - \hat{V}(\theta^0, \underline{\gamma}^1) = 0$ *where* $0 < \underline{\gamma}^0 < \underline{\gamma}^1 < 1$.

**P roof.** Define $f_i(\theta, \underline{\gamma}) = \hat{J}_i(\theta, \underline{\gamma}) - \hat{V}(\theta, \underline{\gamma})$, $i = G, R$. Since we are considering the case when firms want workers with $y = y^L$ to leave we know that $f_G < 0$ for $\underline{\gamma} = 0$. Furthermore, as $\hat{J}(\theta, \overline{\gamma}, 1)$ is the highest possible expected value at the hiring stage we have that $\hat{J}(\theta, \overline{\gamma}, 1) > \hat{V}(\theta)$ for any $\theta$.

Since $f_G(\theta,0)<0$, $f_G(\theta,\overline{\gamma})>0$ for any $\theta\in\left[\theta^0,\theta^1\right]$ and $f_G(\theta,\underline{\gamma})$ is decreasing and continuous in both its arguments there exists a value $\underline{\gamma}^0$, for which $\hat{J}_G(\theta^1,\underline{\gamma}^0)-\hat{V}(\theta^1,\underline{\gamma}^0)=0$ and a value $\underline{\gamma}^1$ for which $\hat{J}_G(\theta^0,\underline{\gamma}^1)-\hat{V}(\theta^0,\underline{\gamma}^1)=0$. Since $\theta^1>\theta^0$ , $\hat{J}_G-\hat{V}$ is increasing in both $\theta$ and $\underline{\gamma}$ we have that $\underline{\gamma}^0<\underline{\gamma}^1$. ■

Next we want to show that for intermediate values of gamma there exist a $\theta_G^C$ $\in\left[\theta^0,\theta^1\right]$ such that for $\theta<\theta_G^C$ it is unprofitable to hire a Green worker, while for $\theta\geq\theta_G^C$ it is profitable.

**Lemma 5** *For $\underline{\gamma}\in\left(\underline{\gamma}^0,\underline{\gamma}^1\right)$, there exists a $\theta_G^C\in\left[\theta^0,\theta^1\right]$ such that $\hat{J}_G(\theta,\underline{\gamma})-\hat{V}(\theta,\underline{\gamma})\gtreqless 0$ for $\theta\gtreqless\theta_G^C$.*

**P roof.** Consider any $\underline{\gamma'}\in\left(\underline{\gamma}^0,\underline{\gamma}^1\right)$. Since $\hat{J}_G-\hat{V}$ is continuos and strictly increasing in $\theta$ it is sufficient to show that $\hat{J}_G(\theta^0,\underline{\gamma}')-\hat{V}(\theta^0,\underline{\gamma}')>0$ and $\hat{J}_G(\theta^1,\underline{\gamma}')-\hat{V}(\theta^1,\underline{\gamma}')<0$. This, however, follows directly from the definitions of $\underline{\gamma}^0$, and $\underline{\gamma}^1$ and that $\hat{J}_G(\theta,\underline{\gamma})-\hat{V}(\theta,\underline{\gamma})$ is strictly increasing in $\underline{\gamma}$ for $\theta\in\left[\theta^0,\theta^1\right]$. ■

**Definition:** Define $\underline{\theta}$ by $\hat{J}_G(\theta,\underline{\gamma})-\hat{V}(\theta,\underline{\gamma})=0$ and $\overline{\theta}$ by $\overline{\theta}=_{arg\min}\left\{\hat{J}_R(\theta,\underline{\gamma})-\hat{V}(\theta,\underline{\gamma})=0,V(\theta)=0\right\}$. Furthermore, define $\underline{K}$ and $\overline{K}$ by $\underline{K}=V(\overline{\theta})$ and $\overline{K}=V(\underline{\theta})$.

Thus, $\underline{\theta}$ is the lowest value of $\theta$ for which it is profitable to hire a Green worker with $\gamma=\underline{\gamma}$ and $\overline{\theta}$ the lowest value of $\theta$ for which it is profitable to hire a Red worker with $\gamma=\underline{\gamma}$ if this value of $\theta$ implies that $V>0$, otherwise $\overline{\theta}$ is defined by $V(\overline{\theta})=0$.

**Proposition 1** *Given Assumptions 1 and 2, there is an interval $(\underline{K},\overline{K}]$ such that for $K\in(\underline{K},\overline{K}]$, a discriminatory equilibrium exists.*

***P roof.*** *Since $\hat{J}_i(\theta,\underline{\gamma})-\hat{V}(\theta,\underline{\gamma})$ is strictly increasing over the interval $\left[\theta^0,\theta^1\right]$, it is also strictly increasing over the interval $\left[\underline{\theta},\overline{\theta}\right)$. (As $\underline{\theta}>\theta^0$ and $\overline{\theta}\leq\theta^1$). From the definition of $\underline{K}$ and $\overline{K}$ we have that $K\in(\underline{K},\overline{K}]\Rightarrow\theta\in\left[\underline{\theta},\overline{\theta}\right)$ and hence that $\hat{J}_G(\theta,\underline{\gamma})-\hat{V}(\theta,\underline{\gamma})\geq 0$ and $\hat{J}_R(\overline{\theta},\underline{\gamma})-\hat{V}(\overline{\theta},\underline{\gamma})<0$ for $K\in(\underline{K},\overline{K}]$. Thus, conditions (20) and (21) are satisfied and the proposition follows.* ■

**Lemma 1** *Given Assumption 1 and 2 are satisfied and $K\in(\underline{K},\overline{K}])$ there always exist a neutral equilibrium where $\gamma_G^C=\gamma_R^C=\underline{\gamma}$.*

**P roof.** Let superscript $NE$ denote the equilibrium where $\gamma_G^C = \gamma_R^C = \underline{\gamma}$ and superscript $DE$ denote the equilibrium where $\gamma_G^C = \overline{\gamma}$ and $\gamma_R^C = \underline{\gamma}$

Assume $\gamma_G^C = \gamma_R^C = \underline{\gamma}$. Then $J_R^{NE}(\underline{\gamma}, 1) = J_G^{NE}(\underline{\gamma}, 1)$. For $\gamma_G^C = \gamma_R^C = \underline{\gamma}$ to be an equilibrium we need to show that $J_G^{NE}(\underline{\gamma}, 1) > K$ . It is sufficient to show that $J_G^{NE}(\underline{\gamma}, 1) > J_G^{DE}(\underline{\gamma}, 1)$ since $J_G^{DE}(\underline{\gamma}, 1) > K$ by assumption (discriminatory equilibria exists)

Profit from hiring a Green worker when $p_G = 1$ is

$$J_i(\underline{\gamma}, 1) = \frac{\underline{\gamma}}{r+s}((1-\beta)y^H + sV) + \frac{(1-\underline{\gamma})}{r+s+\phi}\left(y^L - w^L + (\phi + s)V\right) \tag{24}$$

It is profitable to hire a Green worker with $\gamma = \underline{\gamma}$ if $J_G(\underline{\gamma}, 1) > V$. In equilibrium $V = K$. $J_G(\underline{\gamma}, 1)$ is increasing in $\phi$. Thus if $\phi^{NE} > \phi^{DE}$ we know that $J_G^{NE}(\underline{\gamma}, 1) > J_G^{DE}(\underline{\gamma}, 1)$. Since $V$ is increasing in $\widetilde{J}_R$ and $\widetilde{J}_R$ increasing in $p_R$ it follows that when $p_G = p_R = 1$ we have that $V > K$ at $\phi^{DE}$. Thus $\phi^{NE} > \phi^{DE}$ ■

## 3.1 Non-profitmaximizing firms

Here we look at the existence of discriminatory hiring and neutral hiring provide that a) some firms have taste for discrimination and b) some firms apply affirmative action. We consider parameters such that Assumption 1 and 2 are satisfied and that $K \in (\underline{K}, \overline{K}])$.(Both equilibria with $\gamma_G^C = \gamma_R^C = \underline{\gamma}$ and $\gamma_G^C = \underline{\gamma}$, $\gamma_R^C = \overline{\gamma}$ exists)

**Taste for discrimination** Assume that a proportion $m$ of vacancies have a taste for discrimination and always apply the hiring rule: $\gamma_G^C = \underline{\gamma}$ and $\gamma_R^C = \overline{\gamma}$

**Proposition 2** *For $m > \tilde{m}$ an equilibrium where profit-maximizing firms apply the neutral hiring rule $\gamma_G^C = \gamma_R^C = \underline{\gamma}$ do not exist while the equilibrium where they apply $\gamma_G^C = \underline{\gamma}, \gamma_R^C = \overline{\gamma}$ exist.*

**P roof.** Equilibrium where profit maximizing firms apply the hiring rule $\gamma_R^C = \underline{\gamma}$ exists if and only if

$$J_R(\underline{\gamma}, p_G) = \frac{\underline{\gamma}}{r+s}((1-\beta)y^H + sK) + (1-\underline{\gamma})\frac{y^L - w^L + (\phi(1-m+m\eta) + s)K}{r+s+\phi(1-m+m\eta)} > K. \tag{25}$$

where $p_G = 1 - m + m\eta$, holds in equilibrium. $J_R(\underline{\gamma}, p_G)$ is decreasing in $m$ and increasing in $\phi$. First note that $\phi$ is decreasing in $m$: The higher is $m$, given $\phi$ (given $\theta$), the lower is $J_R(\underline{\gamma}, p_G)$ the lower is $\widetilde{J}_R$ and hence the lower is $V$. Thus $\theta$ will be lower the the higher $m$ is. Hence, equilibrium $J_R(\underline{\gamma}, p_G)$ is decreasing in $m$.

From that $V$ is continuous in all its arguments (for a given hiring rule), that non-discriminatory exists for $m = 0$ but do not exist for $m = 1$ the proposition follows. ■

The existence of firms with taste for discrimination makes it more likely that profit-maximizing firms also apply discriminatory hiring standards. Note that firms with taste for discrimination here make the same profit as profit-maximizing firms when $m > \tilde{m}$ .

**Affirmative action** Assume that a proportion $a$ of vacancies always apply the hiring rule: $\gamma_G^C = \underline{\gamma}$ and $\gamma_R^C = \underline{\gamma}$

**Proposition 3** *For $a > \tilde{a}$ an equilibrium where profit-maximizing firms apply the discriminatory hiring rule $\gamma_G^C = \underline{\gamma}, \gamma_R^C = \overline{\gamma}$ do not exist while the equilibrium where they apply the neutral hiring rule $\gamma_G^C = \gamma_R^C = \underline{\gamma}$ exist*

**P roof.** Equilibrium where profit maximizing firms apply the hiring rule $\gamma_R^C = \underline{\gamma}$ exists if and only if

$$J_R(\underline{\gamma}, p_G) = \frac{\underline{\gamma}}{r+s}((1-\beta)y^H + sK) + (1-\underline{\gamma})\frac{y^L - w^L + (\phi(a + (1-a)\eta) + s)K}{r + s + \phi(a + (1-a)\eta)} > K. \tag{26}$$

where $p_G = (a + (1-a)\eta)$, holds in equilibrium. $J_R(\underline{\gamma}, p_G)$ is increasing in $a$ and increasing in $\phi$. First note that $\phi$ is increasing in $a$: The higher is $a$, given $\phi$ (given $\theta$), the higher is $J_R(\underline{\gamma}, p_G)$ the higher is $\widetilde{J}_R$ and hence the higher is $V$. Thus $\theta$ will be higher the higher $a$ is. Hence, equilibrium $J_R(\underline{\gamma}, p_G)$ is increasing in $a$.

From that $V$ is continuous in all its arguments (for a given hiring rule), that discriminatory equilibrium exists for $a = 0$ but do not exist for $a = 1$ and the proposition follows. ■

## 3.2 Outside option threat-point in the bargaining.

So far, we have assumed that the wage in the high productivity case only depends on the productivity of the match, and not on the outside alternatives of the workers. We now consider alternative wage setting mechanism, where the wage is also affected by the players' outside options. The upshot is that the weaker outside alternatives of Red workers lead them to have a lower wage. Specifically, we assume that the wage in a high productive match, when $y = y^H$, maximizes the Nash product of each players asset values, i.e.

$$(W_i^H - U_i)^{\beta}(J^H - V)^{1-\beta}. \tag{27}$$

In the non-cooperative interpretation of Binmore et al (1986), (27) is the appropriate specification if there is an exogenous probability of separation while the players bargain over the wage and if a separation occurs during the bargaining, no firing-cost have to be paid. The solution to (27) is

$$w_i^H = \beta y^H + (1-\beta)(r+s)U_i - \beta r V, \tag{28}$$

implying that the asset value of the worker is

$$W_i^H = \frac{\beta y^H + (1-\beta)(r+s)U_i - \beta r V}{r+s}.$$

We shall analyse whether the discriminatory equilibrium derived above, where all Greens are hired, while Reds are only hired if $\gamma = \overline{\gamma}$, still may exist. And, if so, under which circumstances. There are now two opposing mechanisms at work in a discriminatory equilibrium. On the one hand, Red workers still have the disadvantage that they are less likely to find another job, implying that the expected duration of a low productive match is longer. On the other hand, the weaker outside option of Red workers imply that their wage is lower. If the latter effect is stronger, firms will prefer Red workers with $\underline{\gamma}$ to Green workers with $\underline{\gamma}$, and a discriminatory equilibrium of this type cannot exist. Thus, we must check if this is the case. The expected profits from hiring a Green, respectively Red, worker with $\underline{\gamma}$ in a discriminatory equilibrium (note that we have substituted out for the wage equation (28), and that we now need a subscript indicating worker type as the wage differs between the types) are

$$J_G(\gamma,1)=\frac{\gamma}{r+s}\left((1-\beta)(y^H-(r+s)U_G)+(\beta r+s)V\right)+\frac{(1-\gamma)}{r+s+\phi}\left(y^L-w^L+(\phi+s)V\right) \tag{29}$$

$$J_R(\gamma,\eta)=\frac{\gamma}{r+s}\left((1-\beta)(y^H-(r+s)U_R)+(\beta r+s)V\right)+\frac{(1-\gamma)}{(r+s+\phi\eta)}\left(y^L-w^L+(\phi\eta+s)V\right) \tag{30}$$

Which of the effects is the stronger, and thus whether a discriminatory equilibrium may exist, depends on the values of the parameters in the model. For further analysis, let Condition 1 denote the case where the parameter values are such that a discriminatory equilibrium may exist.

**Condition 1** (Necessary condition for discriminatory equilibrium): $J_G(\underline{\gamma},1)>J_R(\underline{\gamma},\eta)$.

**Lemma 6**

$$J_G(\underline{\gamma},1)>J_R(\underline{\gamma},\eta). <=>$$

$$\frac{w_G^H-w_R^H}{r+s}<\frac{1-\underline{\gamma}}{\underline{\gamma}}\frac{\phi(1-\eta)}{(r+s+\phi\eta)(r+s+\phi)}(rK-(y^L-w^L))$$

*with* $w_i^H$ *given by (28), where* $V=K$ *and*

$$U_G=\frac{z(r+s+\gamma^M\phi)+\phi(\gamma^M\frac{(\beta y^H-\beta rK)(r+s+\phi)}{r+s}+(1-\gamma^M)w^L)}{(r+s+\beta\gamma^M\phi)(r+s+\phi)} \tag{31}$$

$$U_R=\frac{z(r+s+\overline{\gamma}\phi\eta)+\phi\eta(\overline{\gamma}\frac{(\beta y^H-\beta rK)(r+s+\phi\eta)}{r+s}+(1-\overline{\gamma})w^L)}{(r+s+\beta\overline{\gamma}\phi\eta)(r+s+\phi\eta)} \tag{32}$$

**P roof.** See Appendix 3 ■

We summarize the equilibrium equations:

1. Value of a vacancy:

$$V = \frac{-c + q\alpha_G(\eta J_G(\overline{\gamma}) + (1-\eta)J_G(\underline{\gamma})) + q\alpha_R \eta J_R(\overline{\gamma})}{r + q\left(\alpha_G + \alpha_R \eta\right)} = K \tag{33}$$

with $J_G(\gamma)$ defined by (29), $J_G(\gamma)$ by (30), $U_G$ by (31) and $U_R$ by (32)

2. Profitable to hire a Green with $\gamma = \underline{\gamma}$: (from $J_G(\gamma, 1) > K$, using (30) and $V = K$, see calculations in appendix x)

$$\frac{\underline{\gamma}(r+s+\phi)(1-\beta)(y^H - (r+s)U_G) + (1-\underline{\gamma})(r+s)\left(y^L - w^L\right)}{r\left((r+s)(1-\underline{\gamma}\beta) + \underline{\gamma}\phi(1-\beta)\right)} > K.$$

3. Non-profitable to hire a Red with $\gamma = \underline{\gamma}$: (from $J_R(\gamma, \eta) < K$, using (30) and $V = K$)

$$\frac{\underline{\gamma}(r+s+\phi\eta)(1-\beta)(y^H - (r+s)U_R) + (1-\underline{\gamma})(r+s)\left(y^L - w^L\right)}{r\left((r+s)(1-\underline{\gamma}\beta) + \underline{\gamma}\phi\eta(1-\beta)\right)} < K.$$

### 3.2.1 Numerical simulations

As the model involves opposing and non-linear effects, numerical illustrations are necessary to explore the effects. In particular, we are interested in exploring under which circumstances a discriminatory equilibrium of the analyzed above, may exist. We have chosen the following parameter values, where the period length is assumed to be one quarter. Output is $y^H = 1.05$ and $y^L = 0.6$, implying that average productivity for filled jobs will be close to unity; this is just a normalization. The cost of opening a vacancy $K = 12$, which corresponds to a capital-output ratio in annual terms of three. The interest rate $r = 0.012$, following Shimer, corresponding to an annual rate of about five The workers' bargaining power $\beta = 0.7$. The wage in a low productivity match $w^L = 0.6$, and the value of being unemployed (leisure and unemployment benefits) $z = 0.6$; in equilibrium, this will induce a replacement rate of about 2/3, which is fairly standard in many European countries. The weight on vacancies in the matching function, $1-\lambda=0.4$, see Petrongolo and Pissarides (2001), who suggest that it should be between 0.3 and 0.5. The job finding rate for unemployed is in European countries between 3% and 21% on monthly basis in European countries, see OECD Employment Outlook 1995, page 27-28, and we choose $\phi=0.4$ on a quarterly basis. Flow into unemployment in European countries is between 0.3% and 2.8% on monthly basis in European countries, see OECD Employment Outlook 1995, page 27-28, and we choose $s=0.03$ on a quarterly basis. The probability that output takes a high value is $\overline{\gamma}=0.6$ and $\underline{\gamma}=0.4$, while the probability that Prob( $\gamma=\overline{\gamma}$) $=\eta=0.4$. The cost of a vacancy $c=0.4$. Finally, we set the share of Green workers, $n_G=0.9$, implying that the share of Red workers, $n_R=0.1$.

With these parameter values, the interval for the cost of opening a vacancy, $K$, within which a discriminatory equilibrium of the proposed type exists, is $\underline{K}^O=8.24$ and $\overline{K}^O=12.38$. These values correspond to a capital-output ratio in annual terms between two or three. For example, if we set $K=12$, we find $J_R(\underline{\gamma},\eta)=9.33<12<J_G(\underline{\gamma},1)=12.20$, implying that it is profitable to hire a Green with $\gamma=\underline{\gamma}$, while it is not profitable hire a Red with $\gamma=\underline{\gamma}$. If $K$ is lower than $\underline{K}^O$, it is profitable to hire both Green and Red workers in spite of a bad signal $\gamma=\underline{\gamma}$, while for $K$ greater than $\overline{K}^O$, it is not profitable to hire any worker when observing $\gamma=\underline{\gamma}$.

TABLE with parameter values TO BE ADDED

**Lower unemployment benefits, $z$.**

If $z$ is reduced, workers receive lower wages, and in particular this happens for Red workers, who have a larger probability of being unemployed. This makes Red workers more attractive, implying that a discriminatory equilibrium becomes less likely. For the chosen parameter values, $z$ has to be reduced down to $z=0.04$ for Condition 1 not be satisfied, i.e. such that $J_G(\underline{\gamma},1)<J_R(\underline{\gamma},\eta)$, implying that a discriminatory equilibrium of the mentioned type is not possible. For higher values of $z$, Condition 1 is fulfilled, and a discriminatory equilibrium is possible. In this simulation, we keep the parameter $A$ in the matching function fixed at the value derived in the basis simulation, $A=0.4188$, and then endogenize $\phi$, which

for $z = 0.04$ takes the value $\phi = 0.8368$. The higher value of $\phi$ reflects that a lower value of $z$ increases the profitability of firms, inducing entry of new firms, thus raising the matching rate for searching workers, $\phi$

**Lower minimum wages $\mathbf{w}^L$, combined with lower unemployment benefits, $z$.**

A reduction in minimum wages $w^L$ reduces the loss for firms in the case of a bad match. This makes Red workers more attractive, making a discriminatory equilibrium less likely. When reducing $w^L$, we also reduce $z$, as we want to keep $w^L \geq z$. For the chosen parameter values, $w^L$ and $z$ has to be reduced down to $w^L = z = 0.48$ for Condition 1 not be satisfied, i.e. such that $J_G(\underline{\gamma}, 1) < J_R(\underline{\gamma}, \eta)$, implying that a discriminatory equilibrium of the mentioned type is not possible. For higher values of $w^L$ and $z$, Condition 1 is fulfilled, and a discriminatory equilibrium is possible. Again, we keep the parameter $A$ in the matching function fixed at the value derived in the basis simulation, $A = 0.4188$, and then endogenize $\phi$, which for $w^L = z = 0.48$ takes the value $\phi = 0.8273$. The higher value of $\phi$ reflects that lower values of $w^L$ and $z$ increase the profitability of firms, inducing entry of new firms, thus raising the matching rate for searching workers, $\phi$.

**Lower cost of opening a vacancy, $K$**

Lower costs of opening a vacancy reduces the loss from a bad match, which reduces the possible costs of hiring a Red worker. The upshot is a narrowing of the range of parameter values for which a discriminatory equilibrium exists. This can be illustrated by reducing $K$ down from 12 to $K = 8$, and then redo the exercises above. We find that unemployment benefits now only can be reduced to $z = 0.18$ before Condition 1 no longer is satisfied, implying that a discriminatory equilibrium no longer is possible. Thus, for a lower cost of opening a vacancy, a discriminatory equilibrium requires a higher value for unemployment benefits, otherwise the Red workers become more profitable to hire than Green workers. As above, we keep the parameter $A$ in the matching function fixed at the value derived in the basis simulation, now $A = 0.2833$, and then endogenize $\phi$, which for $z = 0.18$ takes the value $\phi = 0.5812$.

For minimum wages, we find with $K = 8$ that minimum wages and unemployment benefits combined only to $w^L = z = 0.51$ before Condition 1 no longer is satisfied. Again, for a lower cost of opening a vacancy, a discriminatory equilibrium requires higher values for minimum wages and unemployment benefits, otherwise the Red workers become more profitable to hire than Green workers. Here again, we keep the parameter $A$ in the matching function fixed at the value derived in the basis simulation, now $A = 0.2833$, and then endogenize $\phi$, which for $w^L = z = 0.51$ takes the value $\phi = 0.5769$.

# 4 Discussion

Here we discuss robustness of the discriminatory equilibrium to different modelling assumptions as well as empirical implications of the model.

## 4.1 Robustness

### 4.1.1 Treatment of firing cost in wage determination

In the literature there are different ways of modelling wage determination with firing costs. A much used set-up is to model the wage-bargaining in two stages (see eg. Mortensen and Pissarides, 1999; Pries and Rogerson, 2005). At the second stage the wage is determined by maximizing

$$(W - U)^{\beta}(J - V + F)^{1-\beta}$$

where $F$ is the firing costs and reflects the part of the firing costs that is not transferred to the worker in case he or she is fired. The solution to this problem is

$$w_i^H = \beta y^H + (1 - \beta)(r + s)U_i - \beta(r + s)(V - F)$$

At the first stage the firing-cost is not present. Define $J^0$ to be the value to the firm and $W^0$ the value to the worker and assume that time is discrete[3]

$$W^0 = \frac{(1 - s)W + sU}{1 + r}$$

[3] One can alternatively, as in Mortensen-Pissarides (1999), assume that workers transit from stage 1 to stage 2 at a rate $\mu$.

$$J^0 = \frac{(1-s)J + sV}{1+r}$$

Wages at the first stage are determined by maximizing

$$(W^0 - U)^{\beta}(J^0 - V)^{1-\beta}$$

TO BE CONTINUED

#### 4.1.2 Workers fired

We have assumed that workers are never fired. We conjecture that our results are robust to this assumption. When considering to fire a worker the threshold productivity level will be higher the higher the workers' job-finding rate is. Thus, it is possible to have equilibria where Red worker are fired when $y = y^L$ but Green workers stay. The key is that the argument that given $\gamma$ the value of employing a worker is increasing in the job-finding rate, in case of a bad match.

Similarly, it would be straight forward to extend our model to incorporate a third level of productivity; $y^0$ with $y^0 < y^L$ at which firms always would fire, while wait for voluntary transition at the intermediate level $y^L$.

#### 4.1.3 Workers search intensity

We have assumed that the search intensity is exogenous and identical for of- and on-the-job search. Having different exogenous search intensities would not affect our result as long as workers in matches with $y = y^L$ prefer employment to unemployment. In a setting with endogenous search intensity discriminatory outcomes seem more likely. Green workers would choose a higher search intensity than Reed as their return to search is higher. As a consequence, they would leave low productivity matches even faster.

#### 4.1.4 Continuum of types

In an earlier version we have established in numerical analysis that discriminatory equilibrium are possible also when $\gamma$ is continuously distributed.

Example to be included.

## 4.2 Empirical evidence and implications:

The core idea of our paper is consistent with observers' view on immigrants in Nordic labour markets. In spite of extensive measures to help immigrants entering the labour market, high unemployment rates and over-qualification remain an important problem for immigrants in the Nordic countries. In the Economic Survey of Sweden 2007, one of the key elements to combat exclusions is "to reduce the risk associated with hiring someone who turns out not to be the right person for the job" (OECD 2007, Economic Survey of Sweden 2007). One measure with this aim is to prolong the maximum duration of temporary contracts to 24 months.

To what extend do employers take firing cost into consideration when making hiring decisions? There is strong evidence that strict Employment Protection Legislation EPL reduces hiring and firing rates, see e.g. OECD Employment Outlook 2004, chapter 2. There is also evidence that differences in firing costs affect employers' preferences for different worker groups. Behaghel, Crépon and Sédillot (2005) study the effect of the Delalande tax in France. This tax states that firms laying off workers aged 50 and above have to pay a tax to the unemployment insurance system. Behaghel et al show that the legislative change in 1992, which stated that the tax do not apply if workers are hired after the age 50, lead to a significant increase in the hiring probability of the unemployed aged 50 and above, as compared to unemployed in the late 40s. Another supporting evidence is the study of the enforcement of the Americans with Disabilities Act (ADA) by Acemoglu and Angrist (2001). Using data from the Current Population Survey, Acemoglu and Angrist show that there was a sharp drop in the employment of disabled individuals after the ADA went into effect. Acemoglu and Angrist also found that the effects of the ADA appeared to be larger in medium-size firms, possibly because small firms were exempt from the ADA.

In this section we discuss to what extent our model can shed light on the labour market situation of two groups that are often said to be discriminated in the labour market, immigrants and older workers. We first consider immigrants. Comparing the labour market situation of immigrants across OECD countries is complicated by the vast difference in immigrant populations. OECD countries with large job immigration, like Spain or the US, or rather selective immigration, like Australia and Canada, have fairly low immigrant unemployment, as compared to total unemployment rates. In contrast, unemployment among immigrants is much higher in countries like Denmark, Norway and Sweden, where many immigrants are refugees or family reunification. In spite of the large variation, immigrants generally have higher unemployment rates and lower wages than comparable native workers. To a large extent, this reflects lower skills and language barriers. While many immigrants have high formal education, it is often not recognized in the host country. Some evidence suggests that when comparable measures of skill exists, immigrants with levels comparable to the native-born seem to find work commensurate with their formal qualifications (OECD 2007, Jobs for Immigrants, page 50). However, other types of evidence suggest that discriminatory practices exist. One piece of evidence is based on experimental tests of hiring procedures, based on the so-called ILO method. The test consists of submission of applications for the same job from two fictitious candidates with essentially the same qualifications, but differing in name which also indicates different nationality. In all countries where this test has been undertaken, the results show that employers exercise a certain selectiveness at all stages of the hiring process, favouring the native applicants. On average, the net additional elimination of immigrant applicants is about one third, varying somewhat across countries (OECD, 2007, Jobs for Immigrants, page 53). Further suggestive evidence is the fact that also second-generation immigrants generally have weaker labour market outcomes than native-borns (OECD, 2007, Jobs for Immigrants, page 59). While some of the difference reflects lower educational levels, part of the gap remains even if one controls for lower education (OECD 2007, Jobs for Immigrants, page 64). Even after long stays in the host country, immigrants are also much more likely than native-borns to be overqualified, i.e. to have a job that require lower education that the person has (OECD 2006, Employment Outlook, page 145).

Other labour market features are consistent with the notion that some immigrants face discrimination when trying to obtain a permanent job in the regular labour market. First, in almost all OECD countries, immigrants are much more likely to have temporary jobs than are native-born (OECD, 2007, International Migration Outlook, page 75). Second, evidence from Sweden shows that immigrants are more likely than native-borns to exit from temporary help agencies into other sectors of activity (Anderson and Wadensjö, 2004). This may suggest that temporary work assignments may work as a screening device which may overcome possible reluctance among employers in hiring immigrants. This interpretation is consistent with evidence from Denmark, showing that wage subsidies and subsidised employer-based training are more effective at getting immigrants into employment than native born persons (OECD, 2007, Jobs for Immigrants, page 51). These programs enable employers to experience how well immigrants perform on the job, implying that hiring decisions are made on more certain information.

Our hypothesis suggests that part of the discrimination of immigrants is linked to the existence of EPL (Employment Protection Legislation), implying that in labour markets with strict EPL, employers may be more reluctant to hire immigrants. This hypothesis is consistent with the results of Kahn (2007), who explores the effect of EPL on joblessness and temporary employment by demographic groups on micro data from the International Adult Literacy Survey for Canada, the US and five European countries. Kahn finds that strict EPL has a significant negative effect on employment levels for immigrants, and it also raises the incidence of temporary employment for immigrant women. Sá (2008) on the other hand, using the EU Labour Force Study, finds that strict EPL favours immigrants, as strict EPL reduces employment for natives with no effect on immigrant employment. Sá argues that immigrants in many cases are less informed about their rights, and thus in practice are less protected by EPL. Unionization rates are generally much lower for immigrants than for natives (Sá, 2008), and union membership is often a key way of getting information and help in exercising the rights.

One should however be fairly cautious when interpreting these results. Employment protection legislation is a complex issue with many dimensions that are difficult to capture in a single index. Furthermore, the effective job protection varies strongly across various parts of the labour market. Using data from the European Community Household Panel (ECHP) , Clark and Postel-Vinay (2006) find that workers feel most secure in permanent public sector jobs, and least secure in temporary jobs. Surprisingly, perceived job security is in fact lower in countries with strict EPL, suggesting that there important aspects not captured by the OECD index. The exception to this negative relationship is for employees in permanent public jobs, who feel secure everywhere.

Incidentally, in almost all OECD countries (Belgium being the only exception) immigrants are under represented in public sector jobs, as compared to native-borns (OECD 2007, International Migration Outlook, page 73). Indeed, even children of immigrants tend to be under represented in the public sector (OECD 2007, International Migration Outlook, page 85). The underrepresentation of immigrants in the public sector is consistent with public sector employers being reluctant to hiring immigrants, being aware of the additional difficulty in the public sector of getting rid of employees who do not fit to the job requirements. However, there are also other possible explanations for underrepresentation of immigrants in the public sector, for instance that requirements as to language or societal knowledge may be higher in parts of the public sector.

A second prediction our model is that employers are less reluctant to discriminate a group of workers if a weaker labour market situation has a strong downward effect on wages. This prediction would suggest that foreign unemployed will be high relative to native unemployment in countries with small wage compression. This is consistent with evidence across OECD countries, where we find a strong negative relationship between the ratio of foreign to native unemployment and wage dispersion, as measured by the ratio of the fifth to the first percentile (this measure of wage dispersion captures dispersion in the lower part of the wage distribution, which is the wage dispersion of relevance in the theoretical model).

TO BE CONTINUED

# 5 Conclusions

We offer a novel argument for discriminatory outcomes of equally productive groups. Key to the argument is that workers' with low job-finding rates are risky to hire since they might stay for long also in case of a bad match. In the core model outside options only serve as constraints. When outside options are the treat points in the barging, wages (for a given productivity) are lower for workers that are discriminated at the hiring stage, making discriminatory outcomes less likely. Numerical simulations suggests that a discriminatory outcome is more likely unemployment benefits and minimum wages are higher.

# 6 Appendix

## 6.1 Appendix 1: Proof of Lemma 1

From equation (12) we have that

$$V(\theta) = \frac{-c/q + \alpha_G p_G \widetilde{J}_G + \alpha_R p_R \widetilde{J}_R}{r/q + \alpha_G p_G + \alpha_R p_R}$$

Hence

$$V(0) = \frac{n_G \widetilde{J}_G + n_R \eta \widetilde{J}_R}{n_G + n_R \eta}$$

Substituting in for $\widetilde{J}_G$ and $\widetilde{J}_R$ from (9) and using that $\phi = 0$ and that $\alpha_i = n_i$ when $\theta = 0$ gives

$$\begin{aligned} V(0) &= n_G \frac{\gamma^M((1-\beta)y^H + sV) + (1-\gamma^M)\left(y^L - w^L + sV\right)}{(r+s)(n_G + n_R\eta)} \\ &\quad + n_R\eta \frac{\overline{\gamma}((1-\beta)y^H + sV) + (1-\overline{\gamma})\left(y^L - w^L + sV\right)}{(r+s)(n_G + n_R\eta)}, \end{aligned}$$

and thus that $V(0) > 0$ if $n_G(\gamma^M(1-\beta)y^H + (1-\gamma^M)(y^L - w^L)) + n_R\eta(\overline{\gamma}(1-\beta)y^H + (1-\overline{\gamma})(y^L - w^L)) > 0$.

## 6.2 Appendix 2: Proof of Lemma 3

Define $f_i(\theta,\underline{\gamma}) = \hat{J}_i(\theta,\underline{\gamma}) - \hat{V}(\theta,\underline{\gamma})$. Taking the derivative of $f_i$ w.r.t. $\theta$ gives

$$\frac{df_i(\theta,\underline{\gamma})}{d\theta} = \frac{\partial \hat{J}_i}{\partial \phi}\frac{\partial \phi}{\partial \theta} + \frac{\partial \hat{J}_i}{\partial V}\frac{\partial V}{\partial \theta} - \frac{\partial \hat{V}(\theta)}{\partial \theta}. \tag{34}$$

From (23) we have that

$$\frac{\partial \hat{J}_i}{\partial \phi} = \frac{p_i(1-\underline{\gamma})(rV - (y^L - w^L))}{(r+s+\phi p_i)^2} > 0,$$

and

$$\frac{\partial \hat{J}_i}{\partial V} = \frac{\underline{\gamma}}{r+s}s + \frac{(1-\underline{\gamma})}{(r+s+\phi p_i)}(\phi p_i + s) < 1.$$

Since $\frac{\partial \phi}{\partial \theta} > 0$, $\frac{\partial \hat{J}_i}{\partial \phi} > 0$, $\frac{\partial \hat{J}_i}{\partial V} < 1$ and $\frac{\partial V}{\partial \theta} \leq 0$ when $\theta \in \left[\theta^0, \theta^1\right]$ it follows from (34) that $\frac{df_i(\theta,\underline{\gamma})}{d\theta} > 0$.

b) Using (12) we can write $V$ as a function of $\theta$, $\widetilde{J}_G$ and $\widetilde{J}_R$.

$$V = \widetilde{V}(\theta, \widetilde{J}_G, \widetilde{J}_R) = \frac{-c + q(\theta)\left(\alpha_G \widetilde{J}_G + \alpha_R \eta \widetilde{J}_R\right)}{r + q(\theta)\left(\alpha_G + \alpha_R \eta\right)}. \tag{35}$$

Using (9) we define $\widetilde{J}_G$ as a function of $\underline{\gamma}$ and $\theta$, where

$$\begin{aligned}
\widetilde{J}_G(\theta,\underline{\gamma}) \quad = \quad & \frac{\eta\overline{\gamma} + (1-\eta)\underline{\gamma}}{r+s}(y^H - w_i^H + sV(\theta)) \\
& + \frac{1 - (\eta\overline{\gamma} + (1-\eta)\underline{\gamma})}{r+s+\phi(\theta)}\left(y^L - w^L + (\phi(\theta) + s)V(\theta)\right)
\end{aligned} \tag{36}$$

Noting that $\widetilde{J}_R$ is independent of $\underline{\gamma}$, we can similarly define $\widetilde{J}_R$ as a function of $\theta$ only, with

$$\widetilde{J}_R(\theta) = \frac{\overline{\gamma}}{r+s}(y^H - w_i^H + sV(\theta)) + \frac{(1-\overline{\gamma})}{r+s+\eta\phi(\theta)}\left(y^L - w^L + (\eta\phi(\theta) + s)V(\theta)\right)$$

Define $\hat{V}(\theta,\underline{\gamma}) = \widetilde{V}(\theta, \widetilde{J}_G(\theta,\underline{\gamma}), \widetilde{J}_R(\theta))$. Hence,

$$f_i(\theta,\underline{\gamma}) = \widetilde{J}_i(\theta,\underline{\gamma}) - \widetilde{V}(\theta, \widetilde{J}_G(\theta,\underline{\gamma}), \widetilde{J}_R(\theta)).$$

Taking partial derivative of $f_i$ w.r.t $\underline{\gamma}$ gives

$$\frac{\partial f_i(\theta,\underline{\gamma})}{\partial \underline{\gamma}} = \frac{\partial \widetilde{J}_i}{\partial \underline{\gamma}} - \frac{\partial \widetilde{V}}{\partial \widetilde{J}_G}\frac{\partial \widetilde{J}_G}{\partial \underline{\gamma}}.$$

From (35) it follows that $0 < \frac{\partial \widetilde{V}}{\partial \widetilde{J}_G} < 1$ and from (36) that $\frac{\partial \widetilde{J}_G}{\partial \underline{\gamma}} > 0$, hence, $\frac{\partial f_G(\theta,\underline{\gamma})}{\partial \underline{\gamma}} > 0$. Since $\frac{\partial \widetilde{J}_R}{\partial \underline{\gamma}} = 0$ and $\frac{\partial \widetilde{V}}{\partial \widetilde{J}_G}\frac{\partial \widetilde{J}_G}{\partial \underline{\gamma}} < 0$ we also have that $\frac{\partial f_R(\theta,\underline{\gamma})}{\partial \underline{\gamma}} > 0$.

## 6.3 Appendix 3:

$J_G(\underline{\gamma}) - J_R(\underline{\gamma}) > 0 <=>$

$$\begin{aligned}
& \frac{\underline{\gamma}}{r+s}((1-\beta)y^H - (1-\beta)(r+s)U_G + (\beta r + s)V) + \frac{(1-\underline{\gamma})}{r+s+\phi}\left(y^L - w^L + (\phi+s)V\right) \\
& -\frac{\underline{\gamma}}{r+s}((1-\beta)y^H - (1-\beta)(r+s)U_R + (\beta r + s)V) - \frac{(1-\underline{\gamma})}{(r+s+\phi\eta)}\left(y^L - w^L + (\phi\eta+s)V\right) \\
= \; & \frac{-\underline{\gamma}}{r+s}(1-\beta)(r+s)U_G + \frac{(1-\underline{\gamma})}{r+s+\phi}\left(y^L - w^L + (\phi+s)V\right) \\
& +\frac{\underline{\gamma}}{r+s}(1-\beta)(r+s)U_R - \frac{(1-\underline{\gamma})}{(r+s+\phi\eta)}\left(y^L - w^L + (\phi\eta+s)V\right) \\
= \; & \underline{\gamma}(1-\beta)(U_R - U_G) + \frac{(1-\underline{\gamma})}{(r+s+\phi\eta)(r+s+\phi)}\left((y^L - w^L)\phi(\eta-1) + rV\phi(1-\eta)\right) \\
= \; & \underline{\gamma}(1-\beta)(U_R - U_G) + \frac{(1-\underline{\gamma})\phi(1-\eta)}{(r+s+\phi\eta)(r+s+\phi)}(rK - (y^L - w^L)) > 0
\end{aligned}$$

or

$$(1-\beta)(U_G - U_R) < \frac{1-\underline{\gamma}}{\underline{\gamma}}\frac{\phi(1-\eta)}{(r+s+\phi\eta)(r+s+\phi)}(rK - (y^L - w^L))$$

The asset value of a Green, unemployed worker is

$$(r+s+\phi)U_G = z + \phi E(W_G),$$

$$E(W_G) = \frac{\gamma^M \frac{(\beta y^H + (1-\beta)(r+s)U_G - \beta rV)(r+s+\phi)}{r+s} + (1-\gamma^M)w^L}{r+s+\gamma^M\phi}$$

$$(r+s+\phi)U_G = z + \phi \frac{\gamma^M \frac{(\beta y^H + (1-\beta)(r+s)U_G - \beta r V)(r+s+\phi)}{r+s} + (1-\gamma^M)w^L}{r+s+\gamma^M\phi}$$

$$\begin{aligned} & (r+s+\gamma^M\phi)(r+s+\phi)U_G \\ = \ & z(r+s+\gamma^M\phi) + \phi(\gamma^M \frac{(\beta y^H + (1-\beta)(r+s)U_G - \beta r V)(r+s+\phi)}{r+s} + (1-\gamma^M)w^L) \end{aligned}$$

$$\begin{aligned} & (r+s+\gamma^M\phi)(r+s+\phi)U_G - \phi(1-\beta)\gamma^M(r+s+\phi)U_G \\ = \ & z(r+s+\gamma^M\phi) + \phi(\gamma^M \frac{(\beta y^H - \beta r K)(r+s+\phi)}{r+s} + (1-\gamma^M)w^L) \end{aligned}$$

$$U_G = \frac{z(r+s+\gamma^M\phi) + \phi(\gamma^M \frac{(\beta y^H - \beta r K)(r+s+\phi)}{r+s} + (1-\gamma^M)w^L)}{(r+s+\beta\gamma^M\phi)(r+s+\phi)}$$

Likewise for unemployed Red workers

$$U_R = \frac{z(r+s+\overline{\gamma}\phi\eta) + \phi\eta(\overline{\gamma}\frac{(\beta y^H - \beta r K)(r+s+\phi\eta)}{r+s} + (1-\overline{\gamma})w^L)}{(r+s+\beta\overline{\gamma}\phi\eta)(r+s+\phi\eta)}$$

Appendix x

$J_G(\underline{\gamma}, 1) > K$

$$\frac{\underline{\gamma}}{r+s}\left((1-\beta)(y^H - (r+s)U_G) + (\beta r + s)V\right) + \frac{(1-\underline{\gamma})}{r+s+\phi}\left(y^L - w^L + (\phi+s)V\right) > K$$

$\Leftrightarrow$

$$\begin{aligned} & \underline{\gamma}(r+s+\phi)((1-\beta)(y^H - (r+s)U_G) + (\beta r + s)K) + (1-\underline{\gamma})(r+s)\left(y^L - w^L + (\phi+s)K\right) \\ > \ & K(r+s)(r+s+\phi) \end{aligned}$$

$\Leftrightarrow$

$$\begin{aligned}
& \underline{\gamma}(r+s+\phi)(1-\beta)(y^H-(r+s)U_G)+(1-\underline{\gamma})(r+s)\left(y^L-w^L\right) \\
> \; & K(r+s)(r+s+\phi)-\underline{\gamma}(r+s+\phi)(\beta r+s)K-(1-\underline{\gamma})(r+s)(\phi+s)K \\
= \; & K\left((r+s)(r+s+\phi-\underline{\gamma}\beta r-\underline{\gamma}s-\phi-s+\underline{\gamma}\phi+\underline{\gamma}s)-\underline{\gamma}\phi(\beta r+s)\right) \\
= \; & K\left((r+s)(r-\underline{\gamma}\beta r+\underline{\gamma}\phi)-\underline{\gamma}\phi(\beta r+s)\right) \\
= \; & K\left(rr-\underline{\gamma}\beta rr+r\underline{\gamma}\phi+sr-s\underline{\gamma}\beta r+s\underline{\gamma}\phi-\underline{\gamma}\phi\beta r-\underline{\gamma}\phi s\right) \\
= \; & Kr\left(r-\underline{\gamma}\beta r+\underline{\gamma}\phi+s-s\underline{\gamma}\beta-\underline{\gamma}\phi\beta\right) \\
= \; & Kr\left((r+s)(1-\underline{\gamma}\beta)+\underline{\gamma}\phi(1-\beta)\right)
\end{aligned}$$

Thus $J_G(\underline{\gamma},1)>K \Leftrightarrow$

$$\frac{\underline{\gamma}(r+s+\phi)(1-\beta)(y^H-(r+s)U_G)+(1-\underline{\gamma})(r+s)\left(y^L-w^L\right)}{r\left(r+s)(1-\underline{\gamma}\beta)+\underline{\gamma}\phi(1-\beta)\right)}>K$$

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