

Discrimination and Employment Protection¹

Steinar Holden² and Åsa Rosén³

January 7, 2014

¹We are grateful to Bjørn Bruegeman, Espen R. Moen, Kalle Moene, Kjetil Storesletten, Fredrik Willumsen, Fabrizio Zilibotti, four anonymous Referees, the editor, George-Marios Angeletos; and participants at presentations at the University of Oslo, the Frisch Centre, ETH Zurich, the Norwegian School of Management, the Norwegian School of Economics and Business Administration, the Norwegian Meeting for Labour Economists, Stockholm University, Umeå University, the CEPR/IZA 2009 Summer Symposium in Labour Economics, the Society of Economic Dynamics Meeting 2009, and the 2010 World Congress of Econometric Society for valuable comments. Thanks to Øystein Rembar for efficient research assistance. Rosén thanks Riksbankens Jubileumsfond for financial support. The paper is part of the research activities at the centre of Equality, Social Organization, and Performance (ESOP) at the Department of Economics at the University of Oslo. ESOP is supported by the Research Council of Norway through its Centres of Excellence funding scheme, project number 179552

²Department of Economics, University of Oslo, Steinar.Holden@econ.uio.no.

³Stockholm University (SOFI) and University of Oslo (ESOP). Asa.Rosen@sofi.su.se.

Abstract

We study a search model with employment protection legislation. We show that if the output from the match is uncertain at the hiring stage, a discriminatory equilibrium may exist in which workers with the same productive characteristics are subject to different hiring standards. If a bad match takes place, discriminated workers will take longer to find another job, prolonging the costly period for the firm. This makes it less profitable for firms to hire discriminated workers, thus sustaining the discrimination. In contrast to Becker's model, the existence of employers with a taste for discrimination may make it more profitable to discriminate, even for firms without discriminatory preferences.

Key words: Discrimination, Employment Protection, Hiring Standards

JEL codes: J70, J60

1 Introduction

In almost all countries there are large differences in the labor market outcomes of different worker groups. Several studies find that these differences are greater than what can be explained by objective criteria. The Organisation for Economic Co-operation and Development (OECD, 2008a) shows that second-generation immigrants in many countries have 15%–20% lower employment rates than native-born persons and that only half of this disparity can be explained by differences in education levels. One possible explanation for the difference is discrimination. The existence of such discrimination is supported by studies showing that a foreign-sounding name on a job application can reduce the likelihood of being called for an interview by 40%–50% (Bertrand and Mullainthan, 2004; OECD, 2008a; Jacquemet and Yannelis, 2011).

A vast literature has tried to understand the reasons for discrimination in the labor market. In one strand of the literature, initiated by Becker (1957), discrimination is explained by prejudices or tastes among some employers. However, the existence of prejudices against one group of workers will lead to lower wages for this group, making them more profitable to hire for employers without prejudices. In this case, the existence of profit-maximizing employers will weaken and possibly remove the effect on the labor market outcome of the discriminated group (Arrow, 1973).

In this paper, we argue that there is an important opposing mechanism that makes workers who are discriminated against less attractive to other firms. The underlying idea is that firms often may end up with a worker that is unprofitable, so that the worker's marginal product does not cover wage costs. The reason could be a bad hiring decision, a worker who turned out to be less qualified than expected, or a change in job characteristics

for an existing employee so that he or she is no longer up to the requirements of the job. The upshot is that the firm loses money and the worker has little hope of higher wages or a career in the firm. Thus, both parties will want to terminate the relationship for a new, better-suited partner. However, for the firm, it may be costly or difficult to lay off the worker and it is much better if the worker finds a new job and leaves the firm voluntarily. However, if the worker is in a discriminated group, it may be difficult to find another job. The result may be that the worker remains in the unprofitable match for a long time, leading to substantial loss for the employer. To avoid the risk of such a loss, the firm may avoid hiring workers from a discriminated group, precisely because they are from this group. We show that the outcome may be an equilibrium with different outcomes for two groups with identical productive characteristics and where the discriminated group has a lower hiring probability and a higher unemployment rate.

The crucial assumption and source of discrimination in our model is that it may be costly for the firm to lay off a worker. One important reason for this is employment protection legislation (EPL) that is sufficiently strict so that it constrains firms' layoff decisions. A vast literature has documented that the extensive EPL in OECD countries affects important economic variables, such as unemployment, wages, hiring and firing rates, and investments in human capital (see the survey of the literature in OECD, 2004). Even in the United States, which is among the OECD countries with the least strict EPL, there is evidence that the adoption of the wrongful discharge doctrine in most US states during the 1970s and 1980s reduced the employment rates of certain groups in the labor market (Autor, Donahue, and Schwab, 2006). However, also without EPL, a firm may be reluctant to lay off employees, since doing so can involve a negative signal

about the firm's financial position¹ or personnel policies. Being laid off can involve high costs for employees (e.g., Davis and von Wachter, 2011); so a firm with a reputation for laying off workers may have difficulties hiring or may cause existing employees to spend time and effort looking for other jobs.

The basic mechanism presented by our paper, that the existence of EPL or other firing costs can reduce the hiring and employment rates of specific groups of workers, is supported by empirical evidence in a number of papers. Using micro data for seven industrialized economies, Kahn (2007) finds that strict EPL raises relative non-employment rates for youth and immigrants. Oyer and Schaefer (2002) find evidence that the introduction of the Civil Rights Act of 1991 led to a negative trend break in the employment shares of black and female workers in industries where these groups had low representation. Acemoglu and Angrist (2001) show that there was a sharp drop in the employment of disabled individuals after the enforcement of the Americans with Disabilities Act, which, among other things, prohibits discriminatory discharge on the basis of disability.

The novelty of our paper compared to this literature is due to the fact that we explore the mechanism in a general equilibrium search model. We show that there is an important interaction effect in firms' hiring strategies: If other firms use discriminatory hiring, it will be harder for the discriminated group to find a new job. This increases the costs for the firm associated with EPL, which amplifies the negative effect on the hiring of this group. A key implication, which, to the best of our knowledge, is novel to the literature, is that this mechanism can also explain persistent discriminatory outcomes for workers with the same productive characteristics as other workers.

¹In a study of 347 firms from Fortune's America's Most Admired Companies, Flanagan and Shaughnessy (2005) find a strong, significant negative effect of layoffs on corporate reputation.

In our model with two groups with identical productive characteristics, there also exists a neutral equilibrium with no discrimination. However, if we assume that a sufficiently large share of the employers discriminate as a result of discriminatory preferences (see the evidence of, e.g., Charles and Guryan, 2008), it becomes unprofitable to hire the discriminated group, and therefore also pure profit-maximizing employers without discriminatory preferences will practice discriminatory hiring. The upshot is that the neutral equilibrium vanishes while the discriminatory equilibrium still exists. This is in sharp contrast to the analysis of taste-based discrimination of Becker (1957) and Arrow (1973), where the existence of profit-maximizing employers mitigates the extent of discrimination. If the economy is in a discriminatory equilibrium, there will be no mechanism that moves it to a neutral equilibrium, even if the taste for discrimination vanishes.

As is clear from Becker (1957) and Arrow (1973), the effect of discrimination on wages plays a crucial role in the existence of discrimination. In the main text, we assume discrimination has no direct effect on wages, that is, no effect for given productivity. This assumption can be theoretically justified by the use of the outside option principle of Binmore, Shaked, and Sutton (1989), which says that an outside option puts a lower constraint on the bargaining outcome without affecting the wage if it is above the outside option. The assumption can also be justified on more institutional grounds, because if an individual from a specific demographic group receives a lower wage for the same productivity than individuals from other groups, that would be wage discrimination, which is illegal in many countries. In Online Appendix H.2, we adopt the more common assumption in search models that the wage depends on both productivity and outside options, implying that workers from a discriminated group receive lower wages due to

weaker outside opportunities. In both cases we show that a discriminatory equilibrium may exist. In fact, in a working paper version of this study, we show that a discriminatory equilibrium exists even if we allow workers that are discriminated against at the hiring stage to "buy" jobs by accepting an initial period with low or possibly negative wages.

Our paper is not the first to suggest an explanation for the existence of persistent discrimination of ex ante identical groups in the absence of preferences for discrimination.²One strand is the so-called statistical discrimination literature, where employers make decisions on the basis of average features of different worker groups, due to lack of information about the individual in question. This can lead to discriminatory outcomes if, for example, hiring decisions interact with human capital investments, as explored by Lundberg and Startz (1983), or if firms choose one of many applicants (Cornell and Welch, 1996). A second approach, to which our model adheres, is based on self-fulfilling stereotypes. The specific mechanisms differ from the one we consider. In Coate and Loury's (1993) model, discriminatory equilibrium is due to the interaction between firms' promotion standards and workers' investment in human capital, while in Mailath, Samuelson, and Shaked (2000) the interaction is between firms' search behavior for workers and workers' investment in human capital. Furthermore, in Mailath et al. (2000), firms can direct their search toward a specific group and EPL plays no role, both features in contrast to our specifications. Our paper is closer to that of Rosén (1997), since both papers derive equilibrium discrimination at the hiring stage as a result of the interactions between the firms' hiring policies. However, there are also important differences: In Rosén (1997), the information about match-specific productivity is asymmetric. In equilibrium, non-

²The recent studies of Fang and Moro (2010) and Lang and Lehmann (2010) present excellent surveys of the literature.

discriminated workers apply only to jobs with high match-specific productivity, while discriminated workers may also apply to jobs where they have low match-specific productivity, since their outside alternative is worse. In contrast, our explanation is based on symmetric information and the source of discrimination lies in the combination of on-the-job search and firing costs.³

One of the few theoretical analyses of the interaction between EPL and discrimination is that of Morgan and Várdy (2009). These authors study a statistical discrimination model where the test result (signal) of productivity contains more noise for one group and where employers engage in optimal sequential search. Among other things, Morgan and Várdy show that workers for which the test (signal) is less precise may need—due to Bayesian updating—a higher test result to be hired. However, the model framework differs from ours and the authors do not consider the interaction of hiring strategies, which is the main idea in our paper.

To undertake our analysis, we develop a search model with match-specific productivity and on-the-job search. As Pries and Rogerson (2005), we explore a setting where firms obtain an imperfect signal about match-specific productivity at the hiring stage, where the existence of EPL makes firings costly, and where firms optimally choose the hiring standard. However, while Pries and Rogerson assume that a bad match always results in a layoff, we focus on the possibility that the firm can avoid firing costs by waiting for the worker to find a better job and leave voluntarily. Thus, Pries and Rogerson do not include the key feature of our model, which is that the hiring standard of each firm depends on the hiring standards of other firms. The feature that firms benefit from avoiding firing

³Lang et al. (2005) show, within an urn-ball search model, that the wages and utility of the discriminated group are substantially lower for an arbitrarily small taste for discrimination.

costs is also considered by Saint-Paul (1995). Thus, in both Saint-Paul (1995) and our paper, firm profits increase if a worker in a bad match leaves voluntarily. However, the model and focus are different. In Saint-Paul (1995), the key interaction is related to firms' decision to enter the market. Furthermore, Saint-Paul considers only one group of workers, does not consider discrimination, and does not include the signal of productivity at the hiring stage.

The paper is organized as follows: The model is presented in Section 2, while in Section 3 we consider the existence of a discriminatory equilibrium. Section 4 explores modifications and applications and Section 5 concludes the paper. Most of the proofs are in Appendices A-G, while the Online Appendix H contains extensions and remaining proofs.

2 The model

We consider a sequential search model of the type used by Diamond (1982), Mortensen (1982), and Pissarides (1985), with wages set by bargaining. Workers and firms are risk neutral and have the same discount rate $r > 0$. There are two types of workers in the economy, n_G Greens and n_R Reds, where $n_G + n_R = 1$. The workers are ex ante equally productive and there are no other differences between the types besides some observable characteristic that determines type, such as skin color. Workers are assumed to leave the market at an exogenous rate $s > 0$. New workers enter at the same rate, and are initially unemployed.

There is free entry of jobs in the market, so firms can open a vacancy at zero cost. The flow cost of maintaining a vacancy is $c > 0$. When a firm hires a worker, a random

draw determines whether the match is of high or low productivity, with output $y^H > y^L$.

We make two key assumptions in this paper. First, we assume that some but not all of the uncertainty about the match-specific productivity is revealed when the employer and worker meet. In the words of Pries and Rogerson (2005), match quality is both an “inspection good” and an “experience good”.⁴ Specifically, when a firm is matched with a worker, both parties observe a signal γ that corresponds to the probability that the match is of high productivity. The signal γ is assumed to be independent and identically distributed over matches and, to keep the model transparent, can take only two values: $\bar{\gamma}$ with probability η and $\underline{\gamma} < \bar{\gamma}$ with probability $1 - \eta$.⁵ Having observed γ , the firm decides whether to offer the worker a job and the worker decides whether to accept the offer. The idea is that when the firm and the worker meet, they will obtain information that makes it possible to assess the likelihood that the match will be of high quality, but they cannot foresee perfectly how the worker will perform. There is considerable uncertainty in both how well the worker fits in with the job requirements and with colleagues. To keep the model as simple as possible, we assume that the match productivity is revealed immediately after the worker is hired and is then constant over time.⁶

Second, we assume that it is costly for firms to lay off a worker who wants to remain on the job. In many countries, such costs come in the form of EPL. Crucially, employment protection is assumed to be already at work when match productivity is revealed, so firms cannot fire without cost upon discovering that productivity is low.⁷ The idea is to

⁴The importance of match-specific uncertainty is supported by Nagypal (2007), who presents evidence from French firm-level data, showing that the effect of learning about match quality dominates the effect of learning by doing at tenures above six months.

⁵In a previous version of the paper, numerical simulations showed the existence of a discriminatory equilibrium in a similar model, where the signal was drawn from a continuous interval.

⁶The same results can be derived under the alternative assumption that all matches start out with high productivity, combined with a constant probability rate $1 - \gamma$ that productivity drops to a lower level. However, the analysis would be more cumbersome.

⁷In many cases, worker turnover is costly to the firm (e.g., Burdett and Mortensen, 1998), which might

capture the fact that while there is often a probation period with little or no employment protection, it may take time to discover whether the worker is up to the requirements of the job. Furthermore, the job content or requirements can change at a later stage, turning a worker who had good productivity for many years into a less productive worker. As noted in the introduction, there is also evidence suggesting that layoffs can involve a negative signal about a firm's financial position. Layoffs can also be costly if it makes existing employees or potential newcomers also fear being laid off at a later stage. For our purposes, the precise reason for the firing costs is immaterial; the key issue is that firms profit from a badly matched worker leaving voluntarily. To simplify the formal exposition, we assume that layoff costs are sufficiently high that firms will never benefit from laying off a worker. However, this simplification is not crucial and, as discussed below, essentially the same results can be derived if, in some cases, firms actually lay off the workers.

We assume that search costs are sufficiently low that all workers in low-productivity matches gain from searching. However, workers in high-productivity matches will not search, since all such matches are equal, so there is nothing to gain. For simplicity, search intensity is assumed to be exogenous and the same for both employed and unemployed workers. The search cost is set to zero.

Let u denote the unemployment rate, ε the fraction of employed workers in bad matches and thus searching, and v the vacancy rate. Thus, the fraction of workers searching for jobs is $u + \varepsilon(1 - u)$. The matching between vacancies and workers is random, independent of worker type, and described by a constant returns to scale matching

make discriminated workers more attractive and go against our results. In a more general model, both effects would apply and discrimination would only prevail in equilibrium if the negative effect dominated. This would be similar to the situation in the Online Appendix Section H.2, also with two opposing effects.

function

$$x = x(u + \varepsilon(1 - u), v) \quad (1)$$

A worker finds a vacancy at a rate $\phi = x/(u + \varepsilon(1 - u))$ and a vacancy is found by a searching worker at a rate $q = x/v$. Constant returns to scale implies that ϕ and q are functions of the tightness $\theta = v/(u + \varepsilon(1 - u))$ only and that $\phi = \theta q$. We also assume two boundary conditions: As $\theta \rightarrow 0$, $\phi \rightarrow 0$ and $q \rightarrow \infty$ and, as $\theta \rightarrow \infty$, $\phi \rightarrow \infty$ and $q \rightarrow 0$.

Workers' flow payoff equals their wages, w , when employed and z when unemployed. Furthermore, the expected value to a worker of type i , $i = G, R$, conditional on just being hired, after observing the signal γ , but before observing whether the match is of high or low productivity, is

$$EW_i(\gamma) = \gamma W_i^H + (1 - \gamma)W_i^L, \quad (2)$$

where W_i^j is the asset value of a worker of type i in a match with productivity level j , where $j = L, H$. The asset value of an unemployed worker of type i , is

$$(r + s)U_i = z + \phi \left(\eta p_{i\bar{\gamma}} EW_i(\bar{\gamma}) + (1 - \eta) p_{i\underline{\gamma}} EW_i(\underline{\gamma}) - p_i U_i \right). \quad (3)$$

Matching takes place at a rate ϕ . With probability η , the signal is $\bar{\gamma}$, in which case the hiring probability is $p_{i\bar{\gamma}}$ and the expected value is $EW_i(\bar{\gamma})$. Correspondingly, with probability $1 - \eta$, the signal is $\underline{\gamma}$, the hiring probability is $p_{i\underline{\gamma}}$, and the expected value is $EW_i(\underline{\gamma})$. Conditional on being matched, the hiring probability p_i is given by

$$p_i = \eta p_{i\bar{\gamma}} + (1 - \eta) p_{i\underline{\gamma}} \quad (4)$$

and if the worker is hired we must deduct the value of being unemployed. Workers in a high-productivity match do not search; so their asset value is simply given by

$$(r + s)W_i^H = w_i^H, \quad (5)$$

where w_i^H is the wage in a high-productivity match for a worker of type i . In contrast, a worker in a low-productivity match, earning wage w_i^L , will continue to search and will find a new job at the rate ϕp_i . The asset value for a low-productivity worker is hence

$$(r + s)W_i^L = w_i^L + \phi \left(\eta p_{i\bar{\gamma}} EW_i(\bar{\gamma}) + (1 - \eta) p_{i\underline{\gamma}} EW_i(\underline{\gamma}) - p_i W_i^L \right). \quad (6)$$

The asset value of a job filled with a worker of type i in a high-productivity match, denoted J_i^H , depends on the flow profit $y^H - w_i^H$, as well as the change in asset value if the worker exogenously leaves the market (V is the value of a vacancy):

$$rJ_i^H = y^H - w_i^H + s(V - J_i^H). \quad (7)$$

The value of a match of low productivity, J_i^L , depends, in addition, on the rate at which the worker finds a new job ϕp_i :

$$rJ_i^L = y^L - w_i^L + (s + \phi p_i)(V - J_i^L). \quad (8)$$

The expected value to a firm of hiring a worker from group i after having observed γ is $\gamma J_i^H + (1 - \gamma)J_i^L$. Using (7) and (8), we find the value to the firm of hiring a worker from group i to be a function of the probability that the match is of high productivity, γ ,

and the probability that, in case of a low-productivity match, the worker is hired when matched to another firm, p_i

$$J_i(\gamma, p_i) = \frac{\gamma}{r+s}(y^H - w_i^H + sV) + \frac{(1-\gamma)}{r+s+\phi p_i}(y^L - w_i^L + (s+\phi p_i)V). \quad (9)$$

Since $J_i^H > J_i^L$, it follows that $J_i(\gamma, p_i)$ is strictly increasing in γ . Firms hire a worker iff it is profitable, that is, iff $J_i > V$. Thus, for each color of worker, there are three possible minimum hiring standards, γ_i^S (or hiring rules, in pure strategies): Hire all workers, $\gamma_i^S = \underline{\gamma}$; hire only workers with a high signal, $\gamma_i^S = \bar{\gamma}$; or hire no workers, $\gamma_i^S > \bar{\gamma}$.⁸ Let $\mu(\gamma_i^S)$ denote the proportion of applicants that have a value of γ_i^S or higher. The value of a vacancy for a given hiring rule is

$$rV(\theta) = -c + q(\alpha_G \mu(\gamma_G^S)(E(J_G | \gamma_G^S) - V) + \alpha_R \mu(\gamma_R^S)(E(J_R | \gamma_R^S) - V)), \quad (10)$$

where α_i is the ratio of job seekers of type i to all job seekers.

Consider now the wage setting, which takes place immediately after the match productivity is revealed. As noted above, in the main part of the paper, we assume that the wage depends only on productivity and not on worker type. This will be the outcome if the bargaining is modeled using the outside option principle of Binmore, Shaked, and Sutton (1989), in which the outside options work as constraints on the bargaining outcome. Due to search frictions, the outside options will not bind. In line with Binmore, Rubinstein, and Wolinsky (1986), the threat points should then reflect the players' payoffs during a bargaining dispute. We assume that, in this case, production does not take

⁸Throughout the paper it will always be the case that workers benefit from accepting all job offers.

place while the firm does not pay the worker; for simplicity, the threat points of both players are then set to zero. According to Binmore et al. (1986), the bargaining power of the worker, $\beta \in (0, 1)$, should reflect the players' time preferences, which are assumed to be the same for both groups. Thus, the wages will be the same for both worker types. In a match with high productivity, the wage is

$$w^H = \beta y^H. \tag{11}$$

Further motivation for assuming the same wage for both groups is that wage discrimination is illegal in many countries; so it is of interest to explore the implications of equal wages for discrimination. In a match with low productivity, we assume a binding minimum wage w^L . Furthermore, we assume that the minimum wage is higher than the low productivity output

$$w^L > y^L, \tag{12}$$

implying that the firm incurs a loss as long as the match takes place. 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 the option of reducing the wage so that the match is profitable, EPL would not be relevant, since the firm, in that case, would never want to lay off the worker. We take w^L as exogenous; it could be given by some national law or from a collective agreement imposing a minimum wage. Note also that the minimum wage could be zero if the low productivity output y^L is negative. The key feature we need is for the match to be unprofitable for the firm, with the firm prevented from making the match profitable (by

cutting the wage) or laying off the worker.⁹

3 Equilibrium

We consider an equilibrium where all firms use the same hiring strategies; this is discussed further below. The steady-state share of employed workers of type i in jobs with low match quality, ε_i , is given by

$$\varepsilon_i = \frac{s(1 - E(\gamma | \gamma_i^S))}{s + E(\gamma | \gamma_i^S) \phi p_i}, \quad (13)$$

the unemployment rates for both groups are

$$u_i = \frac{s}{s + \phi p_i}, \quad (14)$$

and the fraction of all job seekers, both unemployed and employed in low-productivity matches, who are of type i , α_i , is

$$\alpha_i = \frac{n_i(u_i + (1 - u_i)\varepsilon_i)}{n_G(u_G + (1 - u_G)\varepsilon_G) + n_R(u_R + (1 - u_R)\varepsilon_R)}. \quad (15)$$

See Appendix A for a derivation of (13) and (14).

Furthermore, when all firms use the same hiring strategies, the workers' hiring probabilities are given by

⁹If wages are set in negotiations even for low-productivity matches and firing costs enter into the threat points of the firm, as assumed by, for example, Mortensen and Pissarides (1999), (12) would follow if the firing costs are sufficiently high (see the Online Appendix H, Section H.10).

$$p_{i\bar{\gamma}} = 1 \text{ if } \gamma_i^S = \{\underline{\gamma}, \bar{\gamma}\} \quad \text{and} \quad p_{i\bar{\gamma}} = 0 \text{ if } \gamma_i^S > \bar{\gamma}, \quad (16)$$

$$p_{i\underline{\gamma}} = 1 \text{ if } \gamma_i^S = \underline{\gamma} \quad \text{and} \quad p_{i\underline{\gamma}} = 0 \text{ if } \gamma_i^S = \bar{\gamma} \text{ or } \gamma_i^S > \bar{\gamma}. \quad (17)$$

In a steady-state equilibrium, free entry ensures that the value of a vacancy is zero:

$$V(\theta) = 0,$$

with V given by (10). Furthermore, firms hire a worker of type i iff this is profitable, that is, iff

$$J_i(\gamma, p_i) \geq V,$$

with $J_i(\gamma, p_i)$ given by (9).

3.1 Characterization and existence of equilibria

In this section we consider the existence of various types of equilibria in the model. To ensure that the economy is productive, we make the following (sufficient) assumption on parameter values. Denote the expected value of the signal γ by γ^M , with $\gamma^M = \eta\bar{\gamma} + (1 - \eta)\underline{\gamma}$.

Assumption 1 (The economy is productive):

$$(1 - \beta)y^H > \frac{1 - \gamma^M}{\gamma^M}(w^L - y^L) \quad (18)$$

Assumption 1 ensures that the value of a vacancy is positive when there are no firms in the market, that is, $V > 0$ in the limit $\theta = 0$. The exact form is chosen so that this is true in all the specifications we consider. Assumption 1 also ensures that it is always profitable to hire an applicant with a high signal (see Appendix B). Note that Assumption 1 is more easily satisfied the higher y^H , y^L , and γ^M are and the lower β and w^L are. Furthermore, it is satisfied for any $\underline{\gamma} \geq 0$, as long as y_H is high enough.

We start by demonstrating the existence of an equilibrium conditional on the hiring strategy (see the proof in Appendix C).

Lemma 1 (*Existence of an equilibrium, given a hiring rule*). *Given $\gamma_G^S \in \{\underline{\gamma}, \bar{\gamma}\}$ and $\gamma_R^S \in \{\underline{\gamma}, \bar{\gamma}\}$, there exists a unique $\theta^* > 0$ where $V(\theta^*) = 0$, $V(\theta) < 0$ for $\theta > \theta^*$, and $\partial V(\theta^*)/\partial \theta < 0$.*

In the standard search model, the value of a vacancy decreases monotonically with labor market tightness θ and there is a unique equilibrium. However, this is not necessarily the case in the present model. A higher θ implies that a badly matched worker will find a new job faster, reducing the expected duration of a bad match. Because of this effect, the value of a vacancy may actually be increasing in θ for some intervals and there may be multiple equilibrium θ levels for a given hiring strategy. This sort of multiplicity is the focus in Saint-Paul (1995), who shows that as a tighter labor market reduces firing costs because more workers will leave voluntarily, there may be a multiplicity of equilibria in labor market tightness. Our results do not depend on a multiplicity of equilibria in labor market tightness. To the contrary, if there are several equilibria, we restrict our attention to only one of them to keep the analysis tractable. Specifically, if there are several

equilibria, we choose that with the highest labor market tightness θ .¹⁰ (Incidentally, that equilibrium maximizes the expected utility of a new worker.) For a sufficiently high θ , the value of a vacancy will always be negative. Since V is continuous in θ for given hiring strategies, it follows that there exists a unique equilibrium θ^* where $V(\theta^*) = 0$, $\partial V(\theta^*)/\partial\theta < 0$, and $V(\theta) < 0$ for all $\theta > \theta^*$.

The next step is to explore optimal hiring strategies. The firm will hire an applicant if and only if the expected profits are positive, that is, if and only if (with $V = 0$)

$$J(\gamma, p_i) = \frac{\gamma}{r+s}(1-\beta)y^H + \frac{1-\gamma}{r+s+\phi p_i}(y^L - w^L) \geq 0, \quad (19)$$

where we use (9) and substitute out for the wage equation (11). The first term of (19) is positive, since the firm profits from a high-productivity match. The second term is negative, since the firm loses from a low-productivity match. The absolute value of this term decreases with ϕp_i , reflecting that the faster a worker in a low-productivity match can find a new job, the shorter the expected duration of the unprofitable match for the firm. Thus, an increase in p_i makes it more profitable to hire the worker; this is the key mechanism in the paper.

As will be clear below, several different equilibria exist in the model. We first consider the existence of a discriminatory equilibrium, where all firms hire Greens, irrespective of the value of the signal γ , but Reds are hired only if $\gamma = \bar{\gamma}$. Thus, $p_G = 1$ and $p_R = \eta$. As can be seen from (19), whether this discriminatory hiring strategy is optimal will depend on the combination of parameter values. We want to show that for given values of the other parameters, there exists an interval $[\underline{\gamma}^0, \underline{\gamma}^1)$ for the value of the low signal $\underline{\gamma}$ for

¹⁰We conjecture that our results go through for all stable θ , that is, whenever $V(\theta) = 0$ and $\partial V/\partial\theta < 0$.

which a discriminatory equilibrium exists. A complication is that θ and thus also ϕ are endogenous and thus depend on $\underline{\gamma}$. It can be shown that θ and ϕ are continuous and increasing in $\underline{\gamma}$.¹¹ This is intuitive, because a higher value of $\underline{\gamma}$ makes it more profitable for firms to enter the market. The bounds of the interval are defined as follows (with slight abuse of the notation to make it clear that the value of a filled job J is a function of γ , p_i , and θ ; $J(\gamma, p_i, \theta)$ - recall that $\phi = \theta q$ - and the value of a vacancy V is a function of θ and $\underline{\gamma}$).

Definition Given the discriminatory hiring rule $\gamma_G^S = \underline{\gamma}$, and $\gamma_R^S = \bar{\gamma}$, (i) the values $\underline{\gamma}^0$ and θ^0 are defined by $J(\underline{\gamma}^0, 1, \theta^0) = 0$ and $V(\theta^0; \underline{\gamma}^0) = 0$ and (ii) the values $\underline{\gamma}^1$ and θ^1 are defined by $J(\underline{\gamma}^1, \eta, \theta^1) = 0$ and $V(\theta^1; \underline{\gamma}^1) = 0$.

Thus, for $\underline{\gamma} = \underline{\gamma}^0$, the firm is indifferent to hiring a Green worker and, for $\underline{\gamma} = \underline{\gamma}^1$, the firm is indifferent to hiring a Red worker. Since J is increasing in both $\underline{\gamma}$ and p_i and $p_G > p_R$, it follows that $\underline{\gamma}^0 < \underline{\gamma}^1$. We are now ready to state our first main proposition (the proof is given in Appendix D).

Proposition 1 *There exists a non-empty interval $\underline{\gamma} \in [\underline{\gamma}^0, \underline{\gamma}^1)$ for which a discriminatory equilibrium exists, where Greens are hired irrespective of the signal while Reds are only hired for the signal $\bar{\gamma}$. For $\underline{\gamma}$ outside this interval, a discriminatory equilibrium of this type does not exist.*

The intuition behind the existence of the discriminatory equilibrium is, as explained above, that a bad match is more costly for the firm if the worker is Red than if the worker is Green. The reason is that other firms hire Green workers even with a bad signal, but

¹¹The proof is in Online Appendix H.8

they do not hire Red workers, implying that the expected duration of a bad match is longer for a Red worker. Thus, for a value of $\underline{\gamma}$ within this interval, it is profitable to hire a Green worker with a bad signal, but not profitable to hire a Red worker with a bad signal.

For values of $\underline{\gamma}$ above the interval, it is profitable to hire Red workers with a low signal, even if other firms discriminate, in which case discrimination cannot exist in equilibrium. For values of $\underline{\gamma}$ below the interval, it is not profitable to hire Green workers with a low signal, even if other firms do so; again, this sort of discrimination cannot exist in equilibrium.

In this equilibrium, firms have stricter hiring standards for Red workers than for Green workers. The following result is immediate.

Corollary 1 *In a discriminatory equilibrium, the unemployment rate for Red workers is higher than for Green workers: $u_R = s/(s + \eta\phi) > u_G = s/(s + \phi)$.*

Regarding wages, Green and Red workers have, by assumption, the same wages for the same productivity. The unconditional average wage depends on the proportion of workers in good and bad matches and, depending on the parameter values, this can go in either direction. (In Online Appendix Sections H.2 and H.3, we explore the case where wages are affected by outside options, implying that Red workers have lower wages for the same productivity in a discriminatory equilibrium.)

Neutral equilibria also exist in the model: one good, where both groups are hired, irrespective of the signal, and one bad, where a worker, irrespective of group, is only hired if the signal is high. The term good refers to the fact that this equilibrium yields higher utility for a new worker, while firms in both cases earn zero profit in equilibrium.

Formally, we obtain the following (the proof is given in Appendix E).

Proposition 2 (i) *There exists a cut-off $\underline{\gamma}^D$ such that for $\underline{\gamma} \geq \underline{\gamma}^D$ a neutral equilibrium exists where $\gamma_G^S = \gamma_R^S = \underline{\gamma}$ and for $\underline{\gamma} < \underline{\gamma}^D$ such a neutral equilibrium does not exist. (ii) *There exists a cut-off $\underline{\gamma}^U$ such that for $\underline{\gamma} \leq \underline{\gamma}^U$ a neutral equilibrium exists where $\gamma_G^S = \gamma_R^S = \bar{\gamma}$ and for $\underline{\gamma} > \underline{\gamma}^U$ such a neutral equilibrium does not exist. (iii) $\underline{\gamma}^D < \underline{\gamma}^0$ and $\underline{\gamma}^U > \underline{\gamma}^1$, which implies that when a discriminatory equilibrium of the type $\gamma_G^S = \underline{\gamma}$ and $\gamma_R^S = \bar{\gamma}$ exists, two neutral equilibria also exist.**

To understand the intuition behind these results, first observe that whenever a discriminatory equilibrium exists, the existence of the good neutral equilibrium would hold trivially if labor market tightness θ were given. Clearly, if it is profitable to always hire a Green worker when all other firms do the same, then the same must be true with a Red worker, since Red and Green workers are identical apart from type. However, θ is not given, so we must take into account the effect of a change in θ . Consider, first, the good neutral equilibrium, where Red workers are now also always hired, irrespective of the signal. In this case the expected duration of a bad match with a Red worker is shorter than in a discriminatory equilibrium. This increases the expected profits from hiring a Red worker, which leads to the entry of more vacancies, increasing θ . A higher value of θ will reduce the expected duration of a bad match, implying that firms will be willing to hire a worker with a lower probability of high productivity, that is, even for values of $\underline{\gamma}$ below $\underline{\gamma}^0$. Thus, the critical value $\underline{\gamma}^D < \underline{\gamma}^0$. Clearly, this good equilibrium will exist for all higher values of $\underline{\gamma}$.

Consider, next, the bad neutral equilibrium, where no worker is hired with a low signal. The same effect takes place, but in the opposite direction. The expected duration

of a bad match with a Green worker is longer than in a discriminatory equilibrium, which reduces the expected profits from hiring a Green worker. Lower expected profits lead to fewer vacancies and a lower θ , which implies that there will be values of $\underline{\gamma}$ above $\underline{\gamma}^1$ for which expected profits from hiring a worker with a low signal will be negative. This bad equilibrium will exist for all lower values of $\underline{\gamma}$.

A discriminatory equilibrium also exists where the roles are reversed, that is, the Greens are discriminated against. Again, if labor market tightness θ were given, it would follow trivially that the reversed discriminatory equilibrium would hold for the same interval for $\underline{\gamma}$. However, the loss for the employers caused by lower hiring probability under discrimination—and thus longer expected duration of a bad match—is greater the larger the discriminated group. Thus, if the Greens are the larger group, the expected profit of a vacancy for a given θ is lower in an equilibrium in which Greens are discriminated against than one in which Reds are discriminated against. This leads to the exit of vacancies, lowering θ . The lower value of θ increases the duration of a bad match, which implies that the equilibrium where Greens are discriminated against exists for higher values of $\underline{\gamma}$. Formally, we have the following result.

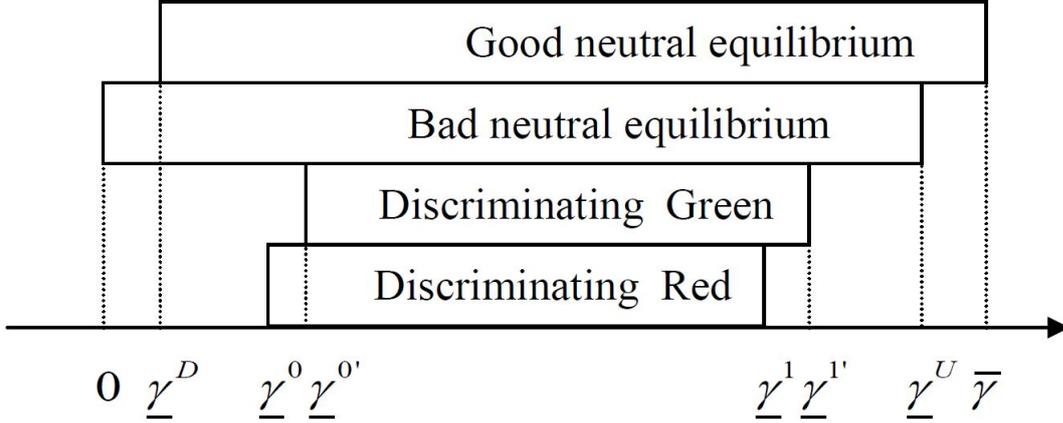
Proposition 3 *(i) There exists a discriminatory equilibrium with $\gamma_G^S = \bar{\gamma}$ and $\gamma_R^S = \underline{\gamma}$ when $\underline{\gamma} \in [\underline{\gamma}^{0'}, \underline{\gamma}^{1'})$, (ii) $\underline{\gamma}^{0'} > \underline{\gamma}^0$ and $\underline{\gamma}^{1'} > \underline{\gamma}^1$ when $n_G > n_R$, and (iii) $\underline{\gamma}^D < \underline{\gamma}^{0'}$ and $\underline{\gamma}^U > \underline{\gamma}^{1'}$, implying that when a discriminatory equilibrium of the type $\gamma_G^S = \bar{\gamma}$ and $\gamma_R^S = \underline{\gamma}$ exists, two neutral equilibria also exist.*

Proof. Parts (i) and (iii) are analogous to the proofs for Proposition 2 and therefore omitted. The proof of part (ii) is given in Appendix F. ■

Propositions 1 to 3 completely characterize the stable equilibria in the model as long

as Assumption 1 holds, ensuring that workers are always hired with a high signal. Figure 1 shows the intervals for which the various equilibria exist.

Figure 1: Existence of equilibria for different values of $\underline{\gamma}$



Note that all the equilibria are stable: If one firm deviates from the equilibrium hiring strategy, it will have very small impact on the probability, p_i , that a worker of type i is hired, conditional on being matched. Thus, the equilibrium hiring strategy will still be optimal for other firms. Furthermore, there does not exist a stable equilibrium in mixed strategies or where firms use different hiring strategies. This can be formally proven, along the following lines. Assume that all firms hire Greens, irrespective of signal; that a fraction κ of all firms hires all Reds, irrespective of signal; and that the remaining fraction $1 - \kappa$ hires only Reds with a high signal. This can be an equilibrium only if $J(\underline{\gamma}, p_R) = 0$. It is straightforward to show that there exists a $\kappa = \kappa^0$ where $J(\underline{\gamma}, p_R) = 0$. However, since $J(\underline{\gamma}, p_R)$ depends positively on p_i and hence on κ , this equilibrium is unstable, since $J(\underline{\gamma}, p_R) < 0$ for $\kappa < \kappa^0$ and $J(\underline{\gamma}, p_R) > 0$ for $\kappa > \kappa^0$.

3.2 Firing costs and wage setting

In the basic model, we impose the strong assumption that the firing costs are prohibitive. We now show that the main results also hold in a model where some workers are actually laid off. Consider an extension of the model that includes a third and lower level of productivity, y^{Min} , with $y^{Min} < y^L$. Furthermore, assume that y^{Min} is so low that firms prefer to lay off the worker and pay the firing costs. For the intermediate level y^L , firms still wait for voluntary transitions. Thus, the model now allows layoffs to happen (when y^{Min} is realized), but it also includes the key feature that if a bad match with intermediate productivity occurs, the firm will choose to wait until the worker leaves voluntarily. Hence, the same discriminatory equilibrium as before would exist, given similar conditions.

In Sections H.2 and H.3 in the Online Appendix H, we explore the more common way to model wage bargaining, where wages are affected by outside options. Since discriminated workers have worse outside options, they obtain lower wages for the same level of productivity. This makes them more attractive for firms, going against the discriminatory outcome. However, a discriminatory equilibrium still exists if the costs of a bad match are sufficiently high. We calibrate the model by the use of empirical estimates whenever possible and find that a discriminatory equilibrium exists under plausible parameter values. In particular, we find that firing costs need to exceed 87% of the average quarterly output to sustain a discriminatory equilibrium. This is well within the parameter range of firing costs explored by Mortenson and Pissarides (1999), which goes from zero to unity, measured as a fraction of the quarterly output per worker. Note also that in many countries employment protection may be more stringent or more strictly enforced

for minority groups subject to discrimination in the labor market. Thus, the firing costs may be sufficient to sustain the discriminatory hiring of a minority group, even if the firing costs for majority group workers are lower than the required threshold value.

4 Discussion

In this section we show that by modifying some of the features of the model, we are able to make a number of novel arguments and predictions. The main point of the paper is to show how discrimination can arise among profit-maximizing employers. However, since there is evidence that some firms have a taste for discrimination (e.g., Charles and Guryan, 2008), it would be interesting to see how this affects the model. More specifically, assume that a proportion $m \in (0, 1)$ of the vacancies, for exogenous reasons, always apply the discriminatory hiring rule: $\gamma_G^S = \underline{\gamma}$ and $\gamma_R^S = \bar{\gamma}$. Thus, these firms are willing to hire Red workers if they observe a good signal but not if they observe a bad one. Such behavior could arise from these employers receiving a certain disutility from hiring Red workers, as in Becker's model.

According to Becker's argument, the existence of some discriminatory firms makes it profitable for non-discriminatory firms to hire the workers that are discriminated against. In the Online Appendix H (Section H.1), we show that the opposite effect is at work in our model. More specifically, we show that if the share of firms with an exogenous discriminatory hiring rule exceeds a critical value \tilde{m} , profit-maximizing firms will also apply discriminatory hiring in equilibrium. Thus, the equilibrium with neutral hiring no longer exists. In this case, it is neutral hiring that is less profitable, which implies that it is the non-discriminatory hiring that is driven out of the market. Since both types of

firms apply the same hiring rule, they also make the same profits.

A thought-provoking implication of this result is that if the economy is in a discriminatory equilibrium, there is no power or mechanism that can take it to a different equilibrium. This implies that there is large scope for persistence. Consider a labor market where discrimination has prevailed historically, for reasons of taste and power, and where discrimination was also a part of the legislation. Then assume that the discriminatory legislation is removed and the taste for discrimination vanishes in the sense that new firms with neutral preferences gradually replace existing firms with a taste for discrimination. However, when the neutral firms enter, they too will practice discriminatory hiring, since the economy is in a discriminatory equilibrium where this is the profit-maximizing hiring strategy. Thus, the discriminatory equilibrium prevails, in spite of the removal of discriminatory legislation, even if all firms lose their taste for discrimination. To exit a discriminatory equilibrium, some sort of concerted action would be required to ensure that firms hire discriminated workers even if it is not profitable, or to ensure changes so that it becomes profitable to hire discriminated workers. This line of argument is consistent with descriptions of the evolution of racial segregation in the US labor market by Darity and Mason (1998), who argued that discriminatory practices were sustained long after the discriminatory legal practices were removed.

Next we consider how the outcome is affected by anti-discriminatory rules. In many countries, the authorities undertake various measures to reduce the extent of discrimination. One key measure is a hiring quota, where firms are required to have a certain proportion of hires from specific groups perceived to be subject to discrimination in the labor market (for a discussion of the US experience, see Holzer, 2007). This measure is

controversial and the effect varies across models. In the mentoring model of Athey et al. (2000), hiring quotas work to reduce discrimination, while the opposite effect can occur in the human capital investment model of Coate and Loury (1993). We capture a hiring quota by assuming that a proportion a of vacancies always apply the neutral hiring rule: $\gamma_G^S = \gamma_R^S = \underline{\gamma}$. With this specification, the hiring quota case is the mirror image of the case with a taste for discrimination above. It follows immediately that if a sufficient fraction of the firms follow the neutral hiring rule, the discriminatory equilibrium no longer exists (see Online Appendix H, Section H.1). Thus, in our model, affirmative action in the form of minimum hiring quotas works to counteract discrimination. If a hiring quota is at work in sufficiently many firms, it will also prevent discriminatory behavior in jobs that are not directly affected by the hiring quota.

In our model, workers are homogeneous except for color, so the model cannot address any link between discrimination and education. It turns out that in all OECD countries, the unemployment gap between immigrants and natives widens as the education level rises (OECD, 2008b, p. 114). However, if we assume that the costs of a bad match are greater for educated workers than for workers without education, our model would predict that discrimination is more likely for the educated workers. One reason for this assumption is that capital is complementary with the use of skilled labor (Hornstein, Krusell, and Violante, 2005) and presumably the increased use of capital increases the costs associated with a badly matched worker. Another reason is that jobs requiring more skills are often more complex, with the likely implication that the output is more sensitive to the suitability of the worker.

The mechanism we highlight may also be important for groups for whom there is

no underlying subjective reason for discrimination, such as racial or cultural prejudice. Old workers are a case in point. In contrast to immigrants, there are no issues of race or cultural or language skills. Yet in all OECD countries, the hiring rates of workers decline significantly after the age of 50, more sharply in some countries than in others (OECD, 2006, p. 132). There might be several reasons for this, which are not captured by our model. However, within our model, the drop in hiring rates will have negative feedback effects on the employability of older workers, since firms expect older workers to have a harder time finding another job in case the current one does not work out. Thus, given the lower hiring rates, our model predicts that older workers will be subject to discrimination in the labor market, in line with the OECD (2006) findings. Furthermore, our model is also consistent with the findings of Behaghel, Crépon, and Sédillot (2008). These authors find that a tax on firms laying off workers aged 50 and above had a negative effect on firms' hiring of workers in the relevant age groups, consistent with the mechanism proposed in our paper. Autor, Donohue, and Schwab (2006) find that the introduction of wrongful discharge laws have reduced state employment rates and that long-term effects are greater for older workers than for younger workers.

5 Concluding remarks

We offer a novel argument for the discriminatory outcomes of equally productive groups in labor markets where it is costly for firms to lay off workers. The key mechanism is that workers with low job-finding rates are risky to hire since they might stay for a long time, even in the case of a bad match. Discrimination is self-enforcing, since it is precisely because a group is discriminated against that it has lower job-finding

rates and thus becomes less attractive to hire. While non-discriminatory equilibria also exist in our model, these vanish if a sufficiently large proportion of employers have a taste for discrimination. Thus, the existence of discriminatory employers also makes it profitable for profit-maximizing firms to practice discriminatory hiring, in sharp contrast to the effect in Becker's model, implying that discrimination is the unique equilibrium outcome. However, if we alternatively assume that a sufficiently large share of employers hire according to the population shares of each group—a hiring quota—the discriminatory equilibrium vanishes.

The aim of this paper is to make a theoretical contribution about the possible existence of discrimination against a group of workers with identical productive characteristics as other workers. However, it is interesting to see whether key predictions correspond to the actual labor market situation of a group for whom there is evidence of discrimination in the labor market, namely immigrants. One prediction of the model is that workers from the discriminated group have a lower rate of job-to-job movement (see Appendix G). This is consistent with recent evidence from Norwegian matched employer–employee data, where Dapi (2013) finds that first-generation immigrants have a highly significant 40% lower probability than natives of direct job-to-job movement, controlling for other explanatory variables such as industry, county, and individual characteristics such as age, seniority, a dummy for part-time work, and education (in years). The effect is slightly smaller but still highly significant with firm fixed effects. A related prediction of our model is that workers from a discriminated group are more likely to experience an intermittent spell of unemployment between jobs; Barth, Bratsberg, and Raaum (2011) show that this is the case for immigrants in Norway. Furthermore, in almost all OECD

countries, immigrants are much more likely to hold temporary jobs than native-born persons, consistent with the idea that employers are reluctant to hire immigrants directly into permanent jobs with employment protection.

Another prediction of our model is that discrimination is positively related to the existence of EPL. One way to explore this prediction is to look at variations in EPL across countries and, as noted above, Kahn (2007) finds supporting evidence using micro data from the International Adult Literacy Survey for Canada, the United States, and five European countries. However, one problem with comparisons across countries is that there is large variation in effective job protection within countries and immigrants may find employment in other parts of the labor market where legislation is less strict. Thus, an alternative is to look at differences across sectors. Typically, employment protection is much stricter in the public sector and, indeed, in almost all OECD countries (Belgium being the only exception) immigrants are underrepresented in public sector jobs, as compared to native-born persons (OECD, 2007c, p. 73). In fact, even children of immigrants tend to be underrepresented in the public sector (OECD, 2007c, p. 85). While there are also other possible reasons for the underrepresentation of immigrants in the public sector, such as language requirements, the difference is nevertheless suggestive.

6 Appendices

Appendix A: Steady state conditions

Let ε_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

$$n_i \varepsilon_i (s + \phi p_i) (1 - u_i) = v q \mu (\gamma_i^S) (1 - E(\gamma | \gamma_i^S)) \alpha_i.$$

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

$$n_i (1 - \varepsilon_i) s (1 - u_i) = v q \mu (\gamma_i^S) E(\gamma | \gamma_i^S) \alpha_i.$$

Using the above two equations gives us

$$\varepsilon_i = \frac{s(1 - E(\gamma | \gamma_i^S))}{s + E(\gamma | \gamma_i^S) \phi p_i}.$$

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

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

Solving for the unemployment rate

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

Appendix B: Assumption 1 implies that $J(\bar{\gamma}, p_i) > 0$

For $\gamma = \bar{\gamma}$, we have that (using (19) and that $V = 0$ in equilibrium)

$$J(\bar{\gamma}, p_i) > 0 \Leftrightarrow (1 - \beta) y^H > \frac{r + s}{r + s + \phi p_i} \frac{(1 - \bar{\gamma})}{\bar{\gamma}} (w^L - y^L)$$

which clearly follows from (18) as $(r + s)/(r + s + \phi p_i) \leq 1$ and $(1 - \bar{\gamma})/\bar{\gamma} < (1 - \gamma^M)/\gamma^M$.

Appendix C: Proof of Lemma 1

For a given hiring rule we have that (from equation (10))

$$V(\theta) = \frac{-c/q(\theta) + (\alpha_G \mu(\gamma_G^S) E(J_G | \gamma_G^S) + \alpha_R \mu(\gamma_R^S) E(J_R | \gamma_R^S))}{r/q(\theta) + \alpha_G \mu(\gamma_G^S) + \alpha_R \mu(\gamma_R^S)}$$

Using that $\phi = 0$ and $\alpha_i = n_i$ when $\theta = 0$ gives

$$V(0) = \frac{n_G \mu(\gamma_G^S) E(J_G | \gamma_G^S) + n_R \mu(\gamma_R^S) E(J_R | \gamma_R^S)}{n_G \mu(\gamma_G^S) + n_R \mu(\gamma_R^S)},$$

With (using equation (19))

$$J_i(\gamma, p_i) = \frac{\gamma}{r+s} ((1-\beta)y^H + sV) + \frac{1-\gamma}{r+s} (y^L - w^L + sV)$$

As $J_i(\gamma, p_i)$ is increasing in γ it follows that

$$E(J_i | \gamma_i^S) \geq E(J_i | \gamma_i^S = \underline{\gamma}) = \gamma^M \frac{(1-\beta)y^H + sV}{r+s} + (1-\gamma^M) \frac{y^L - w^L + sV}{r+s}$$

Thus,

$$V(0) \geq \gamma^M \frac{(1-\beta)y^H + sV}{r+s} + (1-\gamma^M) \frac{y^L - w^L + sV}{r+s}$$

or

$$rV(0) \geq \gamma^M (1-\beta)y^H + (1-\gamma^M)(y^L - w^L)$$

Hence by Assumption 1 we have that $V(0) > 0$.

In the limit, we have $\lim_{\theta \rightarrow \infty} V = -c/r < 0$. As V is continuous in θ for given hiring

strategies, positive for low values of θ and negative for high values, it follows that there exist an equilibrium θ^* (conditional on hiring strategy) where $V(\theta^*) = 0$, $\partial V(\theta^*)/\partial\theta < 0$ and $V(\theta) < 0$ for all $\theta > \theta^*$.

Appendix D: Proof of Proposition 1

First we prove existence and uniqueness of $\underline{\gamma}^0$. In equilibrium, the expected value of hiring a worker of type i with a low signal is

$$J(\underline{\gamma}, p_i, \theta^*) = \frac{\underline{\gamma}}{r+s}(1-\beta)y^H + \frac{(1-\underline{\gamma})}{r+s+q(\theta^*)\theta^*p_i}(y^L - w_i^L) \quad (\text{D.1})$$

where we have used that $\phi^* = q(\theta^*)\theta^*$. From (D.1) it follows that $J(0, 1, \theta) < 0$ and from Assumption 1 that $J(\bar{\gamma}, 1, \theta) > 0$. Differentiating with respect to $\underline{\gamma}$ gives

$$\frac{dJ(\underline{\gamma}, p_i, \theta^*)}{d\underline{\gamma}} = \frac{\partial J(\underline{\gamma}, p_i, \theta^*)}{\partial \underline{\gamma}} + \frac{\partial J(\underline{\gamma}, p_i, \theta^*)}{\partial \theta} \frac{d\theta^*}{d\underline{\gamma}}$$

From equation (D.1) it is clear that $\partial J(\underline{\gamma}, p_i, \theta^*)/\partial \underline{\gamma} > 0$ and $\partial J(\underline{\gamma}, p_i, \theta^*)/\partial \theta > 0$, and since $d\theta^*/d\underline{\gamma} > 0$, we have that $dJ(\underline{\gamma}, p_i, \theta^*)/d\underline{\gamma} > 0$. As J is continuous and strictly decreasing in $\underline{\gamma}$, it follows that there exists a unique $\underline{\gamma}^0 \in (0, \bar{\gamma})$ such that $J(\underline{\gamma}^0, 1, \theta^0) = 0$, $J(\underline{\gamma}, 1, \theta^*) < 0$ for $\underline{\gamma} < \underline{\gamma}^0$, and $J(\underline{\gamma}, 1, \theta^*) > 0$ for $\underline{\gamma} > \underline{\gamma}^0$. Existence and uniqueness of $\underline{\gamma}^1$ are proved in the same way, and $\underline{\gamma}^0 < \underline{\gamma}^1$ because J is strictly increasing in p_i .

It now follows that for all $\underline{\gamma}^0 \in [\underline{\gamma}^0, \underline{\gamma}^1)$, it is profitable to hire Green workers with a low signal in a discriminatory equilibrium, while it is not profitable to hire Red workers with a low signal, implying that the discriminatory hiring strategy is profit maximising. Furthermore, for values of $\underline{\gamma}^0$ outside this interval, this discriminatory hiring is not profit maximising.

Appendix E: Proof of Proposition 2

(i) and (ii) Existence and uniqueness of $\underline{\gamma}^D$ and $\underline{\gamma}^U$ are proven in the same way as existence and uniqueness of $\underline{\gamma}^0$ in Proposition 1.

(iii) First we show that $\underline{\gamma}^D < \underline{\gamma}^0$. The definition of $\underline{\gamma}^D$ is

$$V(\theta^D; \underline{\gamma}^D, \gamma_G^S = \underline{\gamma}, \gamma_R^S = \underline{\gamma}) = \frac{-c + q(\theta^D)(\eta J(\bar{\gamma}, 1, \theta^D) + (1 - \eta)J(\underline{\gamma}^D, 1, \theta^D))}{r + q(\theta^D)} = 0,$$

with

$$J(\underline{\gamma}^D, 1, \theta^D) = \frac{\underline{\gamma}^D}{r + s}(1 - \beta)y^H + \frac{1 - \underline{\gamma}^D}{r + s + q(\theta^D)\theta^D}(y^L - w_i^L) = 0,$$

and the definition of $\underline{\gamma}^0$ is

$$\begin{aligned} V(\theta^0; \underline{\gamma}^0, \gamma_G^S = \bar{\gamma}, \gamma_R^S = \underline{\gamma}) \\ = \frac{-c + q(\theta)(\alpha_G(\eta J(\bar{\gamma}, 1, \theta^0) + (1 - \eta)J(\underline{\gamma}^0, 1, \theta^0)) + \eta\alpha_R J(\bar{\gamma}, \eta, \theta^0))}{r + q(\theta)(\eta + (1 - \eta)\alpha_G)} = 0, \end{aligned}$$

with

$$J(\underline{\gamma}^0, \eta, \theta^0) = \frac{\underline{\gamma}^0}{r + s}(1 - \beta)y^H + \frac{1 - \underline{\gamma}^0}{r + s + \eta q(\theta^0)\theta^0}(y^L - w_i^L) = 0.$$

As J increasing in $\underline{\gamma}$ and θ it is sufficient to show that $\theta^D > \theta^0$. This follows from the fact that for a given $\underline{\gamma}$ and θ , the value of hiring a Green worker is the same in the two hiring regimes, while the value of hiring a Red worker (for a given signal) is higher in the first regime, which implies that $V(\theta; \underline{\gamma}, \gamma_G^S = \underline{\gamma}, \gamma_R^S = \underline{\gamma}) > V(\theta; \underline{\gamma}, \gamma_G^S = \bar{\gamma}, \gamma_R^S = \underline{\gamma})$.

The proof of that $\underline{\gamma}^U > \underline{\gamma}^1$ is analogous and therefore omitted.

Appendix F: Proof of Proposition 3 part (ii)

Consider the lowest level of $\underline{\gamma}$ for when discriminatory hiring exist. If $n_G > n_R$, the

tightness θ is larger when $\gamma_G^S = \underline{\gamma}$ and $\gamma_R^S = \bar{\gamma}$ than when $\gamma_G^S = \underline{\gamma}$ and $\gamma_R^S = \bar{\gamma}$. This follows from the fact that for a given θ the value of a vacancy, V , is larger when $p = 1$ for the majority group rather than from the minority (from (10)). Since J is increasing in θ and $\underline{\gamma}$ we have that $\underline{\gamma}^{0'} > \underline{\gamma}^0$. Analogously we have that $\underline{\gamma}^{1'} > \underline{\gamma}^1$.

Appendix G: Greens have higher rate of job-to-job movements

From Appendix A we have that

$$\varepsilon_i = \frac{s(1 - E(\gamma | \gamma_i^S))}{s + E(\gamma | \gamma_i^S) \phi p_i}.$$

Thus we have that the rate of job-to-job movements are

$$\phi p_i \varepsilon_i = \phi p_i \frac{s(1 - E(\gamma | \gamma_i^S))}{s + E(\gamma | \gamma_i^S) \phi p_i} = \frac{s - sE(\gamma | \gamma_i^S)}{\frac{s}{\phi p_i} + E(\gamma | \gamma_i^S)}$$

Hence the rate of job-to-job movements ($\phi p_i \varepsilon_i$) are increasing in p_i and decreasing in $E(\gamma | \gamma_i^S)$, i.e. increasing in the $1 - E(\gamma | \gamma_i^S)$. Thus Greens have higher job-to-job transitions than Reds as $p_G > p_R$ and $1 - E(\gamma | \gamma_G^S) = 1 - \gamma^M > 1 - \bar{\gamma} = 1 - E(\gamma | \gamma_R^S)$. The result is intuitive: A higher job finding rate p_i increases the job-to-job transition. A higher probability of being in a low productivity match ($1 - E(\gamma | \gamma_i^S)$) also increases the job-to-job transitions.

7 References

- Acemoglu, Daron and Joshua D. Angrist (2001). “Consequences of Employment Protection? The Case of the Americans with Disabilities Act.” *Journal of Political Economy*, 109, 915-957.
- Arrow, Kenneth J. (1973). “The Theory of Discrimination.” In O. Ashenfelter (ed.), *Discrimination in Labor Markets*. Princeton University Press, 3-33.
- Athey, Susan C., Christopher Avery and Peter Zemsky (2000). “Mentoring and Diversity.” *American Economic Review*, 90(4), 765-786.
- Autor, David, John J. Donohue and Stewart Schwab (2006). “The Costs of Wrongful-Discharge Laws.” *The Review of Economics and Statistics*, 88(2), May, 211-231.
- Barth, Erling, Bernt Bratsberg and Oddbjørn Raaum (2012). “Immigrant wage profiles within and between establishments.” *Labour Economics*, 19(4), 541-556.
- Becker, Gary S. (1957). *The Economics of Discrimination*. University of Chicago Press.
- Behaghel, Luc, Bruno Crépon and Béatrice Sédillot (2008). “The perverse effects of partial employment protection reform: The case of French older workers.” *Journal of Public Economics*. Elsevier, 92(3-4), 696-721.
- Bertrand, Marianne and Sendhil Mullainathan (2004). “Are Emily and Greg More Employable than Lakisha and Jamal? A Field Experiment on Labor Market Discrimination.” *American Economic Review*, 94(4), 991-1013.
- Binmore, Ken G., Ariel Rubinstein and Asher Wolinsky (1986). “The Nash Bargaining Solution in Economic Modelling.” *Rand Journal of Economics*, 17(2), Summer, 176-188.
- Binmore, Ken G., Avner Shaked and John Sutton (1989). “An outside option experiment.” *Quarterly Journal of Economics*, 104(4), 753-770.

- Burdett, Kenneth and Dale T. Mortensen (1998). "Wage differentials, Employer Size and Unemployment." *International Economic Review*, 39, May, 257-273.
- Charles, Kerwin K. and Jonathan Guryan (2008). "Prejudice and Wages: An Empirical Assessment of Becker's The Economics of Discrimination." *Journal of Political Economy*, 116(5), 773-809.
- Coate, Stephen and Glenn C. Loury (1993). "Will Affirmative-Action Policies Eliminate Negative Stereotypes?" *American Economic Review*, 83(5), 1220-1240.
- Cornell, Bradford and Ivo Welch (1996). "Culture, Information, and Screening Discrimination." *Journal of Political Economy*, 104(3), 542-571.
- Dapi, Bjorn (2013). "*Immigrants and job-to-job movements.*" Work in progress, University of Oslo.
- Darity, William A. and Patrick L. Mason (1998). "Evidence on Discrimination in Employment: Codes of Color, Codes of Gender." *Journal of Economic Perspectives*, 12(2), 63-90.
- Davis, Steven J. and Till von Wachter (2011). "Recessions and the Costs of Job Loss." *Brookings Papers on Economic Activity*, 43(2), 1-72.
- Diamond, Peter A. (1982). "Wage Determination and Efficiency in Search Equilibrium." *Review of Economic Studies*, 49(2), 217-227.
- Fang, Hanming and Andrea Moro (2011). "Theories of statistical discrimination and affirmative action: A survey." In J. Benhabib, A. Bisin and M. Jackson (eds.), *Handbook of Social Economics*. North Holland, Vol. 1A, 133-200.
- Flanagan, David J. and Kenneth O'Shaughnessy (2005). "The Effect of Layoffs on Firm Reputation." *Journal of Management*, 31(3), 445-463.

- Holzer, Harry (2007). "The economic impact of affirmative action in the US." *Swedish Economic Policy Review*, 14, 41-71.
- Hornstein, Andreas, Per Krusell and Giovanni L. Violante (2005). "The effect of technical change on labor market inequalities." In P. Aghion and S. Durlauf (eds.), *Handbook of Economic Growth*. North Holland, Vol. 1B, Chapter 20, 1275-1370.
- Jacquemet, Nicolas and Constantine Yannelis (2012). "Indiscriminate discrimination: A correspondence test for ethnic homophily in the Chicago labor market." *Labour Economics*, 19(6), 824-832.
- Kahn, Lawrence M. (2007). "The Impact of Employment Protection Mandates on Demographic Temporary Employment Patterns: International Microeconomic Evidence." *The Economic Journal*, 117(521), pp. F333-F356.
- Lang, Kevin, Michael Manove and William Dickens (2005). "Racial Discrimination in Labor Markets with Posted Wage Offers." *American Economic Review*, 95(4), 1327-1340.
- Lang, Kevin, Jee-Yeon Lehmann (2012). "Racial Discrimination in Labor Markets: Theory and Empirics." *Journal of Economic Literature*, 50(4), 959-1006.
- Lundberg, Shelly J. and Richard Startz (1983). "Private Discrimination and Social Intervention in Competitive Labor Markets. " *American Economic Review*, Vol 73(3), 340-347.
- Mailath, George, Larry Samuelson and Avner Shaked (2000). "Endogenous inequality in integrated labor markets with two-sided search." *American Economic Review*, 90(1), 46-72.
- Morgan, John, and Felix Várdy (2009). "Diversity in the Workplace." *American Economic Review*, Vol 99(1), 472-475.
- Mortensen, Dale T. (1982). "The Matching Process as a Noncooperative Bargaining

- Game.” In J. McCall (ed.), *The Economics of Information and Uncertainty*. University of Chicago Press, 233-254.
- Mortensen, Dale T. and Christopher A. Pissarides (1999). “New Developments in Models of Search in the Labor Market.” In O. Ashenfelter and D. Card (eds.), *Handbook of Labor Economics*. North Holland, vol. 3B, 2567-2627.
- Nagypál, Éva (2007). “Learning by Doing vs. Learning about Match Quality: Can We Tell Them Apart?” *Review of Economic Studies*, 74(2), 537-566.
- OECD (1995). Employment Outlook
- OECD (2004). Employment Outlook.
- OECD (2006). Employment Outlook
- OECD (2007c). International Migration Outlook
- OECD (2008a). Employment Outlook
- OECD (2008b). A profile of immigrant populations.
- Oyer, Paul and Scott Schaefer (2002). “Sorting, quotas, and the Civil Rights Act of 1991: Who hires when it’s hard to fire?” *Journal of Law and Economics*, 45, 41-68.
- Petrongolo, Barbara and Christopher A. Pissarides (2001). “Looking into the Black Box: A Survey of the Matching Function.” *Journal of Economic Literature*, 39(2), 390-431.
- Pissarides, Christopher A. (1985). “Short-Run Dynamics of Unemployment, Vacancies, and Real Wages.” *American Economic Review*, 75(4), 676-90.
- Pries, Michael and Richard Rogerson (2005). “Hiring Policies, labor market institutions, and Labor Market Flows.” *Journal of Political Economy*, 113(4), 811-839.
- Rosén, Åsa (1997). “An Equilibrium Search-Matching Model of Discrimination.” *European Economic Review*, 41, 1589-1613.

Saint-Paul, Gilles (1995). “The High Unemployment Trap.” *Quarterly Journal of Economics*, 110(2), 527-550.

Shimer, Robert (2005). “The Cyclical Behavior of Equilibrium Unemployment and Vacancies.” *American Economic Review*, 95, 25-49.