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WHO IS HURT BY DISCRIMINATION?

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Who is hurt by discrimination ?

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Abstract

The effects of discrimination of immigrants on the labour market are studied within a search and wage-bargaining setting including a risk of losing skills during the experience of unemployment. The negative effects of discrimination in the form of higher unemployment and lower wages spread to all workers, immigrants and natives, in all sectors of the economy. The effect is stronger for immigrants, but natives suffer as well. An increase in the share of immigrants in the economy exacerbates the problem of discrimination.

1 Introduction

Labour market discrimination is a situation where individuals who are equally productive are treated unequally - receive lower wages or face lower demands for their services at a given wage - in a way that is related to an observable characteristic, such as race or ethnicity.

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In 2003, 90% of the respondents to the "Integrationsbarometer" (Swedish Integration Barometer), a survey carried out by Integrationsverket (Swedish Integration Board), thought that immigrants are discriminated against in Sweden. Furthermore, 9% of the respondents declared to have witnessed ethnic discrimination at their own workplace. Field experiments provide further evidence for the existence of discrimination. Carlsson and Rooth (2006) performed a field experiment in May 2005 to February 2006 that showed every fourth employer to discriminate against men with Arabic sounding names in the hiring process. Similar field experiments find evidence of discrimination in the selection of job interviews in Australia (Riach and Rich (1991)) and in the USA (Bertrand and Mullainathan (2003)).

The present paper takes into account that, because of discrimination, workers may end up in occupations below their qualifications. The problem of discrimination becomes more severe if workers are subject to the risk of losing skills during the experience of unemployment. If a worker's attachment to the labour market becomes very fragile due to discrimination, then her skills potentially deteriorate and the worker ends up searching for less qualified jobs. Hence, discrimination may not only result in natives and immigrants getting different pay for the same work but also in native and immigrants with similar skill levels to end up in different occupations, if in any occupation at all. This issue has previously been ignored in the theoretical literature.

Our purpose in this paper is to study theoretically the effects of discrimination of immigrants on labour market performance for both natives and immigrants, given that all workers are subject to a risk of losing skills during the experience of unemployment.[1]

We formulate a model of Becker-style taste discrimination within a search and wage-bargaining setting. Even an employer who does not dislike immigrants himself may think that it is against his interest to employ them if he expects that co-workers and clients will disapprove of immigrants. Not all firms discrim-

[1] See Larsen (2001) for a related set-up but not distinguishing between immigrants and natives.

inate against immigrants. For simplicity, we assume that neither job searchers nor firms opening a vacancy know whether discrimination will take place before the match. We motivate this by assuming that each firm has many interviewers, some of which dislike immigrants. We assume that firms cannot observe if a particular interviewer has such discriminatory tastes. A discriminatory interviewer does not offer a job to an immigrant. Discrimination implies that immigrants face a lower probability of getting a job.

An alternative way of modelling discrimination is to assume that immigrants are discriminated against when they separate from the job instead of upon entry. An immigrant worker will then either be fired or forced to resign due to discrimination with a probability that is higher than that of a native worker. This alternative set-up fits better with the assumption that neither job searchers nor employers can observe whether discrimination will take place in a particular firm. However, we believe that discrimination at entry is more common in the labour market; moreover, the two modelling strategies yield qualitatively similar results.

We assume for simplicity that all workers enter the labour market as skilled workers. Unemployed workers face the risk of losing their skills. If this happens, they can only search for jobs in the low productivity sector. Low productivity workers may regain their skills by accumulating work experience or by training when unemployed.

The model delivers the following results. Discrimination directly reduces an immigrant worker's transition probability out of unemployment and thereby deteriorates her wage-bargaining position. Discrimination therefore implies that wages received by immigrants are lower than wages received by natives, even when they face a non-discriminary employer. A lower hiring probability also implies that immigrants suffer higher unemployment rates, despite receiving lower wages. By being unemployed more often, immigrants are subject to a higher risk of losing their skills and the economy ends up with a higher proportion of immigrants than natives in low productivity jobs. Not only are immigrants affected by discrimination, but all workers in the economy are.

We perform comparative statics analysis where we analyse the effect on all workers of an increase in the level of discrimination and the share of immigrants in the economy.

Finally, we endogenize the training decision which allows us to examine how discrimination affects the relative skill levels of natives and immigrants.

Related Research

Empirical evidence supports that employment below ones qualifications and loss of skill is an important issue to consider. Firstly, Arai et al (2000) compare the percentage of immigrants in different occupations with the percentage of immigrants in the labour force in Sweden. Immigrants are overrepresented in only three out of 29 occupations, all of which require no education or training.[2] The authors estimate the likelihood of getting a qualified job, controlling for the years since immigration and the level of education. Immigrants born in the other Nordic countries or in Western Europe have a 25% lower probability of getting a qualified job than natives. The probability of getting a qualified job is 50% lower for immigrants born in Latin America and 70% lower for those born in East Europe, Asia or Africa, than for natives. Secondly, Reitz (2001) shows that the under-utilization of immigrant skills is significant in Canada. Finally, in an empirical study for Denmark, Nielsen et al (2004) show that a large fraction of the wage gap between immigrants and natives would disappear if only immigrants could find employment and thus accumulate work experience.

Most of the existing theoretical models introducing discrimination in the labour market emphasize two broad types of discrimination. The first is prejudice, which Gary Becker formalizes as a "taste" by at least some members of the majority group against interacting with members of the minority group. The

[2] Immigrants are overrepresented in handicraft (such as baker, butcher, tailor), service work that requires no vocational education / training (such as salesman, cleaner, newspaper distributor) and other work that requires no vocational education / training (such as unskilled labour in building and construction and other factory work). The underrepresentation in all other occupations is stronger for immigrants coming from Africa, Asia or Latin-America than for those born in Europe.

second is statistical discrimination by employers in the presence of imperfect information about the skills or behaviour of members of the minority group.

Simple models of taste-based discrimination often predict the elimination of discrimination through competition or segregation. Borjas and Bronars (1989) and subsequent papers merge ideas from search models of the labour market with Becker-style models of taste discrimination and obtain a number of important results. Rosén (1997), Flabbi (2004) and our own model belong to this group. The difference between our model and the models of Rosén, Flabbi and Borjas is that we incorporate in a thorough analysis of unemployment the risk that workers potentially lose skills.

The paper is organized as follows. In section 2 the model is set up. Section 3 incorporates the comparative statics. In section 4 we show the effect of relaxing simplifying assumptions and endogenize the training decision when unemployed. Section 5 concludes.

2 The model

We develop a model with two types of agents, workers and firms. Both workers and firms are risk-neutral and infinitely-lived and have a common discount rate. Workers may be either employed or unemployed. To hire new workers, firms must create a vacancy at a cost of k. Free entry drives the discounted profits from creating a vacancy to zero.

The economy is divided into two different sectors, called h and l. Firms in sector h require skilled workers with high productivity, while firms in sector l can employ low productivity workers. The skills of workers are observable, implying that low productivity workers never get a job offer in sector h.

The economy is populated by native and immigrant workers. The labour force is normalized at one. The proportion of native workers, n, is exogenously given.

In order to acknowledge that not all firms discriminate against immigrants we consider the following set-up:

- All firms have interviewers that meet job seekers, a proportion d_s of which dislike immigrants ($s = h, l$).
- When a discriminatory interviewer meets a skilled immigrant, she does not get a job offer.
- Firms cannot observe whether their own interviewers discriminate against immigrants or not. Neither job searchers nor the firm opening a vacancy know whether discrimination will take place before the match.
- Firms and workers only know that, with a given probability d_s $(s = h, l,)$, an immigrant worker will not get a job, and a vacancy will not be filled due to discrimination.

We assume for simplicity that all workers enter the labour market as skilled workers. A more realistic set-up where we assume that a proportion of workers are low skilled to start with, does not substantially modify the results. When unemployed, skilled workers lose their skills with probability λ. Workers who have lost their skills are only able to search for jobs in the low productivity sector. Workers may regain skills in two different ways: i).they can train while unemployed and become skilled unemployed, which happens at the rate γ and ii) they can get a low produvtivity job and regain their skills at rate a. For simplicity, γ and a are assumed to be exogenous and identical for natives and immigrants. An alternative would be to let workers decide whether they want to make an effort to train and become skilled again. We consider this case in an extension below.

2.1 Matching

Unemployed workers search for jobs in sector h or l, depending on their productivity level. The matching function for sector s is assumed to have the functional form $(v_s)^{\alpha} (u_s)^{1-\alpha}$, where v_s is the vacancy rate and u_s is the unemployment rate in sector $s = h, l$ and $0 < \alpha < 1$.

A native worker with productivity s gets a job offer at rate f_s^N. The transition rate into employment for a native worker of productivity s is given by $f_s^N = f(\theta_s) = \theta_s^\alpha$, $s = h, l$,where $\theta_s = v_s/u_s$ captures sectorial labour market tightness. An immigrant faces a discriminative interviewer with probability d_s, so the transition rate into employment for an immigrant worker of productivity s is reduced relatively to the transition rate of natives to $f_s^I = f(\theta_s)(1 - d_s) = \theta_s^\alpha (1 - d_s)$, $s = h, l$. The rate at which vacant jobs become filled is $q_s = q(1/\theta_s) = \theta_s^{\alpha-1}$, $s = h, l$.

2.2 Workers and firms

The arbitrage equations facing workers are given by

$$\rho U_h^J = f_h^J \left(W_h^J - U_h^J\right) + \lambda \left(U_l^J - U_h^J\right), \qquad J = N, I. \tag{1}$$

The present discounted value (PDV) of being an unemployed skilled worker of origin $j = N, I$ (natives or immigrants) is given by the likelihood that the worker changes state. With probability f_h^J she gets a job in the high productivity sector and receives the value W_h^J and with probability λ she loses skills and becomes a low skilled unemployed with value U_l^J.

$$\rho U_l^J = f_l^J \left(W_l^J - U_l^J\right) + \gamma \left(U_h^J - U_l^J\right), \qquad J = N, I. \tag{2}$$

Low skilled unemployed workers get a job in the low productivity sector with probability f_l^J and regain skills by training while unemployed at the rate γ. The value of γ is assumed to be exogenous but will be endogenized in an extension.

The present discounted utility for a skilled employed worker of origin J satisfies

$$\rho W_h^J = w_h^J + \sigma \left(U_h^J - W_h^J\right), \tag{3}$$

where w_{jh} is the wage received by skilled workers of origin j and σ is the rate of job separation, assumed to be the same for all workers. Similarly

$$\rho W_l^J = w_l^J + \sigma \left(a U_h^J + (1 - a) U_l^J - W_l^J\right). \tag{4}$$

We assume that, when workers separate from their jobs and join the pool of skilled unemployed, they have regained their skills a the rate a. With probability $(1-a)$, workers join the pool of low skilled unemployed after separation.

The present discounted value of a vacancy in sector s is

$$\rho V_s = q_s\left(\phi_s\left(X_s^N - V_s\right) + (1-\phi_s)(1-d_s)\left(X_s^I - V_s\right)\right) - k, \quad s = h, l. \quad (5)$$

q_s is the likelihood that a firm matches with any worker, ϕ_s is the proportion of natives among the unemployed workers of productivity s and k is the cost of opening a vacancy. With probability $q_s\phi_{s,}$ the vacancy can be filled by a native and provide a value X_s^N to the firm, while the probability of filling it with an immigrant is $q_s(1-\phi_s)(1-d_s)$ creating the value X_s^I.

Interviewers always hire the native worker they are matched with, but if they are discriminative, they do not hire an immigrant. As a consequence, there is a probability $q_s(1-\phi_s)d_s$ that the vacancy is not filled at all. Firms would prefer to avoid discriminative interviewers in this setting, but they can not as this characteristic is not observable.

The PDV of a job occupied with a worker of origin j, X_{jm} satisfies

$$\rho X_s^J = y_s - w_s^J + \sigma\left(V_s - X_s^J\right), \qquad s = h, l \text{ and } j = N, I. \quad (6)$$

The productivities y_h and y_l and the exogenous separation rate σ are assumed to be the same for natives and immigrants. Free entry drives the value of vacancies to zero in both sectors. Using equations (**??**) and (6) and setting $V_s = 0$ we obtain two equations to determine labour market tightness, θ_s $s = h, l$.

$$g_h = k\frac{1}{q_h}(\rho+\sigma) - \phi_h\left[y_h - w_h^N\right] - (1-\phi_h)(1-d_h)\left[y_h - w_h^I\right] = 0, \quad (7)$$

$$g_l = k\frac{1}{q_l}(\rho+\sigma) - \phi_l\left[y_l - w_l^N\right] - (1-\phi_l)(1-d_l)\left[y_l - w_l^I\right] = 0. \quad (8)$$

The matching function relates the rates at which vacant jobs become filled to labour market tightness. Note that, for given wages, a firm's outside option deteriorates when there are many unemployed immigrants in the unemployment

pool, that is when ϕ_s is small. In the next subsection we derive equilibrium wages which depend on labour market tightness through the transition rates into employment.

2.3 Wages

Wages are determined by Nash Bargaining with bargaining power equal to one half, so they are set to equalize the parties' outside options,

$$W_s^J - U_s^J = X_s^J.$$

For the skilled workers the equalization implies the wage rate

$$w_h^J = \frac{1}{2}\left(y_h + \rho U_h^J\right), \qquad J = N, I, \tag{9}$$

while, for the low skilled workers, the equilibrium wage is

$$w_l^J = \frac{1}{2}\left(y_l + \rho U_l^J - \sigma a\left(U_h^J - U_l^J\right)\right), \qquad J = N, I. \tag{10}$$

The wage of a low skilled worker decreases with σa, the rate by which an employed worker separates from the present match having regained skills. The possibility of regaining skills turns employment more attractive, so the worker is willing to accept a lower wage in the bargaining process.

Substituting equation (2) into the wages of low skilled workers, we obtain

$$w_l^J = \frac{1}{2}\left[y_l + f_l^J\left(W_l^J - U_l^J\right) + \gamma\left(U_h^J - U_l^J\right) - \sigma a\left(U_h^J - U_l^J\right)\right]$$

For simplicity, we assume that $\gamma = \sigma a$, that is, the rate by which a low skilled worker moves to the pool of skilled unemployed by training during unemployment equals the rate by which she enters that pool after separating from a job where she regained skills. This assumption implies that the last two terms in w_l^J cancel and the wages of low skilled workers become independent of the transition rate of skilled workers. The model becomes recursive and we can solve it analytically.

By inserting the PDV from equation (1)-(4) in equation (9) and (10) and solving the two equations we obtain:

$$w_l^J = \frac{\rho+\sigma+f_l^J}{2(\rho+\sigma)+f_l^J} y_l \qquad J=N,I, \tag{11}$$

$$w_h^J = \frac{\left[(\rho+\sigma)(\rho+\lambda+\gamma)+(\rho+\gamma)f_h^J\right] y_h + \lambda f_l^J \frac{\rho+s}{2(\rho+s)+f_l^J} y_l}{2(\rho+\sigma)(\rho+\lambda+\gamma)+(\rho+\gamma)f_h^J} \tag{12}$$

where $f_s^N = f_s$ and $f_s^I = f_s(1-d_s)$, $s=h,l$ and $J=N,I$.

Proposition 1 *Native workers receive higher wages than immigrants, $w_s^N > w_s^I$, $s=h,l$ as $f_s^N > f_s^I$. Also, skilled workers, of either origin, receive higher wages than low skilled workers, $w_h^J > w_l^J$, $J=N,I$ if $f_h > f_l$.*

Wages are increasing in the transition rates out of unemployment. Due to discrimination, skilled natives have a higher transition rate than skilled immigrants. This gives them a better bargaining position after a match, so they receive higher wages. Skilled workers receive higher wages than low skilled workers due to their higher productivity.

These equations together with equations (7) and (8), determine labour market tightness for the two sectors, $\theta_h = v_h/u_h$ and $\theta_l = v_l/u_l$.

A sufficient condition for the labour market tightness facing skilled workers to be higher than that facing low skilled workers, $\theta_h > \theta_l$ is that there is more discrimination in the low productivity sector, $d_h \leq d_l$ when the match efficiency $\alpha = \frac{1}{2}$. This implies that it is easier for a skilled worker to find a job than it is for a low skilled worker, $f_h > f_l$, irrespective of country of origin. This is only a sufficient condition and we can easily obtain $f_h > f_l$ even if discrimination is higher in the high productivity sector as long as the productivity difference is sufficiently large.

2.4 Unemployment

Steady state employment and unemployment for skilled and low skilled workers are derived by considering the flows into and out of employment and the fact that $e_l^N + e_h^N + v_h^N + v_l^N = n$ and $e_l^I + e_h^I + v_h^I + v_l^I = 1-n$, where $e_s^J\left(v_s^J\right)$

denotes employment (unemployment). We obtain the following unemployment rates for immigrants and natives:

$$u_s^N = \frac{\upsilon_s^N}{e_s^N + \upsilon_s^N} = \frac{\sigma}{\sigma + f_s}, s = h, l \tag{13}$$

$$u_s^I = \frac{\upsilon_s^I}{e_s^I + \upsilon_s^I} = \frac{\sigma}{\sigma + f_s\left(1 - d_s\right)}, s = h, l \tag{14}$$

Proposition 2 *Immigrants face higher unemployment than natives in both sectors. That is, the relative unemployment faced by immigrants relatively to natives for both high and low skilled workers,* u_h^I/u_h^N *and* u_l^I/u_l^N *are higher than one. The rate of unemployment facing skilled workers is lower than that experienced by low skilled workers as long as* $f_h > f_l$.

Both skilled and low skilled immigrants face an additional negative impact through discrimination, which increases unemployment of immigrants relatively to unemployment of natives. This is easily seen using equations (13)-(14).

The proportion of native workers among the unemployed high and low productivity workers are given by

$$\phi_h = \frac{1}{1 + \frac{(1-n)}{n}\kappa}, \quad \phi_l = \frac{1}{1 + \frac{(1-n)}{n}\frac{(\sigma+f_l)}{(\sigma+f_l(1-d_l))}\kappa},$$

where we assume that $\gamma = \sigma a$ and define $\kappa = \frac{\lambda+a(f_h+\sigma)}{\lambda+a(f_h(1-d_h)+\sigma)} > 1$. The additional negative impact of discrimination on low skilled workers results in relatively more natives among the skilled unemployed, $\phi_h > \phi_l$.

We now consider some partial impacts on the proportion of natives among the unemployed. When there are more immigrants searching for jobs, a lower n, this directly reduces the share of native unemployed workers. If discrimination increases, a higher d_s, there will be relatively more immigrants among the unemployed workers. When labour market tightness increases, workers' transition rates increase, reducing unemployment in particular for natives, as their transition rate is higher.

The unemployment facing high productivity workers is

$$\upsilon_h = \upsilon_h^N + \upsilon_h^I = \frac{n\sigma a}{\lambda + (\sigma + f_h)\, a} + \frac{(1-n)\,\sigma a}{\lambda + (\sigma + f_h\,(1-d_h))\, a}$$

and the unemployment facing low productivity workers is

$$v_l = \frac{\lambda n \sigma}{(\sigma + f_l)(\lambda + (\sigma + f_h)a)} + \frac{\lambda(1-n)\sigma}{(\sigma + f_l(1-d_l))(\lambda + (\sigma + f_h(1-d_h))a)}$$

The unemployment rate facing natives and immigrants are

$$u^J = \frac{u_h^J + u_l^J}{u_h^J + u_l^J + e_h^J + e_l^J} = \frac{\sigma\left(a\left(\sigma + f_l^J\right) + \lambda\right)}{\left(a\left(\sigma + f_h^J\right) + \lambda\right)\left(\sigma + f_l^J\right)}, \quad J = N, I \qquad (15)$$

Discrimination reduces the transition rates for immigrants respect to natives, $f_s^I < f_s^N$, so that the unemployment rate facing immigrants is higher than the one facing natives.

2.5 Skills

The difference in unemployment rates derived in the previous subsection has consequences for the distribution of skills.

Proposition 3 *Due to discrimination, the proportion of low skilled immigrants is higher than the proportion of low skilled natives in the economy.*

Proof. The proportion of high productivity workers among immigrants and natives are

$$\begin{aligned} \frac{v_h^I + e_h^I}{1-n} &= \frac{a(\sigma + f_h(1-d_h))}{(\lambda + a(f_h(1-d_h) + \sigma))}, \\ \frac{v_h^N + e_h^N}{n} &= \frac{a(\sigma + f_h)}{(\lambda + a(f_h + \sigma))}. \end{aligned}$$

We observe that

$$\frac{v_h^I + e_h^I}{1-n} < \frac{v_h^N + e_h^N}{n}, \quad \frac{v_l^I + e_l^I}{1-n} > \frac{v_l^N + e_l^N}{n}.$$

■

Discrimination means that the proportion of skilled workers among natives is higher than for immigrants and vice versa. In a model where natives and immigrants enter the economy with the same distribution of skills, immigrants become less skilled just because some interviewers refuse to offer them a job**.** Note that this result is independent of whether we have discrimination of low

skilled workers or not. This is due to the fact that the rate of regaining skills during the unemployment spell is equal to the rate of regaining skills through the spell of employment. On the other hand, if there is no discrimination of high skilled workers, the proportion of natives and immigrants among both high and low skilled workers are identical.

Next, we consider comparative statistics of an increase in the level of discrimination and an increase in the share of immigrants in an economy where some interviewers discriminate immigrants.

3 Comparative Statics

We will consider two different ways in which the labour market conditions of workers are altered, an increase in the level of discrimination and an increase in the share of immigrants in the economy. When labour market conditions change, this affects the bargaining position of a worker in the match. If her position has been strengthened, because of a better outside option, then she will be able to negotiate a higher wage. This is the direct effect of the change. But there is a firther indirect effect. Firms get discouraged by the fact that at least some workers require higher wages to accept the job and, therefore, they offer less vacancies. This reduces labour market tightness and, therefore, the probability that any worker in that sector (independently of the origin) gets employed. Therefore, the indirect effect affects both natives and immigrants in the sector.

In each of the following subsections we need to identify how the comparative statics affect the position of the different workers to assess the direct and the indirect effect they have on their wages and unemployment rates.

3.1 Effects of higher discrimination

In this section we perform comparative statics on the impact of an increase in the share of discriminatory interviewers on the rates of unemployment, the

distribution of unemployment, wages and the distribution of wages. The proofs are easily derived by differentiation.

The intuition behind the results is easier if we concentrate on discrimination in a single sector at a time. First, we consider the case when discrimination only appears in the high productivity sector. We will then describe the effect of an increase in the level of discrimination when it exists only in the low productivity sector. Last, we describe the effect of having discrimination in the whole economy. Empirical evidence is not conclusive with respect to which sector is the most affected by discrimination, but most theoretical papers assume that the problem is more acute for skilled immigrants. [3]

3.1.1 Discrimination of skilled workers

If discrimination is only present in the high productivity sector, it has no effect on the transition rates in the low productivity sector and the wage received by low skilled natives equals that of low skilled immigrants, due to the simplifying assumption ($\gamma = \sigma a$) that makes the model recursive. Furthermore, the proportion of natives among the unemployed is the same for skilled and non skilled workers, that is, $\phi_h = \phi_l$, as low skilled immigrants are only affected indirectly by discrimination in sector h.

When only skilled immigrants are discriminated, the sufficient condition that $d_h \leq d_l$ to ensure that $f_h > f_l$ no longer holds. If productivity differences are not sufficiently large, $f_h (1 - d_h) < f_l$ is a possibility. In this case it would be optimal for high skilled workers to search for low skilled jobs. In order to rule out this possibility we therefore assume that productivity differences are sufficiently large so that $f_h (1 - d_h) > f_l$ holds.

Proposition 4 *All wages in the high productivity sector decrease whenever the discrimination of skilled workers, d_h, increases. Wages of low skilled workers*

[3] In a companion paper, Waisman and Larsen (2007), we show that well educated immigrants suffer more than less educated immigrants when attitudes are more negative against them. We interpret this result as evidence that discrimination affects more the skilled workers.

are not affected. The relative wages of skilled immigrants and skilled natives, w_h^I/w_h^N*, decrease.*

As d_h increases, the wages of skilled immigrants are reduced directly by the deterioration in the bargaining position caused by higher discrimination and indirectly by the lower transition rate faced by all skilled workers. Wages of skilled natives are only affected by the lower transition rates, so relative wages of immigrants in the high productivity sector are reduced.

Due to the simplifying assumption that turns the model recursive, discrimination in the high productivity sector has no impact on the labour market tightness faced by low skilled workers. This implies that their wages are not affected.

Proposition 5 *Unemployment of all skilled workers increase when discrimination of skilled workers,* d_h*, increases. Skilled immigrants are more affected than skilled natives. Unemployment of low skilled workers is not affected by* d_h*.*

The direct effect of higher discrimination is that more skilled immigrants become unemployed and risk losing their skills, which would imply that they join the pool of low skilled unemployed. This direct effect affects immigrants only, increasing their relative unemployment rate among skilled workers, $\left(u_h^I/u_h^N\right)$.

The indirect effect is a reduction in the transition rates into employment for all skilled workers when less vacancies are opened. At the same time, discrimination conducted by some interviewers generates a reduction in wages which provides a positive externality on firms with non discriminatory interviewers. The first impact dominates and the total impact on labour market tightness is negative. Due to discrimination, natives are over-represented among skilled workers and are more affected by this negative indirect effect.

The impact on skilled natives' unemployment is smaller than the total impact on skilled immigrants' unemployment if

$$\frac{\lambda+\gamma}{\lambda+af_h+\gamma}\left(\frac{d_h}{f_h}\right)\frac{df_h}{dd_h}+1>0$$

If this is the case, $\left(u_h^I/u_h^N\right)$ increases with d_h. The relative unemployment rate of low skilled vs high skilled workers decrease for both immigrants $\left(u_l^I/u_h^I\right)$ and natives $\left(u_l^N/u_h^N\right)$.

3.1.2 Discrimination of low skilled workers

Wages are affected in the following way:

Proposition 6 *All wages decrease whenever the discrimination of low skilled workers, d_l, increases. Relative wages of immigrant vs. native low skilled workers, w_l^I/w_l^N, decrease with discrimination.*

Low skilled immigrants suffer from both the direct and the indirect effect of discrimination. Low skilled natives suffer only from the indirect effect, hence their wages decrease less than those of low skilled immigrants. More discrimination in the low productivity sector reduces vacancy supply and therefore the outside option even for low skilled natives and for skilled workers, as they are subject to a risk of losing skills. Skilled workers' bargaining position is then damaged and all skilled workers accept lower wages. The wage reduction increases their transition rate, which in turn has a positive effect on wages, but this effect is smaller than the wage reduction. The total impact on wages is then negative for all skilled workers.

The impact on relative wages of immigrants vs native skilled workers, w_h^I/w_h^N, is ambiguous as there are several diverging effects. As d_l increases, there is a direct negative impact on relative wages. In addition, high productivity sector workers' transition rate increases, tending to decrease relative wages. Finally, the reduction in the transition rate of low productivity workers has an ambiguous impact on relative wages as immigrants' wages already being lower dampens the impact.

Proposition 7 *When discrimination of low skilled workers, d_l increases, unemployment of skilled workers falls and the unemployment of low skilled workers increases. The relative unemployment of immigrant vs. native low skilled workers increases with d_l.*

The direct effect of higher discrimination in the low productivity sector is that more low skilled immigrants can not get a job. But all low skilled workers face higher unemployment due to the indirect effect that reduces the transition rates in this sector. This indirect effect hits stronger the immigrants as they are over-represented in the low productivity sector. The relative unemployment of low skilled workers, $\left(u_l^I/u_l^N\right)$, increases with d_l as a result of both the direct and the indirect effect.

When the value of being a low skilled worker decreases, all skilled workers accept a lower wage in order to avoid losing skills during the experience of unemployment. The lower wage makes skilled workers more attractive for firms and therefore more vacancies are opened in the high productivity sector. Hence, in this case the existence of discrimination in the low productivity sector provides a positive externality on the high productivity sector by weakening the skilled workers' outside option. This raises the labour market tightness in the high productivity sector and therefore reduces the unemployment of skilled workers. Hence, the discrimination of low skilled immigrants improves employment perspectives of all skilled workers.

The relative unemployment of immigrants $\left(u_l^I/u_h^I\right)$ and natives $\left(u_l^N/u_h^N\right)$ increase as u_l^J increases and u_h^J falls for $J = N, I$.

3.1.3 Discrimination in both sectors

When discrimination prevails in both sectors we can not obtain analytical results any more and turn instead to numerical solutions. The parameter values chosen (which are annual values) for this exercise are: the discount rate is set to $\rho = 0.08$; the separation rate is set to $\sigma = 0.08$.(see Millard and Mortensen 1997); the match efficiency is assumed to be $\alpha = 0.5$ (Pissarides 1995); y_l is normalized at one; y_h is set equal to 1.3 to obtain a relatively large difference between productivity levels in the two sectors and hiring costs are assumed to be $k = 0.6$. These costs are set in relation to the productivity of the high skilled workers in order to generate reasonable unemployment rates. In Sweden in 2005 the

fraction of natives was around $n = 0.9$ (www.scb.se).

The rest of the parameters are set to approximately match unemployment in Sweden in 2005, $u = 0.073$ (www.oecd.org), the fact that the unemployment of natives was 59% of the unemployment of immigrants (Integrationsverket [4]) and that the fraction of long term unemployed (more than 12 months of unemployment) was 19% (www.scb.se and www.oecd.org). In our model, the long term unemployed correspond to the workers that have lost their skills. We assume $\lambda = 0.25$ and $\gamma = 0.08$. This implies that $a = \gamma/\sigma = 0.8$. We assume in the benchmark that one fourth of the interviewers discriminate immigrants in both sectors[5]. The table in Appendix 4 shows the wages and unemployment rates of all workers in the economy as well as the share of skilled natives and immigrants.

We can start comparing our benchmark with an economy where immigrants are not discriminated at all. Discrimination reduces all wages, increases the rates of unemployment faced by all workers and reduces the share of skilled natives and immigrants. But the negative effect is much stronger for immigrants than for natives. In our numerical exercise, immigrants' wages are reduced by 3%, while natives' wages are reduced by less than 0.1%. The rates of unemployment faced by immigrants increase by more than 30%, while those faced by natives increase by less than 1%. The share of skilled natives decreases by almost 5% compared to less than 0.1% for natives. Natives are in this numerical analysis only marginally affected by discrimination.

The share of low skilled workers obtained in the exercise is close to the share of long term unemployed workers in Sweden, that is, those workers who are most likely to have lost their skills. Our numerical exercise shows that, due to discrimination, immigrants end up being less skilled than natives even if they entered the economy being as productive as natives. The share of skilled workers would be smaller had we not assumed, for simplicity, that all workers enter the economy being skilled. Furthermore,the difference in the skill composition of

[4] http://ivpxweb.digitalinformation.se/Database/

/Integrationsverket/Arbetslivet/Arbetslöshet/Arbetslöshet.asp

[5] Consistent with the results by Carlsson and Rooth (2006).

natives and immigrants would be larger if we had assumed that immigrants enter the economy with low skills to a higher extent.

In the rest of this subsection, the benchmark with $d_h = d_l = 0.25$ constitutes the basis from which we will study the effect of increasing the level of discrimination in one sector at a time.

Doubling of the share of interviewers that discriminate in the high productivity sector reduces the wages of skilled immigrants by 4% and increases the unemployment rate they face from 6.63% to 9.77%. The unemployment rate faced by skilled natives increases slightly from 5.05% to 5.14%. The reduction in skilled natives' wages and the increase in the unemployment rate faced by all low skilled workers are very small (they all change by less than 1%). The share of skilled immigrants falls by almost 9%, while the share of skilled natives decreases by only 0.3%.

The same increase in the level of discrimination in the low productivity sector affects mainly the low skilled immigrants, whose wages decrease by 5.3% while the unemployment rate they face increases from 8.6% to 12.53%. The unemployment rate faced by low skilled natives increases from 6.59% to 6.69%. All other wages and unemployment rates change by 1% at the most. The share of skilled workers, both natives and immigrants, increase slightly.

The simulations basically confirm the results derived in the previous subsections. In general, the effect of an increase in the level of discrimination on the wages has a smaller order of magnitude than the effect on the unemployment rates.

When we allow for different levels of discrimination in the two sectors we find the following additional results worth noting:

- When discrimination is higher in the low productivity sector, the relative wages of immigrants vs natives are higher for the skilled workers and vice versa, that is, $\left(w_h^I/w_h^N\right) \gtrless \left(w_l^I/w_l^N\right)$ when $d_h \lesseqgtr d_l$.

- When discrimination is higher in the high productivity sector, the relative unemployment of immigrants vs natives is larger for the skilled work-

ers than for the low skilled workers and vice versa, that is, $\left(u_h^I/u_h^N\right) \gtrless \left(u_l^I/u_l^N\right)$ when $d_l \lesseqgtr d_h$.

- When discrimination is higher in the high productivity sector, the relative unemployment of low skilled vs skilled natives is higher than that of low skilled vs skilled immigrants and vice versa, that is, $\left(u_l^N/u_h^N\right) \gtrless \left(u_l^I/u_h^I\right)$ when $d_l \lesseqgtr d_h$.

3.2 Effects of higher share of immigrants

In this subsection we perform comparative statistics on an increase in the proportion of immigrants in the population, while the total work force is still normalized at one. If there is discrimination in one sector, then an increase in the share of immigrants searching for a job in that sector makes vacancies less attractive, as the probability that they will be filled is now smaller. We will describe the effect of an increase in the share of immigrants on wages and unemployment rates. The proofs are easily derived by differentiation.

3.2.1 Discrimination of skilled immigrants

Proposition 8 *When the share of immigrants rises in an economy where only skilled immigrants are discriminated, then wages received by all skilled workers decrease. The impact on relative skilled wages across population groups is ambiguous. Wages received by low skilled workers remain unchanged.*

When there are more immigrants in the work force, the likelihood that a high productivity firm with a discriminatory interviewer matches with one of them is higher and this makes vacancies less attractive. The bargaining position of all workers in the sector is weakened, so they accept lower wages. The reduction in wages itself increases the transition rates for skilled workers, which in turn leads to a smaller reduction in wages. The impact on the relative wages of immigrant vs natives skilled workers $\left(w_h^I/w_h^N\right)$ is ambiguous. When the high productivity sector workers' transition rates increase, this tends to decrease the

wages of immigrants relative to natives. However, this impact is modified due to immigrants' transition rate already being the lower.

Due to the simplifying assumption relating the rates at which workers regain skills, discrimination in the high productivity sector has no impact on the labour market tightness faced by the low skilled workers. This implies that their wages are not affected.

Proposition 9 *When the share of immigrants increases in an economy where only skilled immigrants are discriminated against, the unemployment rate of all skilled workers increases. The unemployment rate of skilled natives increases relatively more than that of skilled immigrants. The unemployment of low skilled workers remains unchanged.*

When vacancies become less attractive, more skilled immigrants end being unemployed. Note that the impact is purely a result of discrimination which reduces the rate by which an open vacancy is filled and thereby reduces the equilibrium number of vacancies supplied in the economy. The prevalent discrimination means that skilled natives are working to a higher extent, so they are more affected by the reduction in the transition rates in the high productivity sector. As a consequence, the relative unemployment rate of immigrant vs native skilled workers $\left(u_h^I/u_h^N\right)$ decreases. The relative unemployment of low skilled vs skilled workers $\left(u_l^J/u_h^J\right)$ decreases for both natives and immigrants. This is because u_l^J is constant and u_h^J increases for $J = N, I$.

3.2.2 Discrimination of low skilled workers

Proposition 10 *In an economy where low skilled immigrants are discriminated against, a higher proportion of immigrants, a higher* $(1-n)$*, lowers wages received by all low skilled workers. The impact on skilled workers' wages and relative wages is ambiguous.*

An increase in the share of immigrants makes opening a vacancy in the low productivity market less attractive. The fall in the transition rate of low skilled

workers when less vacancies are opened deteriorates their bargaining position causing them to accept lower wages. Even skilled workers are induced to accept lower wages to avoid unemployment and the risk of losing skills, but the lower wages themselves lead to an increase in the transaction rate that raises wages again. The total effect on skilled workers' wages is ambiguous.

As natives are employed to a higher extent, they are more affected by the reduction in wages. But the fact that immigrants' wages were already lower dampens the impact. The effects on relative wages for immigrant vs. native skilled workers $\left(w_h^I/w_h^N\right)$ and low skilled workers $\left(w_l^I/w_l^N\right)$ are ambiguous.

Proposition 11 *When the share of immigrants,* $(1-n)$*, increases in an economy where only low skilled immigrants are discriminated against, the unemployment rates of all low skilled workers increase, while the unemployment rates of all skilled workers fall. The unemployment of low skilled natives increases more than the unemployment of low skilled immigrants. The relative unemployment of skilled workers is kept unchanged.*

Fewer vacancies reduce the transition rate of all low skilled workers and increase their unemployment. As low skilled natives are employed to a higher extent, they suffer a higher increase in unemployment whereby the relative unemployment rate for immigrant vs native low skill workers $\left(u_l^I/u_l^N\right)$ decreases.

The fall in the transition rate of low skilled workers even deteriorates the wage-bargaining position of skilled workers. Skilled workers accept lower wages to avoid unemployment and the potential loss of skills. As there is no discrimination in the high productivity sector, all workers there are equally affected by the indirect effect, so relative unemployment for immigrant vs native skilled workers $\left(u_h^I/u_h^N\right)$ remains unchanged.

3.2.3 Discrimination in both sectors

The comparative analysis when discrimination is present in both sectors in only possible in a numerical exercise. We start from the same benchmark defined in subsection 3.1.3 and analyze two different increases in the share of immigrants

in the economy: i) we double the share of immigrants and ii) we increase this share by the same amount of percentage points as we increased the level of discrimination. These two exercises allow us to compare the effect on wages, unemployment rates and skills of an increase in the share of immigrants with the effect of an increase in the level of discrimination.

A doubling of the share of immigrants in the economy decreases the wages of all agents by 0.1% at most and increases the unemployment rates they face by 0.6% at most. If the share of immigrants in the economy increases by from 10% to 35%, the wages of all agents still increase by 0.1% at most while the unemployment rates increase by 1.2% at most. In both exercises the share of skilled workers (natives and immigrants) decreases slightly.

Our numerical example shows that the effect of an increase in the share of immigrants has a much smaller order of magnitude than the effect of an increase in discrimination.

4 Extensions

4.1 Comparative analysis with $\gamma \neq \sigma a$

In the main text we have assumed that $\gamma = \sigma a$ as a devise to make the model recursive. When we relax this assumption, wages in the low productivity sector depend on the difference in the value of being a high skilled vs a low skilled unemployed according to the following equation:

$$w_l^J = \frac{1}{2}\left[y_l + f_l^J\left(W_l^J - U_l^J\right) + (\gamma - \sigma a)\left(U_h^J - U_l^J\right)\right]. \tag{16}$$

Let us compare to the case where $\gamma = \sigma a$. When $\gamma > \sigma a$ the low skilled worker's outside option improves, as the probability of regaining skills is higher while unemployed. This tends to increase the wages of low skilled workers. When $\gamma < \sigma a$, then the opposite holds: low skilled workers are more eager to get a job as training opportunities are now relatively higher while employed.

The new equilibrium wages and shares of natives among the unemployed in both sectors in the economy are presented in Appendix 1. The unemployment

rates are defined by the same functions as before, they are only affected through the changes in the transition rates.

We now examine the impact on wages and unemployment of increasing the probability of regaining skills in a numerical exercise where parameters have the same values as in subsection 3.1.3. In the graphs in Appendix 2, we observe that both wages and unemployment rates increase when the probability of regaining skills when unemployed, γ, increases for a given σa. An increase in the probability of regaining skills while unemployed raises the low skilled worker's outside option and increases the wages of low skilled workers. It also improves the outside option of skilled workers as, if they happen to lose their skills, they will more easily regain them and, furthermore, they face higher wages when unskilled. A better outside option means that skilled workers get better wages as well. Fewer vacancies are therefore created in both sectors.

The effect of an increase in γ is stronger for low skilled workers, as they are more directly affected. The stronger negative impact on labour market tightness and therefore low skilled worker's transition rate, implies that they face a stronger increase in unemployment. Hence, a larger increase in the rate by which low skilled workers regain skills induces a negative impact on workers due to the increase in unemployment and a positive impact on workers due to the increase in wages.

Simulations however show that relaxation of this simplifying assumption changes little the effect on wages and unemployment rates of an increase in discrimination or the share of immigrants. The main difference is that discrimination in the high productivity sector now affects low skilled workers' wages as well. When $\gamma > \sigma a$, the wages received by low skilled immigrants fall, while w_l^I was unaffected by d_h when $\gamma = \sigma a$. The reduction in wages received by skilled workers causes an increase in labour market tightness in the low productivity sector which reduces low skilled workers' unemployment. When $\gamma < \sigma a$, wages of low skilled immigrants instead increase with d_h. This is the case as low skilled workers are more eager to get a job when $\gamma < \sigma a$ because they regain skills more frequently while employed than when unemployed. Therefore, when

discrimination facing high skilled workers increase, their outside option deteriorates and they become relatively less eager to get a job which corresponds to an improvement of their bargaining position. The wage induces a negative impact on vacancy supply in the low productivity sector whereby labour market tightness falls. The effect on unemployment is however very small in our numerical example.

4.2 Endogenous training

In the previous subsection we have showed the effect on wages and unemployment of an increase in the exogenous rate at which skills are regained by an unemployed low skilled worker. This rate was assumed to be identical for natives and immigrants. We will now ask a different question. We would like to know to which extent would low skilled unemployed individuals choose to train and regain skills if they could do it at a cost and analyze how this decision is affected by discrimination.

We assume that low skilled unemployed individuals face different costs of training every period. We think on this cost in terms of effort. The exact amount of effort a worker needs in a particular period depends on the location and time where this training is provided, whether she is healthy or sick, etc. These factors vary over time, so the worker does not know in advance how costly it would be for her to train. Each worker only knows the distribution of these costs in the population, which is assumed to be the same for natives and immigrants. This distribution determines the percentage of natives and immigrants choosing to train, which is equal to the probability that each worker will regain her skills. Once the choice to train becomes endogenous, immigrants will face different probabilities of regaining skills than natives because discrimination alters the value of skills.

Every period in which they happen to be low skilled unemployed, natives and immigrants compare the value of skills with the cost of regaining skills they face in that particular period and decide whether to train or not. Notice that a

worker that chose to train because he had a low cost of training in one period may instead have a very high cost next time he happens to get unemployed. The costs a worker gets over time are completely independent. This is equivalent to assuming that the low skilled unemployed draw costs from a lottery in each period.

Let the distribution of the cost of training $c_{i,}$ be uniformly distributed between 0 and 1 and identical for natives and immigrants. The value of skills is the same for all natives irrespective of the cost, and the same is true for immigrants. All workers will choose to train if their cost is lower or equal to the value skills have for them.

The value of regaining skills, for a given share of low skilled unemployed of origin J that decide to train γ^J, is defined as

$$\begin{aligned}
\rho Z^J\left(\gamma^J\right) &= \rho U_h^J\left(\gamma^J\right) - \rho U_l^J\left(\gamma^J\right) \ , \\
&= \rho U_h^J\left(\gamma^J\right) - \frac{\rho}{(\rho+sa)}\left[2w_{jl} - y_l + saU_h^J\left(\gamma^J\right)\right] \ , \\
&= \rho\left[2w_h^J\left(\gamma^J\right) - y_h\right] - \frac{\rho}{(\rho+sa)}\left[2w_{jl} - y_l + sa\left(2w_h^J\left(\gamma^J\right) - y_h\right)\right] \\
&= \frac{\rho}{(\rho+sa)}\left\{\left[2w_h^J\left(\gamma^J\right) - y_h\right] - \left[2w_l^J\left(\gamma^J\right) - y_l\right]\right\}.
\end{aligned}$$

Workers choose to train as long as $\rho Z^J \geqslant c_{i.}$ Let $\widehat{c^J}$ be the cost of the marginal low skilled unemployed of origin J that chooses to train, so that $\rho Z^J = \widehat{c^J}$. Given that c_i is uniformly distributed between 0 and 1 for $J = N, I$, the proportion of workers of origin J that choose to train is equal to $\widehat{c^J}$. We have until now called this proportion γ^J. This means that the equilibrium condition that determines the optimal proportion of low skilled unemployed choosing to train is $\rho Z^J\left(\gamma^J\right) = \widehat{c^J} = \gamma^J$. The optimal proportion is then solved as a fixed point:

$$\frac{\rho}{(\rho+sa)}\left\{\left[2w_h^J\left(\gamma^J\right) - y_h\right] - \left[2w_l^J\left(\gamma^J\right) - y_l\right]\right\} = \gamma^J, \qquad J = N, I. \tag{17}$$

Incorporating equation (17) to the model for natives and for immigrants, we can solve for the optimal choice in our numerical exercise.

If discrimination prevails in the high productivity sector, skills are more valuable for natives than for immigrants, so they choose to train to a larger extent. Consequently, $\gamma^N > \gamma^I$ when $d_h > 0$ and $d_l = 0$. If discrimination exists instead in the low productivity sector only, then the value of being able to regain skills is the highest for the low skilled immigrants. Training means that they can escape the sector where they are discriminated against and move into a sector where productivity is larger and where they are as likely to get jobs as natives. This means that $\gamma^I > \gamma^N$ when $d_l > 0$ and $d_h = 0$.

The graphs in Appendix 3 show the results of the comparative statics analysis of increasing discrimination in one sector at a time in the presence of discrimination in both sectors when the decision to train is endogenous. We assume that $d_s = 0.25$ in the sector where discrimination is constant.

As discrimination in the high productivity sector increases, the value of skills decreases for all workers, so less of them choose to train. The effect is much stronger for immigrants that suffer discrimination directly. When $d_h > d_l$, then $\gamma^N > \gamma^I$. When d_h is much lower than d_l, then $\gamma^I > \gamma^N$. But natives choose to train to a higher extent than immigrants already when $d_h < d_l$. The reason for this is that discrimination has a larger impact on wages in the high productivity sector than in the low productivity sector as wages in the high productivity sector are relatively higher.

As discrimination in the low productivity sector increases, the value of skills increases for all workers. As a consequence, more workers of both origins choose to train. The effect is much stronger for immigrants that suffer discrimination directly. When d_l is low relative to d_h, then $\gamma^N > \gamma^I$. When d_l is much larger than d_h,then $\gamma^I > \gamma^N$. But natives choose to train to a higher extent than natives still when $d_l > d_h$, until the difference in discrimination becomes high enough. This is the case for the same reason as above: discrimination has a larger impact on wages in the high productivity sector than in the low productivity sector as wages in the high productivity sector are relatively higher.

The numerical analysis shows that, when the same level of discrimination prevails in both sectors $d_l = d_h = 0.25$ and the share of immigrants increases,

the effect of d_h prevails and the value of skills decreases for all workers. This means that less workers of both origins choose to train and the optimal share is higher for the natives than for immigrants for all shares n.

5 Conclusion

We formulated a model of employer discrimination within a search and wage-bargaining setting, where workers are subject to a risk of losing skills during the experience of unemployment. We allowed low skilled workers to regain skills both during employment and during training while unemployed. We assumed that discrimination takes the form of a share of interviewers that refuses to offer a job to immigrants. We then analyzed the equilibrium implication of discrimination and how the economy responds to higher discrimination facing high and low productivity workers and a larger share of immigrants.

Discrimination directly reduces an immigrant worker's transition out of unemployment and thereby deteriorates her outside option in the wage-bargaining situation. Consequently, discrimination causes wages received by immigrants to be lower than wages received by natives, even when immigrants face a non-discriminatory employer. A lower transition rate also implies that immigrants suffer higher unemployment rates, despite receiving lower wages. As immigrants experience more unemployment they also face a higher risk of losing their skills. Therefore, the economy ends up with a higher proportion of immigrants than natives in low productivity jobs.

When discrimination increases in the high productivity sector, unemployment increases and skilled sector wages fall. Skilled immigrants' labour market outcomes are affected to a larger extent than natives'. The share of skilled immigrants decreases more than that of skilled natives.

When the share of discriminatory interviewers in the low productivity sector increases, low skilled workers face lower wages and higher unemployment. Low skilled immigrants are again worse hit by discrimination than low skilled natives. However, skilled workers accept lower wages facing a worsened outside option

and thereby the unemployment rate they face falls. More discrimination in the low productivity sector enhances the share of skilled natives and immigrants.

An increase in the share of immigrants in the economy exacerbates the negative impacts on labour market performance due to discrimination. If discrimination could be eliminated, then an increase in the share of immigrants would have no effect in this model.

Finally, we endogenized the decision to train in order to regain skills while unemployed. When only high skilled workers face discrimination, then skills are more valuable for natives as they are more likely to keep them. Therefore more natives than immigrants choose to train and regain skills. If, instead, low skilled workers are subject to discrimination, then immigrants value skills more than natives as skills allow them escape discrimination. Hence, relatively more immigrants than natives regain skills.

Even when we assume that discrimination exists only in one sector of the economy, its negative effects spread to all workers in both sectors. The effect is stronger for immigrants, especially those that are directly discriminated against, but natives suffer as well, even if they work in the sector in which discrimination is absent. Holding skills allowing you to apply for jobs in the sector where there is no discrimination and/or holding the 'right' ethnicity do not offer full protection against the negative consequences of discrimination.

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Appendix 1

In Section 4, subsection 4.1, we relax the assumption that $\gamma = \sigma a$. This turns the model non-recursive and makes it impossible for us to obtain analytical solutions for the comparative statistics. But we can still solve the model numerically. The equilibrium wages when $\gamma \neq \sigma a$ are:

$$w_l^J = \frac{\left\{ \begin{array}{c} \left[\begin{array}{c} \left(2\left(\rho+\sigma\right)\left(\rho+\lambda+\gamma\right)+\left(\rho+\gamma\right)f_h^J\right)* \\ \left(y_l\left(\rho+\sigma+f_l^J\right)\left(\rho+\lambda+\gamma\right)+\left(\gamma-\sigma a\right)\left(f_h^J y_h - f_l^J y_l\right)\right) \end{array} \right] \\ -\left(\gamma-\sigma a\right)f_h^J\left(y_h\left(\left(\rho+\sigma\right)\left(\rho+\lambda+\gamma\right)+\left(\rho+\gamma\right)f_h^J\right)+\lambda f_l^J y_l\right) \end{array} \right\}}{\Omega},$$

$$w_h^J = \frac{\left\{ \begin{array}{c} -\lambda f_l\left(y_l\left(\rho+\sigma+f_l^J\right)\left(\rho+\lambda+\gamma\right)+\left(\gamma-\sigma a\right)\left(f_h^J y_h - f_l^J y_l\right)\right) \\ +\left[\begin{array}{c} \left(\left(2\left(\rho+\sigma\right)+f_l^J\right)\left(\rho+\lambda+\gamma\right)+f_l^J\left(\sigma a-\gamma\right)\right)* \\ \left(y_h\left(\left(\rho+\sigma\right)\left(\rho+\lambda+\gamma\right)+\left(\rho+\gamma\right)f_h^J\right)+\lambda f_l^J y_l\right) \end{array} \right] \end{array} \right\}}{\Omega},$$

where $\Omega = \left\{ \begin{array}{c} \left[\begin{array}{c} \left(\left(2\left(\rho+\sigma\right)+f_l^J\right)\left(\rho+\lambda+\gamma\right)+f_l^J\left(\sigma a-\gamma\right)\right)* \\ \left(\left(2\left(\rho+\sigma\right)\left(\rho+\lambda+\gamma\right)+\left(\rho+\gamma\right)f_h^J\right)\right) \end{array} \right] \\ -\lambda f_l^J\left(\gamma-\sigma a\right)f_h^J \end{array} \right\}$

The shares of natives among the unemployed becomes:

$$\phi_h = \frac{1}{1+\frac{1-n}{n}\frac{(\gamma+af_l(1-d_l))}{(\gamma+af_l)}\kappa},\ \phi_l = \frac{1}{1+\frac{1-n}{n}\kappa},$$

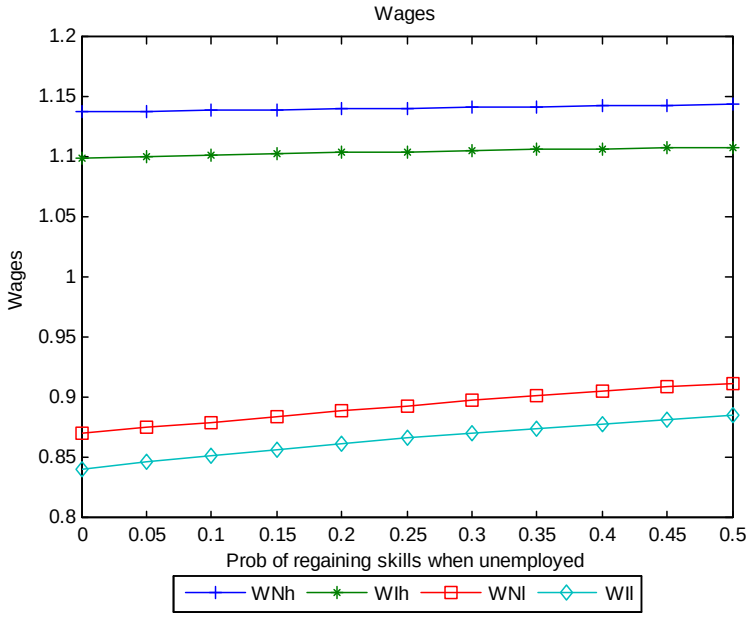
where

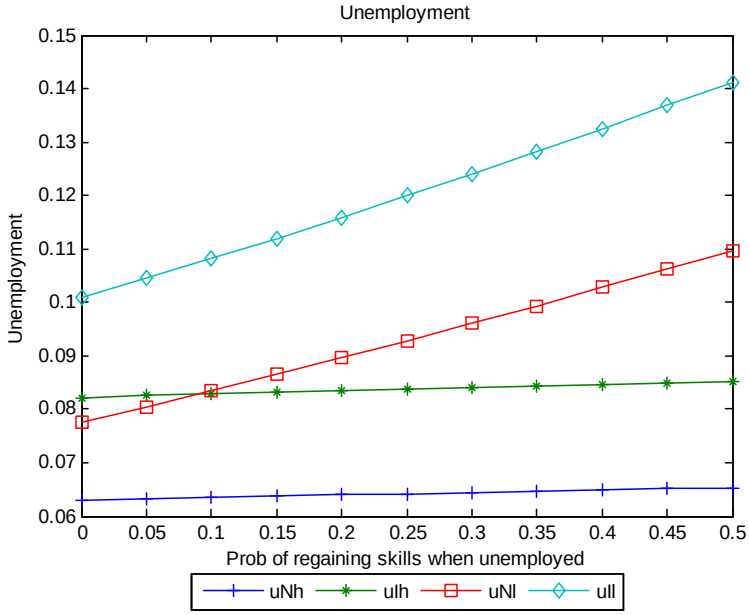
$$\kappa = \frac{\left(\left(\sigma+f_l\right)\lambda+\left(\sigma+f_h\right)\left(\gamma+af_l\right)\right)}{\left(\sigma+f_l\left(1-d_l\right)\right)\lambda+\left(\sigma+f_h\left(1-d_h\right)\right)\left(\gamma+af_l\left(1-d_l\right)\right)}.$$

The unemployment rates are defined by the same functions as before, they are only affected through the changes in the transition rates.

Appendix 2

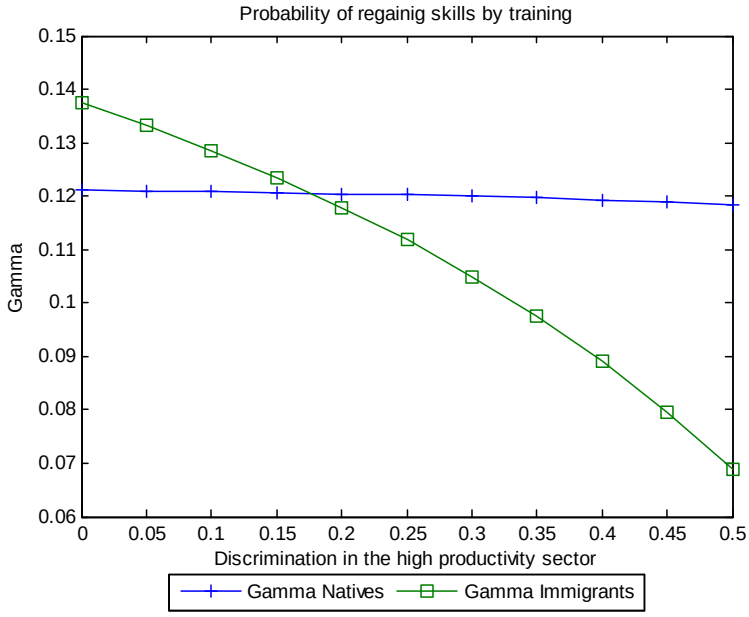
Effect of an increase in the probability of regaining skills when unemployed, γ, when discrimination prevails in both sectors ($d_h = d_l = 0.25$).

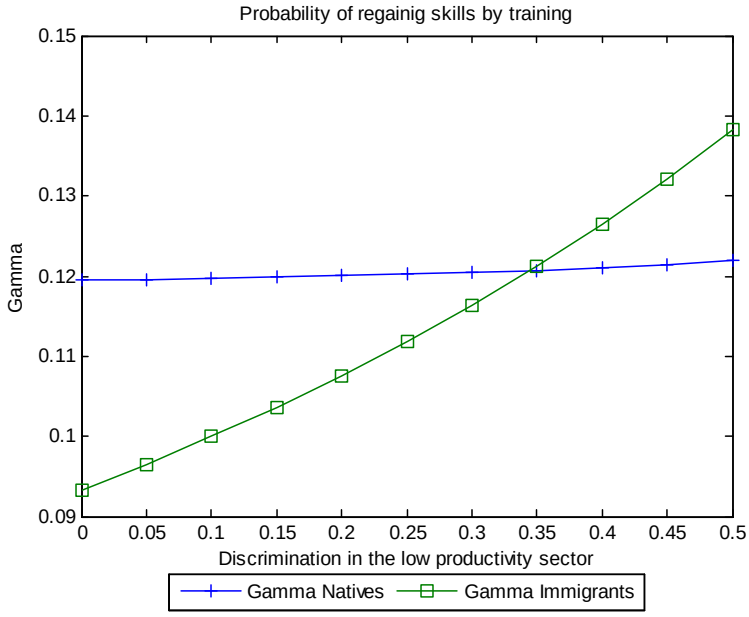




Appendix 3

Comparative statics when the decision to train is endogenous.





Appendix 4

	No Discrimination	Benchmark	↑ d_h	↑ d_l	↑ (1-n)	
Discrimination in the high productivity sector	0.00	0.25	0.50	0.25	0.25	0.25
Discrimination in the low productivity sector	0.00	0.25	0.25	0.50	0.25	0.25
Share of immigrants in the economy	0.10	0.10	0.10	0.10	0.20	0.35
Wages :						
Skilled Natives (W^N_h)	1.1550	1.1545	1.1528	1.1547	1.1540	1.1532
Low-Skilled Natives (W^N_l)	0.8905	0.8900	0.8898	0.8886	0.8895	0.8889
Skilled Immigrants (W^I_h)	1.1550	1.1196	1.0745	1.1085	1.1189	1.1181
Low-Skilled Immigrants(W^I_l)	0.8905	0.8633	0.8632	0.8178	0.8628	0.8621
Unemployment Rates :						
Skilled Natives (u^N_h)	5.03%	5.05%	5.14%	5.03%	5.08%	5.11%
Low-Skilled Natives (u^N_l)	6.55%	6.59%	6.60%	6.69%	6.62%	6.67%
Skilled Immigrants (u^I_h)	5.03%	6.63%	9.77%	6.59%	6.66%	6.70%
Low-Skilled Immigrants(u^I_l)	6.55%	8.60%	8.61%	12.53%	8.64%	8.70%
Share of skilled workers:						
Natives	0.8357	0.8351	0.8329	0.8359	0.8345	0.8336
Immigrants	0.8357	0.7944	0.7237	0.7952	0.7937	0.7926