Who is hurt by discrimination?

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Abstract

The effects of the 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 (especially those in the sector where discrimination prevails), but natives suffer as well. An increase in the share of immigrants in the economy exacerbates the problem of discrimination. A numerical example shows, however, that this effect is relatively small.

1 Introduction

Labour market discrimination can be thought of as a situation where individuals who are equally productive are treated unequally - receive lower wages or face

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lower demands for their services at a given wage - in a way that is related to an observable characteristic, such as race or ethnicity.

The discrimination of immigrants prevails in many countries, not the least in Europe. In 1997, the “Eurobarometer”, a survey carried out by the European Commission, found that 89% of the respondents in Sweden agreed that "people from minority groups are discriminated against in the job market" and 60% agreed that the country had already "reached its limit" in terms of the number of people from minority groups. 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 and discrimination to be higher in low-skilled compared to high-skilled occupations. 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)).

We have to acknowledge that 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. The problem of discrimination becomes even more severe if workers are subject to the risk of losing skills during unemployment. If a worker’s attachment to the labour market becomes very fragile due to discrimination, then his/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 different work but also in native and immigrants with similar skill levels to end up in different occupations - if any occupation at all, and therefore receive different salaries. This has previously been ignored in the theoretical literature.

Empirical evidence supports this. 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.\footnote{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.} 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. Immigrants born in Latin America have a 50% lower probability and for those born in East Europe, Asia or Africa, the probability is 70% lower probability of getting a qualified job than natives. Secondly, Reitz (2001) studies the under-utilization of immigrant skills in Canada. He shows the under-utilization of immigrant skills to be significant, though less significant than unequal pay within occupations. 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.

Therefore, against this empirical evidence, 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.\footnote{See Larsen 2001 for a related set-up but not distinguishing between immigrants and natives.}

In a companion paper, Larsen and Waisman (2007), we examine empirically the impact of discrimination on the labour market performance of immigrants in Sweden. The analysis shows that immigrants exogenously placed in a certain municipality upon arrival in Sweden are more likely to stay if the municipality has low discrimination, once we control for the number of immigrants, average level of unemployment and wages. Preliminary results show that skilled immigrants from non developed countries receive lower wages in regions where discrimination is high than in those regions where it is low, after controlling for individual and regional differences over time.
Most of the existing theoretical models introducing discrimination in the labour market are competitive models. These models 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 second is statistical discrimination by employers in the presence of imperfect information about the skills or behavior 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, 2003), Flabbi (2004) and our own model belong to this group. Borjas (2006) considers how immigrants influence the joint determination of wage structure and internal migration patterns for native-born workers in local labour markets.

The difference between our model and the models of Rosén, Flabbi and Borjas is that those lack a thorough analysis of unemployment including the risk that workers potentially lose skills. Receiving very high wages while you are employed is irrelevant if your attachment to the labour market is fragile. The risk of unemployment is indeed essential for workers’ expected lifetime income. Including the risk of unemployment, Kemnitz (2005) shows that immigration of some low-skilled workers can be of advantage for low-skilled natives when the host economy suffers from unemployment due to the presence of trade unions and an unemployment insurance scheme. Müller (2003) uses a dynamic efficiency-wage model to analyze the consequences of immigration when there is discrimination against immigrants in a dual labor market with unemployment. In this paper we disregard trade unions and efficiency wages and instead consider a general search and matching model acknowledging that the loss of skills shifts workers between labour markets.

We formulate a model of Becker-style taste discrimination within a search and wage-bargaining setting. Not all firms discriminate 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. This means that discrimination takes the form of a lower probability of getting a job for immigrants.

An alternative way of modelling discrimination would be to assume that discrimination takes place at separation 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 setup 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 yield qualitatively similar results.

We assume for simplicity that all workers enter the labour market as skilled workers. It would be more realistic to assume that a proportion of workers are low skilled to start with, but this would complicate the analyses and would not substantially modify the results. Unemployed workers face the risk of losing their skills. If this happens, then 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 his/her wage-bargaining position. Discrimination therefore implies that wages received by immigrants are lower than wages received by natives, even when they have an employer who does not discriminate himself. A lower hiring probability also implies that immigrants suffer higher unemployment rates, despite receiving lower wages. By being unemployed more often, immigrants face 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 in non discriminatory firms affected by discrimination, but all workers in the economy are.

An increase in the share of discriminatory interviewers in the high productivity sector raises unemployment and reduces the wages of all skilled workers.
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. Skilled workers accept lower wages in order to reduce the risk of unemployment. The share of skilled natives and immigrants increases when the level of discrimination in the low productivity sector rises.

An increase in the share of immigrants in the economy exacerbates the problem of discrimination. It makes vacancies in the discriminatory sector even less attractive and reduces the likelihood of getting a job. This is because firms realize that the risk of not filling a vacancy is higher when there are more immigrants around.

We use a numerical example to show, in two extensions, that assuming that discrimination prevails in both sectors and relaxing a simplifying assumption that makes the model recursive does not modify the main results to a great extent. In the numerical example 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. In general, the effect on the wages has a smaller order of magnitude that the effect on the unemployment rates.

In the last extension, we endogenized the training decision while unemployed. If discrimination prevails in the high productivity sector only, then skills are more valuable for natives that are more likely to keep them and more natives than immigrants choose to train and regain skills. If discrimination prevails in the low productivity sector instead, then immigrants value more getting the skills that allow them escape discrimination, so more immigrants choose to train and regain skills than natives. If there is as much discrimination in both sectors, then an increase in the share of immigrants in the economy will result in a reduction of the share of both natives and immigrants that choose to train and regain skills. We additionally show how all workers’ wages and unemployment change if they are allowed to chose optimally to train and regain skills after the share of discriminatory interviewers increased from 0% to 25%.
in both sectors. All wages increase and all unemployment rates decrease. In this particular numerical example, the difference in unemployment rates is so big that we end by having a higher share of skilled individuals despite the fact that less of them choose to train while unemployed for both origins.

The paper is organized as follows. In section 2 the model is set up. In section 3, the impact on unemployment and wages from higher discrimination is examined. Section 4 shows how unemployment and wages are affected by an increase in the fraction of natives in the economy. In section 5 we show the effect of relaxing simplifying assumptions and endogenize the training decision when unemployed. Section 6 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, $s = h, l$, dislike immigrants, while a proportion $(1 - d_s)$ do not.
- When a discriminatory interviewer meets a skilled immigrant, he / 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. When unemployed, skilled workers lose their skills with probability \( \lambda \). Workers who have lost their skills are only able to search for jobs in the low productivity sector. Workers may change their state back in two different ways. They can train while unemployed and become skilled unemployed, which happens at the rate \( \gamma \). Alternately, if the low productivity workers obtain employment, they regain their skills at the rate \( a \). For simplicity, \( \gamma \) 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 become skilled again. We consider this 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 given 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 \( 0 < \alpha < 1 \). The matching function is increasing in both arguments with negative second order derivatives and positive cross partial derivatives.

A native worker with productivity \( s \) gets a job offer at rate \( f^N_s \). The transition rate into employment for a native worker of productivity \( s \) is given by \( f^N_s = f (\theta_s) = \theta^\alpha_s, s = h, l \), 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 \( f^I_s = f (\theta_s) (1 - d_s) = \theta^\alpha_s (1 - d_s), s = h, l \). The rate at which vacant jobs become filled is \( q_s = q (1/\theta_s) = \theta^{\alpha - 1}_s, s = h, l \).
2.2 Workers and firms

The arbitrage equations facing workers are given by

$$\rho U^J_h = f^J_h (W^J_h - U^J_h) + \lambda (U^J_l - U^J_h), \quad J = N, I. \quad (1)$$

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 $f^J_h$ he/she gets a job in the high productivity sector and receives the value $W^J_h$ and with probability $\lambda$ he/she loses skills and becomes a low skilled unemployed with value $U^J_l$.

$$\rho U^J_l = f^J_l (W^J_l - U^J_l) + \gamma (U^J_h - U^J_l), \quad J = N, I. \quad (2)$$

Low skilled unemployed workers get a job in the low productivity sector with probability $f^J_l$ and regain skills by training while unemployed at the rate $\gamma$. The value of $\gamma$ 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

$$\rho W^J_h = w^J_h + \sigma (U^J_l - W^J_h), \quad (3)$$

where $w^J_h$ is the wage received by skilled workers of origin $j$ and $\sigma$ is the rate of job separation, assumed to be the same for all workers. Similarly

$$\rho W^J_l = w^J_l + \sigma (aU^J_h + (1-a)U^J_l - W^J_l). \quad (4)$$

While being employed, low productivity workers regain skills at the rate $a$. We assume that when workers separate from their jobs and join the pool of skilled unemployed they have regained their skills at 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

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

$q_s$ is the likelihood that a firm matches with any worker, $\phi_s$ 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 $X^N_s$ to the firm, while the probability of filling it with an immigrant is $q_s (1 - \phi_s) (1 - d_s)$ creating the value $X^I_s$.

Interviewers always hire the native worker they are matched with, but if they are discriminative, they do not hire an immigrant. 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

$$\rho X^J_s = y_s - w^J_s + \sigma (V_s - X^J_s) ....s = h, l \text{ and } j = N, I. \quad (6)$$

The productivities $y_h$ and $y_l$ and the exogenous separation rate $\sigma$ are assumed to be the same for natives and immigrants. Free entry drives the value of vacancies to zero in both sectors. Using equations (5) and (6) and setting $V_s = 0$ we obtain two equations to determine labour market tightness, $\theta_s = h, l$.

$$g_h = k \frac{1}{q_h} (\rho + \sigma) - \phi_h [y_h - w^N_h] - (1 - \phi_h) (1 - d_h) [y_h - w^I_h] = 0, \quad (7)$$

$$g_l = k \frac{1}{q_l} (\rho + \sigma) - \phi_l [y_l - w^N_l] - (1 - \phi_l) (1 - d_l) [y_l - w^I_l] = 0. \quad (8)$$

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 $\phi_s$ 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 a half, so they are set to equalize the parties’ outside options,

$$W^J_s - U^J_s = X^J_s.\quad (9)$$

For the skilled workers the equalization implies the wage rate

$$w^J_h = \frac{1}{2} \left(y_h + \rho U^J_h\right), \quad J = N, I, \quad (9)$$
while, for the low skilled workers, the equilibrium wage is

\[ w^l_j = \frac{1}{2} \left( y_l + \rho U^l_j - \sigma a (U^h_j - U^l_j) \right), \quad J = N, I. \]  

(10)

The wage of a low skilled worker decreases with \( \sigma a \), the rate by which an employed worker separates from the present match having regained skills.

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

\[ w^l_j = \frac{1}{2} \left[ y_l + f^l_j \left( W^l_j - U^l_j \right) + \gamma (U^h_j - U^l_j) - \sigma a (U^h_j - U^l_j) \right] \]

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 he/she enters that pool after separating from a job where he/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. In an extension in section 5, we derive the equilibrium without this assumption and show in a numerical example that it does not significantly affect the comparative analyses in sections 3 and 4.

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

\[ w^h_j = \frac{\rho + \sigma + f^l_j}{2 (\rho + \sigma) + f^l_j} y_l \quad j = N, I, \]

\[ w^l_j = \frac{\left( (\rho + \sigma)(\rho + \lambda + \gamma) + (\rho + \gamma) f^l_j \right) y_h + \lambda f^l_j \frac{\rho^+ s}{2(\rho + s) + f^l_j} y_l}{2 (\rho + \sigma)(\rho + \lambda + \gamma) + (\rho + \gamma) f^l_j} \]

where \( f^N_s = f_s \) and \( f^I_s = f_s (1 - d_s) \), \( s = h, l \) and \( J = N, I \).

**Proposition 1** Native workers receive higher wages than immigrants, \( w^N_s > w^l_s \), \( s = h, l \) as \( f^N_s > f^l_s \). Also, skilled workers, of either origin, receive higher wages than low skilled workers, \( w^h_j > w^l_j \), \( J = N, I \) if \( f^h_j > f^l_j \).

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 because they produce more for the firm.
These equations together with equations (7) and (8), determine labour market tightness for the two sectors, \( \theta_h = \frac{w_h}{u_h} \) and \( \theta_l = \frac{w_l}{u_l} \).

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 \( \alpha = \frac{1}{2} \). This would imply 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 \( e_{NI} + e_{Nh} + v_{Nh} + v_{NI} = n \) and \( e_{Ii} + e_{Ih} + v_{Ih} + v_{Ii} = 1 - n \), where \( e_s (v_s) \) denotes employment (unemployment). We obtain the following unemployment rates for immigrants and natives:

\[
\begin{align*}
    u^N_h &= \frac{v^N_h}{e^N_h + v^N_h} = \frac{\sigma}{\sigma + f_h} \\
    u^N_l &= \frac{v^N_l}{e^N_l + v^N_l} = \frac{\sigma}{\sigma + f_l} \\
    u^I_h &= \frac{v^I_h}{e^I_h + v^I_h} = \frac{\sigma}{\sigma + f_h (1 - d_h)} \\
    u^I_l &= \frac{v^I_l}{e^I_l + v^I_l} = \frac{\sigma}{\sigma + f_l (1 - d_l)}
\end{align*}
\]

**Proposition 2** The rate of unemployment facing skilled workers is lower than that experienced by low skilled workers as long as \( f_h > f_l \). The relative unemployment faced by immigrants relatively to natives for both high and low skilled workers, \( u^I_h / u^N_h \) and \( u^I_l / u^N_l \) are higher than one.

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)-(16).
The proportion of native workers among the unemployed high and low productivity workers are, using that $\gamma = sa$, given by

$$\phi_h = \frac{1}{1 + \left(\frac{(1-n)}{n}\right)\kappa},$$

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

where $\kappa = \frac{\lambda + a(f_h + \sigma)}{\lambda + a(f_h (1-d_h) + \sigma)} > 1$. The additional negative impact of discrimination on low skilled workers results in relatively more natives among the skilled unemployed, $\phi_h > \phi_l$. Stated differently, low skilled immigrants are both directly affected by discrimination in its own sector and indirectly by discrimination in the high productivity sector.

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 decreases 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 the higher.

The unemployment facing high productivity workers, given that $\gamma = \sigma a$, is

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

and the unemployment facing low productivity workers is

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

The unemployment rate facing natives and immigrants are

$$u_N = \frac{u_h^N + u_l^N}{u_h^N + u_l^N + e_h^N + e_l^N}$$

$$= \frac{\sigma (a (\sigma + f_l) + \lambda)}{(a (\sigma + f_h) + \lambda) (\sigma + f_l)}$$

and

$$u_I = \frac{u_h^I + u_l^I}{u_h^I + u_l^I + e_h^I + e_l^I}$$

$$= \frac{\sigma (a (\sigma + f_l (1-d_l)) + \lambda)}{(a (\sigma + f_h (1-d_h)) + \lambda) (\sigma + f_l (1-d_l))}$$
Immigrants face a higher risk of unemployment due to discrimination, which reduces their transition rates. Therefore 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 immigrants with low skill is higher than the proportion of low skilled natives in the economy.

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

\[
\frac{v_h^l + e_h^l}{1 - n} = \frac{a(\sigma + f_h (1 - d_h))}{(\lambda + a (f_h (1 - d_h) + \sigma))},
\]

\[
\frac{v_h^N + e_h^N}{n} = \frac{a(\sigma + f_h)}{(\lambda + a (f_h + \sigma))}.
\]

We observe that

\[
\frac{v_h^l + e_h^l}{1 - n} < \frac{v_h^N + e_h^N}{n},
\]

\[
\frac{v_h^l + e_h^l}{1 - n} > \frac{v_i^N + e_i^N}{n}.
\]

Discrimination means that the proportion of skilled workers among natives is higher than for immigrants. This implies that the proportion of low skilled workers among immigrants is higher than among natives. 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.
In the next two sections we perform comparative statistics looking at the overall effect of an increase in the level of discrimination and an increase in the share of immigrants in an economy where discrimination prevails.

3 Effects of higher discrimination

In this section we perform comparative statistics 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 results are easier to understand if we concentrate on discrimination in a single sector at a time. We will start with 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. 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.

3.1 Discrimination of skilled workers only

If there is discrimination in the high productivity sector only, 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 discrimination only is present in sector \(h\) 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. We return to the issue of optimal skill
choice decision in an extension of the paper.

**Proposition 4** All wages in the high productivity sector decrease whenever the discrimination of skilled workers, $d_h$, increases. The wages of low skilled workers are not affected. The relative wages of skilled immigrants vs skilled natives, $w_{ih}/w_{nh}$, decrease.

As $d_h$ increases, there is a direct negative impact on all wages in the high productivity sector. The wages of skilled immigrants are reduced directly by the higher discrimination and indirectly by the lower transition rate faced by all skilled workers. Both factors worsen the bargaining position of immigrants and reduce their wages. The 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 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 5** The unemployment of all skilled workers increase when discrimination of skilled workers, $d_h$, increases. Unemployment of low skilled workers is not affected by $d_h$. Skilled immigrants are more affected than skilled natives.

The direct effect of higher discrimination is that more skilled immigrants are turned down by the interviewers and join the pool of skilled unemployed. These additional unemployed skilled immigrants risk losing their skills and joining the pool of low skilled unemployed. This direct effect affects immigrants only, increasing their relative unemployment rate among skilled workers, $(u_{ih}/u_{nh})$.

There is an additional indirect effect of the increase on discrimination, which consists of two impacts. The fact that more vacancies are left unfilled reduces the incentives to open vacancies in the high productivity sector which tend to lower the labour market tightness and the transition rates into employment for skilled workers. The second impact is that 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. More skilled workers (of any origin) become unemployed and could lose their skills. Due to discrimination, natives are over-represented among skilled workers and are more affected by this indirect effect.

The direct effect dominates if the negative impact on the common part of the skilled workers’ transition rate, \( f_h \), is not too high. The impact on skilled natives is smaller than the impact on skilled immigrants, that is, relative unemployment of skilled workers \( (u_{lh}/u_{Nh}) \) increases with \( d_h \) given that \( ((\lambda + \gamma)/(\lambda + af_h + \gamma) (df_h/f_h)(df_h)/(dd_h) + 1 < 0) \). The relative unemployment rate of the low skilled vs the high skilled decrease for both immigrants \( (u_l^I/u_h^I) \) and natives \( (u_l^N/u_h^N) \).

3.2 Discrimination of low skilled workers only

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.

Skilled workers understand that more discrimination in the low productivity sector disincentives vacancies and reduces the value of being a low skilled worker even for natives. Their bargaining position is then damaged and all skilled workers accept then lower wages. The lower wage 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.

Low skilled immigrants suffer from both higher discrimination and lower transition rate, so their bargaining position becomes worse and their wage falls. Low skilled natives suffer only from lower transition rates due to the reduction in the availability of vacancies, so their wages decrease less than those of low skilled immigrants.

The impact on relative wages facing 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 cannot get a job. There is a further indirect effect. If low skilled immigrants tend to be more discriminated against, \( d_l \) increases, then there is a higher risk that a vacancy will not be filled. As a consequence, fewer vacancies are supplied in the low productivity sector. All low skilled workers face higher unemployment due to the reduction of 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, \( \frac{u_l^I}{u_l^N} \), increases with \( d_l \) as a result of both the direct and the indirect effect.

There is no direct negative impact on skilled workers. However, the fall in the transition rate of low skilled workers reduces the value of being a low skilled worker. Consequently, all skilled workers, natives and immigrants, accept a lower wage. When skilled workers accept a lower wage, they become 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 labour market tightness in the high productivity sector and therefore reduces unemployment of skilled workers. Hence, the discrimination of low skilled immigrants improves employment perspectives of all skilled workers.

The relative unemployment of immigrants \( \frac{u_l^I}{u_h^I} \) and natives \( \frac{u_l^N}{u_h^N} \) increase as \( u_l^I \) falls and \( u_h^I \) increases for \( J = N, I \).
4 Effects of higher share of immigrants

In this section we perform comparative statistics on an increase in the proportion of immigrants relatively to natives, starting from a situation where immigrants face discrimination in the labour market. The total work force is still normalized at one.

A change in the share of immigrants in an economy with discrimination affects unemployment and wages through its effect on the share of natives among the unemployed. 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 again describe the effect of an increase in the share of immigrants on wages and unemployment rates. The proofs are easily derived by differentiation.

4.1 Discrimination of skilled immigrants only

When there are relatively more immigrants in an economy where skilled immigrants are discriminated, we see the following impacts on wages and unemployment.

**Proposition 8** When the number of immigrants goes up 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.

The bargaining position of all skilled workers is debilitated by the lower transition rate, 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 skilled workers across population groups \( \frac{w_{ih}}{w_{nh}} \) is ambiguous. When the high productivity sector workers’ transition rates increase, this tends to decrease the wages of immigrants relative to natives. However, the 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 number of immigrants goes up in an economy where only skilled immigrants are discriminated, then the unemployment rate of all skilled workers increases. The unemployment rate of skilled natives increases relatively more that of skilled immigrants. The unemployment of low skilled workers remains unchanged.

When there are more immigrants in the work force, the likelihood that a high productivity firm will match with one of them is higher. This makes vacancies less attractive and reduces labour market tightness and thereby the transition rates of all skilled workers.

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 skilled immigrants \( \frac{u_I}{u_h} \) decreases. The unemployment of low skilled natives relative to skilled natives \( \frac{u_N}{u_h} \) decreases, as does the same relative unemployment rate among immigrants \( \frac{u_I}{u_h} \). This is because \( u_I \) is constant and \( u_h \) increases for \( J = N, I \).

### 4.2 Discrimination of low skilled workers only

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

The fall in the transition rate of low skilled workers deteriorates their bargaining position causing them to accept lower wages.
Even skilled workers are induced to accept lower wages when they understand that the value of being a low skilled worker has fallen. Lower wages themselves lead to an increase in the transaction rate that raises wages. The total effect is ambiguous.

Natives work to a higher extent, so they are more affected by the reduction in the transition rate, but the fact that immigrants’ wages were already lower dampens the impact. The effect on relative wages for high skilled immigrants vs high skilled natives \( \frac{w^I_h}{w^N_h} \) and for low skilled immigrants vs low skilled natives \( \frac{w^I_l}{w^N_l} \) 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.

An increase in the share of immigrants makes opening a vacancy in the low productivity market less attractive, as they are more likely to stay unfilled if a discriminatory interviewer happens to meet an immigrant.

Fewer vacancies reduce the transition rate of all low skilled workers and increase their unemployment. As low skilled natives work to a bigger extent (due to discrimination), they suffer more the increase in unemployment and the relative unemployment rate \( \frac{u^I_l}{u^N_l} \) decreases.

The fall in the transition rate of low skilled workers reduces the value of being a low skilled worker. This deteriorates the wage-bargaining position of skilled workers. Lower wages for skilled workers means that they face a higher transition rate and therefore, the unemployment of all skilled workers falls. As there is no discrimination in the high productivity sector, all workers there are equally affected by the increase in the transition rate, so the relative skilled unemployment \( \frac{u^I_h}{u^N_h} \) remains unchanged.
5 Extensions

We will now use a numerical example to show how the comparative analysis changes when we relax some of our simplifying assumptions. We drop first the assumption that there is discrimination in one sector at a time.

The parameter values chosen (which are annual values) are:

- the discount rate is set to $\rho = 0.08$ and the separation rate is set to $\sigma = 0.08$ (see Millard and Mortensen 1997)
- the bargaining power of the firms in the matching function is assumed to be $\alpha = 0.5$ (Pissarides 1995)
- $y_l$ is normalized at one and $y_h$ is set equal to 1.3, to obtain a relatively large difference between productivity levels in the two sectors
- 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 is 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 ³) and that the fraction of long term unemployed (more than 12 months of unemployment) was 19 percent (www.scb.se and www.oecd.org). In our model, this corresponds to the fraction of skilled being 81 percent. We assume $\lambda = 0.25$ and $\gamma = 0.08$. This implies that $a = \gamma/\sigma = 0.8$.

5.1 Comparative analysis when discrimination prevails in both sectors

³http://ivpxweb.digitalinformation.se/Database/
/Integrationsverket/Arbetslivet/Arbetslöshet/Arbetslöshet.asp
We will show in graphs the results from three different comparative analysis exercises: an increase in $d_h$ from 0.0 to 0.5 when $d_l = 0.25$ and fixed, an increase in $d_l$ from 0.0 to 0.5 when $d_h = 0.25$ and fixed and an increase in the share of immigrants from 0.0 to 0.5 (corresponding to a decrease in $n$) when $d_h = d_l = 0.25$ and fixed. We can compare the effects on wages and unemployment across comparative analysis.

5.1.1 Increase in $d_h$

First, we analyze the effect of an increase in the share of discriminatory interviewers in the high productivity sector from 0% to 50%, when 25% of the interviewers in the low productivity sector discriminate against immigrants ($d_l = 0.25$).

The wages earned by natives are higher than that of immigrants, for both skill levels, because of the presence of discriminative interviewers. When $d_h$ increases from 0 to 0.5, the wage of skilled immigrants decreases by 7%, while that of skilled natives decreases by only 0.2%. The wages of low skilled levels decrease slightly (by less than 0.04%) due to the existence of discrimination in the low productivity sector as well. As $w_h^I$ decreases more than $w_h^N$, the relative wages of skilled immigrants vs skilled natives decreases as $d_h$ increases.
The unemployment of skilled immigrants doubles from 6.3% to 12.1%. It becomes higher than the unemployment of low skilled natives when $d_h$ reaches 0.25 and that of low skilled immigrants when $d_h$ reaches 0.45. The unemployment of skilled natives increases by far less, from 6.3% to 6.5%. The unemployment of low skilled workers increases slightly for both origins (by less than 0.04%). The relative unemployment of skilled immigrants vs skilled natives increases. The relative unemployment of low skilled vs high skilled workers decreases for all origins, but the decline is much stronger for immigrants.

The share of skilled workers is identical for natives and immigrants when there is discrimination in the low productivity sector only (83.58%). The share of skilled natives falls to 83.23%, while only 72.55% of the immigrants are still
high skilled when $d_h$ reaches 0.5.

### 5.1.2 Increase in $d_l$

Second, we analyze the effect of an increase in the share of discriminatory interviewers in the low productivity sector from 0% to 50%, when 25% of the interviewers in the high productivity sector discriminate against immigrants ($d_l = 0.25$).

When $d_l$ increases, the wage of low skilled immigrants falls the most, by 8.7% in this example. The wage of skilled immigrants falls by 1.8%, that of low skilled natives falls by 0.2%, and that of skilled natives increases by only 0.04%. The relative wages of immigrants vs natives decreases for both skill levels as $d_l$ increases, but the decline is stronger for low skilled workers.
The unemployment of low skilled immigrants increases from 8.17% to 12.1%. The unemployment of low skilled natives increases by far less, from 8.17% to 8.35%. The unemployment of skilled workers decreases instead, from 8.30% to 8.23% for immigrants and from 6.36% to 6.30% for natives. The relative unemployment of low skilled immigrants vs low skilled natives increases. The relative unemployment of low skilled vs high skilled workers increases for both origins, but the increase is stronger for immigrants.

The share of skilled workers increases for both origins, but by less than 0.2%. It averages 83.5% for natives and 79.5% for immigrants.

5.1.3 Decrease in $n$

Third, we analyze the effect of an increase in the share of immigrants in the economy, that is a reduction in $n$ from 100% to 50%, when 25% of the interviewers in both the high and the low productivity sector discriminate against immigrants ($d_h = d_l = 0.25$).
Wages decrease slightly for all workers. The biggest decline is 0.34% for low skilled immigrants, then 0.32% for skilled immigrants, 0.30% for low skilled natives and smallest (0.27%) for skilled natives. As a consequence, relative wages are almost constant despite the big increase in the share of immigrants.

Unemployment rates increase for all workers. The biggest increase is 2.57% for low skilled natives, then 2.45% for low skilled immigrants, 2.38% for skilled natives and smallest (2.31%) for skilled immigrants. Natives are then more affected than immigrants for both skill levels with respect to their employment chances. Relative unemployment rates do not experience much variation when the share immigrants increases.

The share of skilled workers averages 83.5% for natives and 79.5% for immi-
grants and falls slightly for both origins, by less than 0.5%.

5.1.4 Remarks

Wages and unemployment rates move in the same way as predicted by the analytical solution in the last section, except for the fact that the low skill wages are now dependent on skilled wages as well. The model is not recursive in these extensions and therefore we are forced to solve it numerically. We find the following results worth noting:

1. In general, the effect on the wages has a smaller order of magnitude that the effect on the unemployment rates

2. The relative wages of immigrants vs natives for each skill level satisfies 
\[ \frac{w^I_h}{w^N_h} \geq \frac{w^I_l}{w^N_l} \] when \( d_h \leq d_l \)

3. The relative unemployment of low skilled workers for each origin satisfies 
\[ \frac{u^N_l}{u^N_h} \geq \frac{u^I_l}{u^I_h} \] when \( d_l \leq d_h \)

4. The relative unemployment of immigrants respect to natives for each skill level satisfies 
\[ \frac{u^I_h}{u^I_l} \geq \frac{u^N_h}{u^N_l} \] when \( d_l \leq d_h \).

5. 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.

5.2 Comparative analysis with \( \gamma \neq \sigma a \)

In the main text we have assumed that \( \gamma \neq \sigma a \) as a trick for turning the model more recursive. When we relax this assumption, then the wages in the low productivity sector will depend on the difference in the value of being a high skilled vs a low skilled unemployed according to the following equation:

\[
w^I_l = \frac{1}{2} \left[ y_l + f^I_l \left( W^I_l - U^I_l \right) + (\gamma - \sigma a) \left( U^I_h - U^I_l \right) \right].
\]  

(21)

Let us compare to the case where \( \gamma = \sigma a \). When \( \gamma > \sigma a \) then the low skilled worker’s outside option increases as the probability of getting training is higher as an unemployed, which tend to increase 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 at employed. The new equilibrium wages satisfy:

\[
\begin{align*}
w_J^l &= \Omega \left\{ \begin{array}{c}
(2(\rho + \sigma)(\rho + \lambda + \gamma) + (\rho + \gamma) f_J^l) * \\
(y_J (\rho + \sigma + f_J^l)(\rho + \lambda + \gamma) + (\gamma - \sigma a) (f_J^l y_J - f_J^l y_I)) \\
- (\gamma - \sigma a) f_J^l (y_J ((\rho + \sigma)(\rho + \lambda + \gamma) + (\rho + \gamma) f_J^l) + \lambda f_J^l y_J)
\end{array} \right\}, \\
\end{align*}
\]

\[
\begin{align*}
w_I^l &= \Omega \left\{ \begin{array}{c}
- \lambda f_I (y_J (\rho + \sigma + f_I^l)(\rho + \lambda + \gamma) + (\gamma - \sigma a) (f_I^l y_J - f_I^l y_I)) \\
+ \left( (2(\rho + \sigma)(\rho + \lambda + \gamma) + f_I^l (\sigma a - \gamma)) * \\
(y_J ((\rho + \sigma)(\rho + \lambda + \gamma) + (\rho + \gamma) f_I^l) + \lambda f_I^l y_I)
\end{array} \right\}, \\
\end{align*}
\]

where \( \Omega = \left\{ \begin{array}{c}
\left( (2(\rho + \sigma)(\rho + \lambda + \gamma) + f_I^l (\sigma a - \gamma)) * \\
(2(\rho + \sigma)(\rho + \lambda + \gamma) + (\rho + \gamma) f_I^l) \\
- \lambda f_I (\gamma - \sigma a) f_I^l
\end{array} \right\}^{-1} \)

The shares of natives among the unemployed now become:

\[
\begin{align*}
\phi_h &= \frac{1}{1 + \frac{1}{n} \frac{(\gamma + a f_I (1-d_I))}{(\gamma + a f_I)}}, \\
\phi_I &= \frac{1}{1 + \frac{1}{n} \frac{K}{K'}},
\end{align*}
\]

where

\[
K = \frac{(\sigma + f_I) \lambda + (\sigma + f_h) (\gamma + a f_I)}{(\sigma + f_I (1-d_I)) \lambda + (\sigma + f_h (1-d_h)) (\gamma + a f_I (1-d_I))}. 
\]

The unemployment rates are defined by the same functions as before, they are affected through the changes in the transition rates only.
In the graphs we observe that both wages and unemployment rates increase when the probability of regaining skills when unemployed, $\gamma$, increases from 0.00 to 0.50, for $d_h = d_l = 0.25$, $n = 0.9$ and $\sigma a = 0.08$. 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 $\gamma$ is stronger for low skilled workers, as they are directly affected by the increase in $\gamma$. 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. Low skilled workers are mostly affected.

We will show how the relaxation of this assumption affects the effect on wages and unemployment rates of an increase in the share of discriminative interviewers in the high productivity sector. The share of skills are not much affected by relaxing the assumption. An increase in the share of discriminative interviewers in the low productivity sector and an increase in the share of immigrants in the economy have very similar effects even though we lift this simplifying assumption, so we will concentrate on the effect of an increase in $d_h$.

### 5.2.1 Increase in $d_h$ when $\gamma > \sigma a$

An increase in the probability of regaining skills while unemployed, $\gamma$, increases the value of being an unemployed low skilled worker, which has a negative effect on the last two terms of the equation for low skilled wages, eq (21) when $\gamma > \sigma a$. In the following graphs we see the effect of an increase in $d_h$ from 0 to 0.5, while $d_l = 0.25$ and $\gamma = 2\sigma a = 0.16$. 
The main difference when $\gamma > \sigma a$ is a reduction of wages received by low skilled immigrants, by 1.2%, while $w^f_I$ was unaffected when $\gamma = \sigma a$. This is the case as low skilled workers are now affected by the reduction in wages received by high productivity immigrant workers: their outside option falls. The reduction in wages causes an increase in labour market tightness in the low productivity sector which reduces unemployment facing low skilled workers. Unemployment rates for the low skilled workers was unaffected when $\gamma = \sigma a$ because labour market tightness in the low productivity sector was unaffected due to the lack of impact on low productivity sector wages.

### 5.2.2 Increase in $d_h$ when $\gamma < \sigma a$

When $\gamma < \sigma a$, wages of low skilled immigrants increase with $d_h$, instead of decreasing (being unchanged) as it was the case when $\gamma > (\gamma=\sigma a)$. This is the case as low skilled workers are more eager to get a job when $\gamma < \sigma a$ as 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 reduction in labour market tightness reduces wages of low skilled natives slightly. This is the case as natives only face the indirect impact through the reduction in labour market tightness. The unemployment rates of low skilled workers increase slightly by 0.63% for natives and 0.68% for immigrants as their transition rates decrease.

5.3 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 he/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 him/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 his/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, \( c_i \), 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 \( c_i \) be uniformly distributed between 0 and 1 and identical for natives and immigrants. The first workers that choose to train are those with the lowest cost. As more workers choose to train in a given period, the marginal and average costs increase. The value of skills is the same for all natives irrespective of the cost and the same is true for immigrants. More workers of each origin will choose to train until the last one has drawn a cost that equals the value of skills for his origin.

The value of regaining skills, for a given share of low skilled unemployed of each origin that decide to train \( \gamma^J \), is defined as

\[
\rho Z^J (\gamma^J) = \frac{\rho U^d_h (\gamma^J) - \rho U^d_l (\gamma^J)}{(\rho + sa)} [2w_{ji} - y_i + saU^d_h (\gamma^J)],
\]

Workers will choose to train as long as \( \rho Z^J \geq c_i \). Let \( \widehat{\gamma}^J \) be the cost of the last low skilled unemployed of origin \( J \) that chooses to train, so that \( \rho Z^J = \widehat{\gamma}^J \). 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 \( \widehat{\gamma}^J = \widehat{\gamma}^J \). We have until now called this proportion \( \gamma^J \). This means that the equilibrium condition that determines the optimal proportion of low skilled unemployed choosing to train is \( \rho Z^J = \widehat{\gamma}^J = \gamma^J \). The optimal proportion is then solved as a fixed point:

\[
\frac{\rho}{(\rho + sa)} \{ [2w^d_h (\gamma^J) - y_h] - [2w^d_l (\gamma^J) - y_l] \} = \gamma^J, \quad J = N, I.
\]

Incorporating these two additional equations to the model (one for natives and one for immigrants), we can solve for the optimal choice in our numerical exercise. We will show now how this choice is affected by discrimination in the same three comparative analysis exercises of previous subsections.

If the share of workers that choose to regain skill \( \gamma^J \) increases, then the outside option of workers of origin \( J \) improves. Unemployment is less severe
for low skilled workers of origin $J$ when they face a higher chance to train and regain skills, inducing wage increases. The risk of losing skills when unemployed is less of a problem if you are more likely to regain them back, so skilled workers’ wages increase as well.

If discrimination prevails in the high productivity sector, the improvement in the bargaining position as $\gamma^J$ increases is most important for low skilled natives. This is because the difference between the values of being a high and low skilled worker is now much larger for natives than immigrants. Consequently, $\gamma^N > \gamma^I$ when $d_h > 0$ and $d_l = 0$.

If discrimination exists instead in the low productivity sector, then the value of being able to regain skills is the highest for the low skilled immigrants. Regaining skills means that they can escape the sector where they are discriminated against and move into a sector where productivity is higher and they are as likely to get jobs as natives. This means that $\gamma^l > \gamma^N$ when $d_l > 0$ and $d_h = 0$.

### 5.3.1 Increase in $d_h$

First, we analyze the effect on the optimal choice to train while unemployed of an increase in the share of discriminatory interviewers in the high productivity sector from 0% to 50%, when 25% of the interviewers in the low productivity sector discriminate against immigrants ($d_l = 0.25$).

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 \( d_h \) is low relative to \( d_l = 0.25 \), then \( \gamma^I > \gamma^N \), but the natives choose to train to a higher extent already when \( d_h = 0.20 < d_l \). This is the case as discrimination has a larger impact on wages in the high productivity sector than in the low productivity sector as wages in the higher productivity sector are relatively higher.

5.3.2 Increase in \( d_l \)

Second, we analyze the effect on the optimal choice to train while unemployed of an increase in the share of discriminatory interviewers in the low productivity sector from 0% to 50%, when 25% of the interviewers in the high productivity sector discriminate against immigrants (\( d_l = 0.25 \)).

As discrimination in the low productivity sector increases the value of skills increases for all workers, as it allows them to escape from the sector where discrimination prevails. 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 \( d_h = 0.25 \), then \( \gamma^N > \gamma^I \), but the immigrants choose to train to a higher extent only when \( d_l = 0.35 > d_h \). This is the case for the same reason as above: as discrimination has a larger impact on wages in the high productivity sector than in the low productivity sector as wages in
the higher productivity sector are relatively higher.

5.3.3 Decrease in $n$

Third, we analyze the effect of an increase in the share of immigrants in the economy, that is a reduction in $n$ from 100% to 50%.

In the graph of the left 25% of the interviewers in high productivity sector discriminate against immigrants, while there is none in the low productivity sector. More immigrants make it even less valuable to acquire skills and the share of workers of both origins that choose to train decreases. As we already stated, $\gamma^N > \gamma^I$ when $d_h > 0$ and $d_l = 0$ for any share of immigrants.

In the graph in the right, $d_l = 0.25$ and $d_h = 0$. More immigrants than natives choose to train and the share that do so increases in the share of immigrants for both origins.

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 the immigrants for all $n$.

5.3.4 Effect of the endogeneity of $\gamma^J$

Imagine that we start from a situation with no discrimination in any sector. The optimal choice is such that 12.04% of the workers of both origins train while unemployed. The optimal choice is of course identical for natives and immigrants in absence of discrimination given that we have assumed that they are identical in all other respects.

Now assume that for some reason 25% of the interviewers start to discriminate. How important is it to let workers choose if they want to train and regain skills? We compare the wages, unemployment rates and shares of skilled workers when $\gamma^J$ is endogenous with a situation where $\gamma^J$ is exogenous and equal to 12.04%.

<table>
<thead>
<tr>
<th>Assumption on $\gamma^J$</th>
<th>endogenous</th>
<th>exogenous</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\gamma^N$</td>
<td>0.1202</td>
<td>0.1204</td>
</tr>
<tr>
<td>$\gamma^I$</td>
<td>0.1118</td>
<td>0.1204</td>
</tr>
<tr>
<td>skilled N</td>
<td>0.8359</td>
<td>0.8343</td>
</tr>
<tr>
<td>skilled I</td>
<td>0.7953</td>
<td>0.7941</td>
</tr>
<tr>
<td>$w_h^N$</td>
<td>1.1536</td>
<td>1.1394</td>
</tr>
<tr>
<td>$w_h^I$</td>
<td>0.8954</td>
<td>0.8819</td>
</tr>
<tr>
<td>$w_l^N$</td>
<td>1.1185</td>
<td>1.1024</td>
</tr>
<tr>
<td>$w_l^I$</td>
<td>0.8679</td>
<td>0.8539</td>
</tr>
<tr>
<td>$u_h^N$</td>
<td>0.0503</td>
<td>0.0636</td>
</tr>
<tr>
<td>$u_h^I$</td>
<td>0.0689</td>
<td>0.0846</td>
</tr>
<tr>
<td>$u_l^N$</td>
<td>0.0659</td>
<td>0.0830</td>
</tr>
<tr>
<td>$u_l^I$</td>
<td>0.0898</td>
<td>0.1098</td>
</tr>
</tbody>
</table>

The optimal choice of $\gamma^J$ means that all workers receive higher wages and face lower unemployment. In this particular numerical example, the difference in unemployment rates for skilled immigrants is so big that we end by having a higher share of skilled natives and immigrants despite the fact that they both
choose to train less while unemployed.

6 Conclusion

The purpose of this paper was to study the effects of the discrimination of immigrants on the labour market performance of all workers, both immigrants and natives. Acknowledging that difficulties of obtaining a job, especially for immigrants, implies that many immigrants are employed below their qualifications, 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 skill workers to regain skills both during employment and during unemployment. We assumed that discrimination takes the form of a share of interviewers that refuse 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 more immigrants.

We found the following equilibrium results. Discrimination directly reduces an immigrant worker’s transition out of unemployment and thereby deteriorates his or 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 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. The impact on low skilled workers depends on the probability of regaining skills while employed relatively to when unemployed. To obtain analytical results we consider the probability of regaining skills while employed to be equal to the probability when unemployed. In a numerical example we relax this assumption and analyze the consequences
for the results.

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. Skilled workers accept lower wages facing a worsened outside option. More discrimination in the low productivity sector enhances the share of skilled natives and immigrants. We studied in a numerical exercise the impact of discrimination in both the high and low productivity sector.

An increase in the share of immigrants in the economy exacerbates the problem of discrimination. As the risk of not filling a vacancy is higher when there are more immigrants around, fewer vacancies are supplied, reducing wages and raising unemployment. If discrimination could be eliminated, then an increase in the share of immigrants would have no effect in this model. It is the existence of discrimination which causes the negative consequences of increased immigration.

In our numerical example, we observed 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. Furthermore, in general, the effect on the wages has a smaller order of magnitude that the effect on the unemployment rates.

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. We considered a numerical example and showed that if training is endogenous all wages increase and all unemployment rates decrease. In this particular numerical example, the difference in unemployment rates is so big that we end by having a higher share of skilled individuals despite the fact that less of them choose to train while unemployed for both origins.

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 ef-
fect 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 there is no discrimination. 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.

7 Bibliography


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