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Master Thesis Policy Economics

John or Ali: Hiding Your True Identity to Increase Job Opportunities

An analysis of the impact of anonymous application procedures on the hiring probabilities of discriminated applicants

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Even today, discrimination is readily apparent in the labour market. A policy to combat this issue is anonymous application procedures. I develop a model with three applicants and one job to analyze the impact of both taste-based and statistical discrimination on the hiring probabilities of a discriminated applicant. Moreover, I measure the effect of anonymous application procedures on the hiring probabilities of the discriminated applicant. Anonymous application procedures are able to delay the taste-based discrimination to a latter stage of the hiring process and therefore increase the hiring probability of the discriminated applicant. The same applies to statistical discrimination. Moreover, under certain conditions the anonymous application procedure is able to eliminate the statistical discrimination from the hiring process.

Keywords: *taste-based discrimination; statistical discrimination; anonymous application procedure; model*

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Friso Roos

1. Introduction

Even today, discrimination in the labour market is readily apparent. In the U.S. labour market applicants with a white sounding name receive 50 percent more call backs for interviews than applicants with African-American sounding names, despite having *ex ante* equal quality. A white name yields as much as eight more years of experience on a resumé (Bertrand & Mullainathan, 2004). In the Netherlands, experimental research shows that Dutch-named applicants are 60 percent more likely to receive a positive reaction to their application than Arabic-named applicants (Blommaert, Coenders & Van Tubergen, 2014). Thijsen, Coenders and Lancee (2019) show that having a Dutch background increases the likelihood by 30 percent on average that someone will get hired for the job relative to a person with a minority background. Discrimination in the labour market has large societal impact and therefore is worth researching. The existing and persisting racial disparities in the labour market has led to a renewed interest in anonymous application procedures. One famous study of blind application procedures shows that American orchestras hire more women if the audition takes place behind a screen which hides the identity of the applicant (Goldin & Rouse, 2000).

However, in general the results of those anonymous application procedures are mixed and depend on the context in which they are implemented. Extensive research in Sweden shows that anonymous application procedures increase the probability of both women and applicants with a non-Western origin to advance to the interview stage. However, the probability of actually being hired for the job only increases for women and not for ethnic minorities (Åslund & Nordströum Skans, 2012).

Some empirical research even shows that anonymous application procedures only hurt the hiring probabilities of discriminated workers. Policies that restrict employers from asking about applicants' criminal histories seem to decrease the call back rates for black men without criminal records, because employers form their expectations about the individual's criminal history based on the average criminal history of the group the applicant belongs to (Agan & Starr, 2017).

The effects of anonymous application procedures are thus ambiguous. However, a solid theoretical explanation for these results is missing in the literature. This thesis analyses the impact of anonymous application procedures on the hiring probability of discriminated applicants. I analyse the impact of anonymous application procedures on the hiring probability in a model in which three applicants, one of which is discriminated, apply for a job. There are two stages: a resumé and an interview stage. At both stages the firm can learn more about the productivity of the applicant, but it might also discriminate against the applicant. I will allow for the two main types of discrimination described in the literature: taste-based and statistical discrimination. This allows me to compare results. It depends on the type of discrimination and the conditions regarding the discrimination whether anonymous application procedures prove to be beneficial for the discriminated applicant. Moreover, the anonymous application procedure primarily impacts the probability that the discriminated applicant is invited for an interview. These results fit nicely with the empirical results of Agan & Starr (2017) and Åslund & Nordströum Skans (2012).

The analysis of the taste-based discrimination scenario shows that if the discrimination parameter increases, the probability that the discriminated worker will be hired becomes lower. The

anonymous application procedures help to prevent discrimination in the first stage of the hiring process and therefore, increases the probability that the discriminated worker gets interviewed. However, the anonymous application procedure cannot prevent discrimination in the second stage of the hiring process when a candidate is interviewed by the firm. As a consequence, the *a priori* hiring probability of the discriminated applicant is higher under the anonymous application procedure, but the discrimination in the labour market may still persist.

The analysis of the statistical discrimination scenario ended up to be very similar to the analysis of the taste-based discrimination scenario. Under certain conditions statistical and taste-based discrimination are even completely identical. However, there is also one specific scenario in which the statistical discrimination can be fully eliminated from the labour market. This cannot be achieved if the discrimination is taste-based.

Becker (1957) came up with his taste-based discrimination model to explain discrimination in the labour market in 1957. In this model employers bear some sort of additional costs, besides the wage, when employing discriminated workers. Fifteen years later Phelps (1972) and Arrow (1973) developed the statistical discrimination model. Cain (1977) further pioneered their work. In these models economic agents (employers and employees) have imperfect or asymmetric information about the other agent. Therefore, employers use statistical information on the group the employee belongs to, to infer their productivity. However, this inferred information will likely not correspond with the true information of the individual. As a consequence, the productivity expectation of the firm is based on the average group information, which is incorrect for the specific applicant and therefore that individual is disadvantaged. Statistical discrimination relates to the research by Agan & Starr (2017) as firms base their assumptions on mere statistical relations.

Taste-based and statistical discrimination models focus on how discrimination affects wages, employment, profits and the persistence of discrimination in the labour market. In contrast, in my model I focus on how anonymous application procedures affect the hiring probabilities of discriminated applicants.

Coate and Loury (1993) develops another model related to discrimination on the labour market: a job assignment model. This model results in a self-fulfilling prophecy; firms assume that discriminated workers have invested less in their human capital. Even if the discriminated worker would invest in his human capital he would not be able to fully benefit from this investment because of this assumption. However he does bear the full costs of the investment. The firm has a bias assumption against the discrimination workers, as a consequence they decide to invest less in their human capital. This is even worsened by affirmative action policies. To comply with the affirmative action, firms will set lower standards for discriminated workers. This results in discriminated workers investing even less which results in even larger differences.

In my model, I also analyse a policy to combat discrimination in the labour market, but I focus on the hiring probability of the discriminated worker rather than explaining the existing labour market equilibrium that includes discrimination.

This thesis adds to the theoretical literature on discrimination in the labour market. Unlike the earlier literature, it uses a model with two different kinds of discrimination to explain the impact of

anonymous application procedures on the hiring probability of discriminated applicants. To my knowledge, this is the first time that this is performed.

My thesis also adds to the large empirical analysis on the effects of anonymous application procedures. As said, the empirical effects of anonymous application procedures are ambiguous and seem to depend on the circumstances in which it is implemented. This thesis provides insight in the different effects of anonymous application procedures under different circumstances and how the impact of the policy relates to the two different forms of discrimination.

The issue is obviously also important for public policy. My analysis provides policy makers with ideas to reduce discrimination in the labour market, to bring about greater equality between different groups, and to prevent them from suffering economic disadvantages. Prejudiced employers seriously harm the employment prospects of the elderly, women and ethnic minorities. This can also have large economic consequences because, because if the discrimination is large enough, it might prevent the applicant with the highest productivity from being hired. Therefore the productivity of a certain firm will remain below the optimal productivity (Becker, 1957). Discrimination in the labour market can also hurt societal welfare. The costs for the discriminated workers are likely very large (e.g. lower wage, unemployment, unsatisfying job, lack of promotional chances etc.), whilst the benefits for discriminatory firms (especially in case their discriminatory preferences arise from incorrect information) might be very low. Welfare can benefit a lot from policies that limited the impact of discrimination on the labour market.

In the next section, I discuss the most relevant literature. Then, in section III I present my model. In section IV I analyse my model without discrimination. In section V, I will first explain more on the modelling of taste-based discrimination and then I analyse my model under taste-based discrimination. In section VI I do the same for statistical discrimination. Section VII provides a discussion of my results and in section VIII I conclude.

2. Literature

2.1 Taste-based discrimination

In the literature there are two main models to analyse discrimination in the labour market: the taste-based and statistical discrimination model. Becker (1957) pioneered the theoretical research into discrimination in the labour market. In Becker's taste-based model the prejudiced employer does not only bear the costs of the wage, but if a discriminated applicant is hired firms also bear a discrimination penalty. According to Becker the employer has a 'taste' for discrimination. In my model this 'cost' is also modelled as a disutility for the employer. Becker assumes that there are two groups, namely F- and D-workers[1] and that the underlying productivity in both groups is equal. The firm aims to maximize the profit.

The additional costs result in lower employment and wages for discriminated workers. For non-discriminated workers the discrimination parameter will likely be close to or is equal to zero. The increased costs of hiring a discriminated worker lead to lower demand and thus higher unemployment

[1] Originally Becker spoke about W- and N-groups

among discriminated workers. In my model, under taste-based discrimination, the hiring probability of the discriminated applicant is also decreasing in the discrimination parameter.

Becker concludes that the discriminatory preferences of the firm might hurt the profits (net profit minus discrimination costs). The same applies to my model, the discrimination could prevent the firm from hiring the applicant with the highest productivity. As a consequence, the output and thus profit of the firm will be below optimal. This makes discrimination not only worrisome because it is morally wrong, but also because it might hurt overall (economic) efficiency.

Also important to note is that under certain conditions in Becker's model discrimination might 'disappear' if there are enough non-discriminatory firms. The discrimination does not really disappear from the labour market, but the discriminated workers will no longer suffer any monetary penalty. This is achieved because the discriminated and non-discriminated workers will be segregated. Thus the discriminated workers will only work for non-discriminatory firms, whilst the non-discriminated workers will work for discriminatory firms. As a consequence, the first negative effect of discrimination (lower wages for discriminated workers) is replaced by another negative effect: segregation. In this latter scenario, the wages in both firms are equal (Donohue, 2007). In my model, under taste-based discrimination, discrimination cannot be fully eliminated by introducing an anonymous application procedure. This is different in the statistical discrimination case.

Becker assumes perfect competition between firms, however several authors have relaxed this assumption and introduced frictions into the model. Black (1995) introduces search costs: if the job search does not succeed, the employee incurs a cost C. Black's model can explain long term discrimination despite the presence of numerous non-discriminating firms. Discriminated applicants know that due to discrimination some firms will not hire them, this increases the search costs for them. This increase in search costs allows unprejudiced firms to offer a lower wage and still hire discriminated workers, because they don't want to incur the search costs. As a consequence unprejudiced firms have some degree of monopsonistic power. In this model discrimination is localised at the employer-side, Borjas and Bronars (1989) investigate taste-based discrimination on the consumer-side, whilst Sasaki (1999) analyses co-worker taste-based discrimination.

Anonymous application might increase search costs, as it might enable the discriminated candidates to engage into the interview stage, however if the firm is discriminatory then the discriminated applicant will likely not be hired. In this case the anonymous application increases the amount of useless interviews, resulting in a cost increase for both the firm and the applicant.

Bowlus and Eckstein (2002) base their model on Black's model, however they make a couple of different assumptions and conclude that the persistence wage differential reflects a large fraction of prejudiced firms. Rosén (1997) shows that differentials may also be present in a taste-based model if the applicants have private information on the specific productivity at a certain firm. This 'match-specific' productivity is determined by the match between firm and applicant. However in my model the applicant is a passive agent and has no private information.

In many models applicants and firms are randomly matched, however other model allows applicants to decide where they will apply. Lang et al. (2005) describe such a taste-based discrimination model. They fix the wage offer being made to applicants. In this case discriminated applicants apply for

the low wage jobs, because in equilibrium discriminatory firms offer high wages to attract non-discriminated applicants. Charles and Guryan (2007, 2008) find that if discriminatory preferences are portable across worker and employers, discrimination will result in lower hiring probabilities and wages for discriminated applicants, even if there is perfect competition. Lang and Manove (2003) show that a continuum of types rather than just two types (discriminated and non-discriminated) result in high unemployment for less desired applicants, but not in lower wages.

Others that have analysed taste-based discrimination are: Galenianos and Kircher (2009) who allow for multiple applications per applicant; Peters (2009) allows for heterogeneity both among firms and applicants and Shi (2009) analyses wage-tenure contracts.

In general taste-based discrimination models focus on how discrimination affects wages, employment and profit. In contrast, in my model I only focus on how anonymous application procedures affect the hiring probabilities.

2.2 Statistical discrimination

Statistical discrimination models are the second type of models to analyse discrimination in the labour market. This model is consistent with the persistence of discrimination over long periods of time. Phelps (1972) and Arrow (1973) first developed this model (independently of one another). The underlying assumption in this model is that there is scarcity of information in the labour market. There are unobservable characteristics of applicants (that differ by sex, race, or ethical background) and these prevent employers from determining the true individual productivity. The firm in turn uses a statistical method to make an assumption on the productivity of the individual. The average productivity of the group the individual belongs to is portrayed on them as their individual productivity, however this does not necessarily coincide. Thus, employers use characteristics of the group as a cost-effective way to predict individual productivity in a world with limited (or asymmetric) information, rather than to undertake costly actions to learn their true productivity. Altonji and Pierret (2001) confirm that firms use racial information of a specific individual to infer their productivity.

If the employer believes that discriminated employees are less qualified, reliable and productive on average relative to non-discriminated applicants it makes sense for the firm to discriminate against these applicants, because the employer seeks to maximize expected profit. This is especially true if the costs of obtaining the information on the individual applicants' productivity is high. In this case skin colour, sex and race are taken as a proxy for relevant data that is not available to the employer and this information is also available at relative low cost. The negative beliefs the employer has about the discriminated employees might be based on previous (statistical) experiences with employees from this group or from prevailing sociological beliefs about the disadvantaged circumstances in society for these workers. Cognitive biases might confirm the negative stereotypes employers have, whilst disconfirming evidence will likely be discounted (Loury, 2002). As a consequence employers will make hiring and wage decisions based on the observable information of the applicant including the race, sex and ethnic background of the applicant. Compared to Becker's taste-based model, in the statistical discrimination model employers do not necessarily have a distaste against discriminated workers, they simply deem them less productive (or profitable) than non-discriminated workers.

Important to note is that not every distinction made between two applicants of two different groups necessarily constitutes discrimination. If the groups differ in productivity then it makes perfect sense for (a profit maximizing) employer to pay lower wages to the employee that belong to the less productive group. For the purpose of this paper however, I will not consider this situation. In my model the two group will be as productive on average, unless stated otherwise.

Competition will not eliminate discrimination from the labour market in the statistical discrimination setting. However, my model shows that if the statistical discrimination is incorrect (meaning that discriminated applicants are not less productive than non-discriminated applicants) anonymous application procedures might actually be capable of eliminating discrimination from the labour market.

If there is a positive probability that the discriminated applicant has to compete with a non-discriminated worker and firms are less able to assess the productivity of discriminated workers than the productivity of non-discriminated workers, Cornell and Welch (1996) show that discriminated workers have a less than proportional change of getting the job. The results of Lang, Manove and Dickers (2005) also partially arises due to the uncertainty surrounding the productivity of the discriminated applicant.

A strand of statistical discrimination literature examines how stereotypes on the productivity of non-discriminated and discriminated workers influence the firms hiring, job assignment, wage and/or promotion decisions.

Coate and Loury (1993) analyse how an affirmative action policy implemented by the government impacts the employers' belief about the capabilities of the discriminated applicant in the equilibrium that arises after the introduction of the policy. To study this they develop a job assignment model and show that negative stereotypes about discriminated and non-discriminated workers might persist, even if workers are *ex ante* equally productive. This is due to the investment decision made by both type of workers. Investments are hard to observe for the employers. The firms can only observe a noisy signal, which is positively correlated with the worker's investment decision. There are two kind of jobs: easy and hard jobs and workers are either qualified or unqualified. The qualified are better at the hard job, whilst the unqualified are better at the easy job. Due to the noisy signal the firm cannot perfectly determine to which group a certain individual belongs. Based on group membership, which is either the discriminated or non-discriminated group, the firm might have prior beliefs about whether the individual is qualified or not.

The model results in a self-fulfilling prophecy, because firms assume that discriminated workers have invested less in their human capital and the signal is noisy, discriminated workers decide to invest less in human capital as they cannot fully benefit from their investment but do bear the full costs. The interesting thing about this model is that both discriminated and non-discriminated worker have the same *ex ante* skill and investment cost distribution, but due to prior beliefs the outcomes are quite different. Aigner and Cain (1977) also assume that there is a noisy signal, however they assume that there is a difference in the reliability of productivity related information across groups.

Firm's negative stereotypes might worsen due to affirmative action in this model. Because firms believe that discriminated workers are less qualified on average they will set a lower standard for these workers such that the affirmative action standard can be reached by the firm. This can result in

discriminated worker even investing less which results in even less qualified employees. These theoretical results seem to be confirmed by empirical research (Fryer, Goeree & Holt, 2005). The selected equilibrium will remain in place because of the self-fulfilling prophecy. Models with negative stereotypes can also be extended to include promotions (Fryer, 2007 & Lehmann, 2011).

The discrimination results in inefficiencies, because the investment in human capital might be lower than optimal and as a consequence overall efficiency might also be below optimal. Another complication for overall efficiency is that non-discriminated workers can actually experience an incentive to overinvest in human capital (Lundberg & Startz, 1983) or other observable signals (Lang & Manove, 2011).

The above discussed results relate to models in which it is assumed that discriminated and non-discriminated applicants are *ex ante* equally productive. Whether these results also hold true when this assumption is released is unclear due to a lack of research (Lang & Lehmann, 2012).

2.3 Other models

Based on the taste-based and statistical discrimination models, other model were developed to explain discrimination in the labour market. Epstein (1992) introduces a sorting and searching model that combines aspects of both the taste-based and the statistical discrimination model. The idea of this model is that people direct their attention and energy towards others who are willing to interact with them. Thus discriminated people will not focus on discriminatory employers, but on non-discriminatory ones.

Cartel models of discrimination are another type of model to explain discrimination in the labour market and originated mainly from the taste-based model. In Becker's (1957) taste-based model is it assumed that discriminating agents do not want to be associated with discriminated employees. However, this does not reflect reality. The idea of this kind of models is that non-discriminated people want to form a tight socially connected group that is willing to invest in elevating their self-esteem by subordinating discriminated people. Group solidarity is extremely important in this model and explains why people will not break the social norm. Those that dare to break the social norm, will be punished by the rest of the group (Cooter, 1994).

Discrimination might also arise because non-discriminated people fear stigmatisation by other if they do not discriminate. This explains how discrimination might persist in the long run. This might even hold true in an environment where no one prefers discrimination (Pęski & Szentes, 2013).

2.4 Empirical literature

There is a lot of literature on the effects of different policies to combat discrimination in the labour market. One of those policies is anonymous application procedures. Behaghel, Crépon and le Barbanchon (2015) investigate a French initiative to anonymize resumés. Firms voluntarily decided to take part in the experiment and the resumés were anonymized by the French public employment service (Pole Emploi). Firms that decided to participate randomly received anonymous resumés or name-bearing resumés. The firms that participated are actually less likely to interview and hire minority candidates after anonymisation took place, these surprising results can be explained in two ways.

First, firms self-select into the program. The firms that participated already employ relatively many minority workers compared to non-participating firms. Participating firms will likely positively

evaluate resumés of minority applicants, however due to the anonymous application procedures these firm could no longer positively select based on these minority characteristics. So in short, the participating firms no longer had the opportunity to positively discriminate in favour of minority workers.

Second, firms no longer have the possibility to attenuate certain negative signals from minority applicants. For example, consider a resumé with a gap of two years in the working experience in which the applicant was unemployed. If the resumé is anonymous this will likely be a negative signal for the employer and might result in a decision not to interview and/or hire the applicant, as the employer does not know why there is a gap. If the resumé is not anonymous and it belongs to a minority applicant, the employer has the possibility to attenuate the negative signal. Minority workers face more difficult circumstances in the labour market and therefore are more likely to have an unemployment spell.[2]

Concluding, this empirical paper shows that introducing anonymous application procedures can actually be counterproductive and result in lower employment rates for minority groups. It is difficult to put this result in the context of either taste-based or statistical discrimination, because in both models anonymous application procedures reduce the impact of discrimination on the interview decision made by the firm. However the firms in this study are self-selected and therefore might be less discriminatory than the average firm or not discriminatory at all. In case of the latter neither model will apply.

Agan and Starr (2017) investigate an American initiative to anonymise applicants' criminal history. These "Ban the Box" (BTB) policies restrict employers from asking about the criminal history of the applicant. The policy aims to reduce unemployment among disadvantaged groups like Afro-Americans, who are overrepresented in the criminality statistics. However, employers will have to make assumptions about the criminal history of the applicant, this could encourage (racial) discrimination as employers will likely base their assumption on the applicant's race. This is similar to a statistical discrimination model, as the assumptions of the firm are based on statistical relations between someone's group and the fact that that group is overrepresented in the criminal records.

The authors sent approximately 15.000 online job applications on behalf of fictitious young, male applicants to employers in New York City and New Jersey before and after the adoption of the BTB policies. The researchers varied the sounding of the name (either distinctly white or black sounding) and also the felony conviction status (criminal history) of the applicant. The authors find that the criminal records can be a major barrier to employment. Employers that actually asked about the criminal records of the applicant were 63 percent more likely to give a call back to applicants with no criminal history.

However, the results also show that BTB policies encourage (racial) discrimination. The gap between black and white call-back rates grew significantly in firms that applied the BTB policy. Before the introduction of the policy, white applicants received 7 percent more call-backs than comparable black applicants. The BTB policy increased this gap to 43 percent. A likely explanation is that employers rely on exaggerated impressions of true racial difference in criminal history. In reality there are minor differences in felony conviction rates between blacks and whites, however these differences are exaggerated by the employer and as a consequence the employer applies this exaggerated rate to applicants. This explanation is supported by the fact that the call-back rates of black applicants without

[2] See for instance: Abella, M. (2000). *Documenting discrimination against migrant workers in the labour market: A comparative study of four European countries*. International Labour Organization.

a criminal history decreased and the call-back rates for whites with a criminal history actually increased. This explanation is in line with the theoretical model by Aigner and Cain (1977).

However, Craigie (2019) also investigates BTB policies using a difference-in-difference design. Using data from the National Longitudinal Survey of Youth 1997 Cohort, he finds that BTB policies actually raise the probability of public employment for those with a criminal history with on average 30 percent. It seems like the result of Agan and Starr (2017) fits nicely with statistical discrimination, however Craigie (2019) finds no evidence that her result can be explained by statistical discrimination.

Agan and Starr (2017) use fictious resumés to find their results, however there is also research that is based on real-world experiments. For example, in Sweden there has been a pilot with anonymous application procedures for real-world job openings. Åslund, & Nordström Skans (2012) use a dataset to investigate the impact of anonymous application procedures on both interview and job offer probabilities for different groups of applicants. Their research confirms evidence that was found in fictious resumé experiments that discrimination has an ethnic and gender dimension.

The data is based on over 3500 applications within the Swedish local public sector. The researchers show that female and non-Western applicants have a substantially lower change of getting invited for an interview, even after controlling for relevant observable characteristics. Once the anonymous application procedure is implemented, these differences are no longer found. But, the difference remains at the job offering stage for the non-Western applicants (not for women). In my model I find a similar result. Anonymous application procedures increase the probability a discriminated applicant is invited for an interview, however discrimination remains at the job offering stage.

The researchers conclude that anonymous application procedures have a statistically significant and large impact on the interview offers, but not necessarily for all groups on the hiring outcomes. They also conclude that anti-discrimination legislation in itself is not sufficient to prevent or even eliminate discrimination in the labour market.

In the Netherlands there has also been a pilot with anonymous application procedures for local municipalities in a ‘real world’ setting. The anonymous resumés seemed to have positive effects, the number of applicants with a bicultural background increased from 24 to 31 percent. In this group the invitations for an interview increased from 13 to 24 percent. And the amount of bicultural employees in high-end function increased (consistent) from 11 to 36 percent. Similar effects were found in a German research among eight (large) organisations. As my analysis will show this can be explained in both a taste-based and statistical discrimination setting. Nevertheless the pilot was cancelled, because it also had negative side effects. For instance, positive discrimination was no longer possible. Some municipalities even experienced a decrease in the number of women and (ethnic) minorities that were hired (NOS, 2018).

For a more extensive overview on the evolution of the empirical work with regard to discrimination on the labour market, see Guryan and Charles (2013).

Lippens, Vermeiren and Baert (2021) find, using a random effects model and a meta-analysis, that ethnic hiring discrimination has significantly decreased in Europe over the past 15 years.

Interestingly enough the view on the need for and effectiveness of laws and policies to eliminate discrimination greatly depends on the model chosen to explain discrimination. The taste-based model

of discrimination assumes that discrimination will disappear due to competitive forces, therefore no laws or policies are needed. Nevertheless, Donohue (1986) advocates the implementation of anti-discrimination laws as they can speed up the market process towards a non-discrimination equilibrium.

The empirical research has shown that the effects of anonymous application procedures are mixed. In certain circumstances there seems to be a positive effect of anonymous application procedures, whilst in other circumstances the effect is negative. The taste-based and statistical discriminations models are traditionally the most common models to investigate discrimination in the labour market. In the coming chapters I will develop a model in which both types of discrimination can be incorporated and analyse the impact of anonymous application procedures on the hiring probabilities of the discriminated applicant.

3. The model

In this chapter I introduce the model. In the next chapter I analyse the outcome of my model without discrimination, both in case all three applicants and in case only two applicants are interviewed. In chapter five I analyse my model under taste-based discrimination, in the first paragraph of that chapter I explain how this is modelled. In chapter six I do the same for statistical discrimination.

3.1 Introduction

Consider a population of three individuals, $N = \{1, 2, 3\}$, who are looking for a job. There is one firm, F, offering one job. Each individual, i, can belong to one of two groups, $g_i = \{F, D\}$. Where F are the non-discriminated (Favoured) applicants and D are the discriminated (Disfavoured) workers. In the pool of three individuals there are two non-discriminated workers and one discriminated. Assume that individual 1 is the discriminated applicant. Each applicant has a certain underlying (true) productivity, that determines how well the applicant will perform the job. This productivity equals:

$$q_i = c_i + t_i + \varepsilon_i \tag{1}$$

Where q_i stands for the underlying (unknown) productivity.[3] This underlying productivity consists of three different parameters, which are unobservable for the firm before the application procedure starts. However the firm can engage in (costly) activities to observe the first two characteristics. After reading the resumé the firm learns c_i. The value of c_i will be determined by the education and experience of the applicant. The discrimination parameter is denoted as $\beta(g_i)$ and represent the costs of working with individual i of group g_i. If the application is non-anonymous the discrimination parameter will be learned by the firm after it received the resumé. If the application is anonymised the discrimination parameter can only be learned if the discriminated applicant is invited for an interview. During the interview the firm

[3] The true productivity is unknown for both the applicant and the employer. Because the applicant is a passive agent in my model, it does not matter whether the applicant knows his or her productivity or not. This becomes relevant in case the applicant has to decide where to apply, some firms might be a better match for the applicant than others and the applicant could be aware of this.

will learn to which group the applicant belongs. After learning c_i the firm can decide to have an interview with the applicant(s), which enables the firm to learn a new parameter: t_i. This parameter will (partly) be determined by the social skills of an applicant. Despite the interview ε_i remains unobservable, therefore some (random) noise remains.

The employer wants to maximize the (expected) profit and therefore hires the applicant with the highest (expected) productivity, if and only if $E(\Pi_i) \geq 0$. The expected profit is equal to $E(\Pi_i) = E(q_i) - w - s \cdot k - \beta(g_i)$, where $E(q_i)$ equals the expected productivity of individual i, w is the wage which is a fixed and exogenous amount, s denotes the number of interviews being held and is exogenously fixed at three or two and k equals the costs per interview and we assume that these are identical for every individual. We also assume that these cost are very low, therefore interviews are not expected to result in a loss.[4] As said $\beta(g_i)$ denotes the discrimination parameter. We assume that $\beta(D) > \beta(F) = 0$. In the calculations I use β to denote the discrimination parameter rather than $\beta(g_i)$ to make notation more comprehensive.

In my base setting, all parameters are independently drawn from an uniform distribution on the interval [0,1]. The unobservable (at least before the interview) characteristics are correlated with the group an individual belongs to, thus $corr(t_i, g_i) \neq 0$ and $corr(\varepsilon_i, g_i) \neq 0$.

The application process is visually represented in Figure 1 and 2 for two different scenario's. In Figure 1 all three applicants are interviewed and Figure 2 depicts a scenario in which only two of the three applicants are interviewed. These figures resemble the different scenarios which I will analyse.

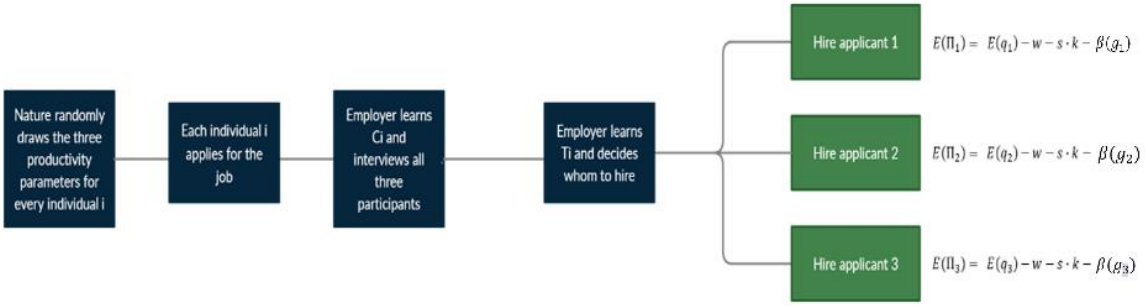

Figure 1: Decision tree hiring procedure when interviewing all three applicants

[4] This allows to endogenize the firms' decision on the number of interviews, however in this thesis that scenario is not analysed.

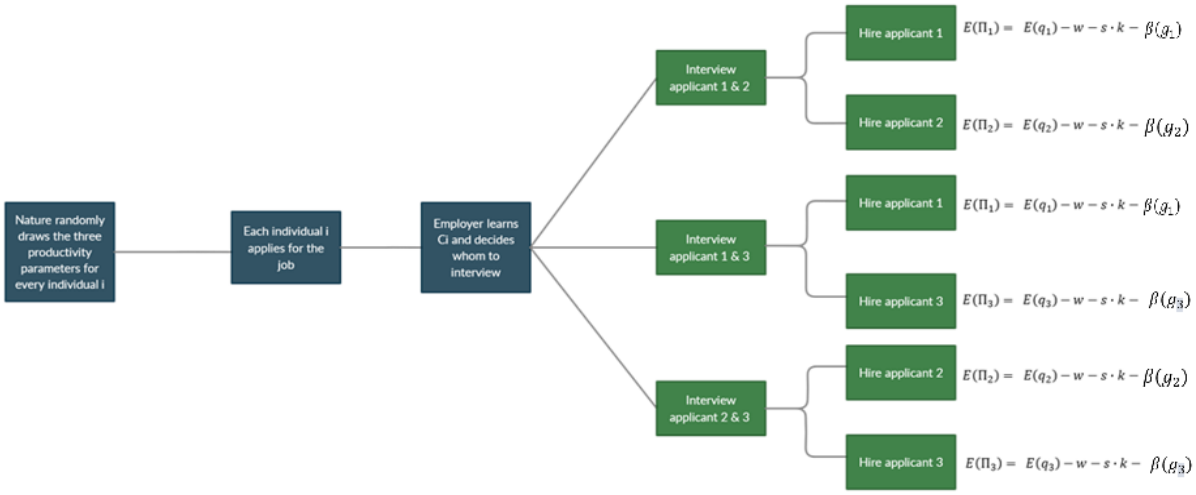

Figure 2: Decision tree hiring procedure when interviewing only two applicants

The figures show the following steps: first nature randomly draws the three productivity parameters from a distribution which is identical for every individual. Then each individual applies for the job.[5] Applicants will apply when the expected benefits of applying are larger than the costs. For now we assume that this is the case. After the individual has applied, the employer observes the first productivity parameter, c_i, based on the resumé. Based on this information the firm decides who to invite for an interview. In Figure 1 the firm decides to interview all the applicants. The interview is costly, but in my model these costs will be ignored. The interview provides the employer with more information on the productivity of the individual. After the interview the firm decides whom to hire, which will result in a certain profit for the firm. The dark blue shapes in Figure 1 indicate that the firm is passive, thus discrimination has no influence at that stage. The green shapes indicate that the firm makes a decision and at those stages discrimination might influence the outcome.

Figure 2 depicts the scenario where only two of the tree applicants are interviewed, despite all applicants applying for the job. The first three steps are the same as in Figure 1. However, in this scenario discrimination might already influence the probability that a certain applicant will be interviewed, because the curriculum vitae contains information on the group (religious or ethnic) the applicant belongs to. Again the interview is costly but also provides the firm with new information on the productivity of the applicant. After observing this parameter the employer decides which of the two remaining applicant to offer the job. Also in this figure the dark blue shapes indicate that the firm is passive, meaning that discrimination has no role at that stage. The green shapes indicate that the firm makes a decision and at those stages discrimination might influence the result. Compared to Figure 1 the firm can now discriminate against the discriminated applicant at two stages: when the interview and hiring decisions are made. The latter is also possible under anonymous application, because the firm will learn the group the individual belongs to during the interview.

[5] Either because the costs of applying are sufficiently low or the individuals have some sort of obligation to apply for a job, possibly because their governmental benefits depend on it.

4. No discrimination

4.1 Three applicants interviewed

In the previous chapter I have introduced the model. In this section I analyse the model when all three applicants are being interviewed without anonymous applications. In this chapter I calculate the probability that the discriminated applicant will be hired in a world without any frictions (e.g. discrimination). In the next chapter I investigate the impact of discrimination on the probability that the discriminated worker will be hired. And finally I analyse the effects anonymous discrimination procedures have on the probability that the discriminated worker will be hired.

The probability that an applicant will get hired, depends on their own productivity parameters and those of the other applicants. In the scenarios in which all three applicants get interviewed I will have to calculate the probability that an applicant will get hired, conditional on being interviewed and I will also calculate the probability that the applicant gets interviewed separately. The probability that any applicant gets hired on the outset of the hiring procedure will equal the multiplication of these two elements. Or to put it in an equation,

$$p(h) = p(h|t) * p(t_g) \tag{2}$$

Where $p(h)$ is the probability of getting hired for the job, $p(h|t)$ is the conditional probability to get hired and $p(t_g)$ is the probability that the applicant will be interviewed.

The scenario in which all three applicants are interviewed is a benchmark for the scenario in which only two candidates are interviewed. The latter will be discussed in the next paragraph. The scenario without discrimination will prove to be a benchmark for the scenario with discrimination.

To calculate this probability that an applicant gets hired when all three are interviewed I first need to define Z_i which is equal to,

$$Z_i = c_i + t_i + E(\varepsilon) \tag{3}$$

The minimum value of the sum is equal to 0.5 (when both c_i and t_i equal zero). The maximum value of the sum is equal to 2.5 (when both c_i and t_i equal 1). Thus the sum is only defined on the interval [0.5, 2.5] and thus the probability that $Z < 0.5$ or $Z > 2.5$ is equal to zero.

An applicant will be hired when he or she has the highest productivity, the firm can then maximise profit. To calculate the probability that a certain applicant has the highest productivity, two things are needed. First we must know the probability that an applicant has a certain productivity, Z_i. Therefore we need the probability density function of Z_i. Second, I must also calculate the probability that the other applicants have a lower productivity than Z_i. If their Z_i is higher, they will be hired. To calculate this second probability I need to calculate the cumulative density function of Z_i. To make this less abstract I

provide an example: assume that the discriminated applicant has a Z_i of 0.7. To calculate the probability that the discriminated applicant gets hired I will need to calculate the probability that the discriminated applicant actually has a Z_i that equals 0.7 and then I will also have to calculate the probability that the other candidates have a Z_i that is lower than 0.7, otherwise the discriminated applicant will not be hired.

Using the cumulative distribution and the probability density function I can calculate the probability that the discriminated applicant will get hired in a scenario in which all three applicants are interviewed and there is no discrimination in the labour market.

The probability that the discriminated applicant gets hired is equal to,

$$\int_0^2 \big(F(z_i)\big)^2 f(z_i)\, dz_i \tag{4}$$

Where $z_i = c_i + t_i$, $E(\varepsilon)$ can be ignored in this case because *ex ante* it will be equal for all three candidates, $F(Z)$ is the cumulative distribution function (CDF) of Z_i, this equals the probability that the sum, Z_i, is less than or equal to some value z_i, $f_Z(z)$ is the probability density function (PDF) of Z_i, this is the probability that Z_i equals a certain value z_i. The square in $\big(F(z_i)\big)^2$ resembles the fact that two non-discriminated applicants are being interviewed.

The PDF of Z_i equals,

$$\begin{matrix} f^{<1}(z) \\ f^{>1}(z) \\ f^{0}(z) \end{matrix} = \begin{cases} z_i, & for\ 0 < z_i < 1 \\ 2 - z_i, & for\ 1 \le z_i < 2 \\ 0, & otherwise \end{cases} \tag{5}$$

And the CDF of Z_i equals:

$$\begin{matrix} F^{<1}(z) \\ F^{>1}(z) \\ F^{0}(z) \end{matrix} = \begin{cases} \frac{1}{2}{z_i}^2 & 0 \le z_i \le 1 \\ 1 - \frac{1}{2}(2 - z_i)^2 & 1 < z_i \le 2 \\ 0 & otherwise \end{cases} \tag{6}$$

Equation (4) then is equal to,

$$p(h|t) = \int_0^1 (\frac{1}{2}z_i^{\ 2})^2 z_i dz_i + \int_1^2 (1 - \frac{1}{2}(2 - z_i)^2)^2 (2 - z_i) dz_i = 0.291667 + 0.0416667 = \frac{1}{3} \qquad (7)$$

The result of equation (7) is intuitive. Remember that all three applicants are interviewed by the firm and there is no discrimination. The productivity of all applicants is determined by the same three parameters, which are all independently drawn from the same underlying uniform distribution. Thus all the applicants have an equal probability to get hired, which equals $\frac{1}{3}$. It is basically a random draw between three individuals and thus also the probability that the discriminated applicant will be drawn as the most productive is equal to $\frac{1}{3}$.

Equation (7) actually provides us with the hiring probability of the discriminated applicant, conditional on being interviewed. Because all three applicants get interviewed the probability that the discriminated applicant will be hired is equal to the conditional probability multiplied by one and thus is equal to $\frac{1}{3}$.

4.2 Two applicants interviewed

In this scenario all three applicants apply for the job, but only two will get an invitation for an interview. Note there is still no discrimination on the labour market. After being interviewed, the firm decides whom to hire (see Figure 2 for a visual representation). The value of c_i (the productivity parameter based on the resumé) now becomes very important as it decides whether or not an applicant may advance to the interview stage. The two applicants with the highest c_i's will get interviewed by the firm and thus have a chance of being hired for the job.

We consider three main cases. In the first scenario the discriminated applicant has the highest c_i. In the second scenario this applicant has the second highest c_i and in the third scenario the discriminated applicant has the lowest c_i. In this last scenario the probability that the discriminated applicant will be hired is obviously equal to zero.

Consider now the first case, thus assume that $c_1 > c_2 > c_3$ or $c_1 > c_3 > c_2$. Then, the probability that the discriminated applicant is hired is equal to,

$$\begin{matrix}(a)(b)(c) & (d) & (b) & (d) & (d) & (c)(b) & (a)(b) & (c) & (d) & (b)(d)(d)(c) & (b)\end{matrix}$$
$$2\int_0^1 \int_0^{c_1} \int_0^{(1-c_1+c_2)} c_2\,(t_1 + c_1 - c_2)\, dt_1 dc_2 dc_1 + 2\int_0^1 \int_0^{c_1} \int_{(1-c_1+c_2)}^1 c_2 1 dt_1\, dc_2 dc_1 \qquad (8)$$

Part (a) refers to the possibility of individual 2 and 3 shifting in the order of c's. However in both scenarios it remains true that c_1 is the largest.

Part (b) refers in its entirely (notice that (b) is also at the end of the first part of the equation) to the probability that any individual progresses into the interview stage. So individual 1 goes to the interview stage if at least c_2 or c_3 is lower, therefore in this part I calculate the probability that c_2 is smaller than c_1. The lower limit in this integral is equal to 0, because that is the minimum value of c_1. The upper limit of the integral is equal to 1, because that is the maximum value c_1 can take on. c_2 is also included in this part in the equation because we want to know the probability that c_2 (or c_3, but that is taken into account by the multiplication) is below c_1. This probability equals c_2 because it is an uniform distributed variable between zero and one.

Part (c) refers to the probability that we are actually in the scenario $c_1 > c_2 > c_3$ or $c_1 > c_3 > c_2$. And therefore again includes the probability that c_2 is smaller than c_1, because that is the scenario under investigation. So here the lower limit of the integral is determined by the lowest value c_1 can take on, which is zero. The upper limit is equal to c_1 because we already know that this is the largest value of c_1, c_2 and c_3.

Finally (d) refers to the probability that individual 1 will be hired. Individual 1 will be hired when:

$$c_1 + t_1 > c_2 + t_2 \tag{9}$$

However, we also know that,

$$c_1 > c_2 \tag{10}$$

For individual 2 to win the following needs to hold,

$$t_2 > c_1 - c_2 + t_1 \tag{11}$$

So if t_2 is below this value, individual 2 can never win and thus individual 1 will be hired. That means that if the value is below this threshold the probability that individual 1 will be hired is equal to 1. Now this also explain the upper limit of the integral in part (d). If $t_1 > t_2 + c_2 - c_1$ the probability will equal 1, that also means that if $t_1 < t_2 + c_2 - c_1$ the probability that the discriminated individual wins is not equal to 0. In this case the probability that the discriminated individuals wins is $(t_1 + c_1 - c_2)$. The lower limit is explained by the fact that the lower limit of t_1 is equal to zero.

Now in the second part of the equation (after the plus) the explanation of (a), (b) and (c) remains the same. The explanation of (d) changes slightly.

As you can see the upper and lower limit of the integral of part (d) have changed in this scenario. That can easily be understood by the explanation above, if $t_1 > t_2 + c_1 - c_2$ individual 1 always wins. The upper limit of the integral is equal to the upper limit of t_2. So if t_1 is in between these values the probability that individual 1 wins is equal to 1.

Equation (8) is equal to

$$2\int_0^1\int_0^{c_1}\int_0^{(1-c_1+c_2)} c_2\,(t_1+c_1-c_2)\,dt_1dc_2dc_1 + 2\int_0^1\int_0^{c_1}\int_{(1-c_1+c_2)}^1 c_2 1dt_1\,dc_2dc_1 = \frac{14}{60} \qquad (12)$$

Finally consider the second scenario, so where the discriminated applicant has the second largest c_i, so when $c_2 > c_1 > c_3$ or $c_3 > c_1 > c_2$, again because these two situation are symmetric there is a multiplication by two in the calculations below.

(a)(b) (c) (d) (b)(d)(d)(c) (b) (a) (b) (c) (d) (b) (d) (d) (c) (b)

$$2\int_0^1\int_{c_1}^1\int_0^{(c_2-c_1)} c_1 0dt_1dc_2dc_1 + 2\int_0^1\int_{c_1}^1\int_{(c_2-c_1)}^1 c_1(t_1+c_1-c_2)dt_1dc_2dc_1 \qquad (13)$$

The explanation of part (a) and (b) remain the same, except that in part (b) we now look at c_1 rather than c_2, because by the nature of this scenario (I take the first order I wrote down as starting point) c_2 is larger than c_1, thus I will have to look at the probability that c_3 is smaller than c_1 rather than the probability that c_2 is smaller than c_1.

This time part (c) refers to the probability that we are actually in the scenario $c_2 > c_1 > c_3$ or $c_3 > c_1 > c_2$. So here the lower limit of the integral is determined by the lowest value c_1 (below that value is not possible otherwise the discriminated individual would not go to the second round). The upper limit is equal to 1 because that is the maximum value c_2 can take on.

Now for part (d) the line of reasoning remains very comparable to the previous scenario. Again individual 1 will be hired when:

$$c_1 + t_1 > c_2 + t_2 \qquad (14)$$

We already know that

$$c_2 > c_1 \qquad (15)$$

Individual 1 can never win if

$$t_2 \geq t_1 - c_2 + c_1 \qquad (16)$$

In this scenario individual 2 will always be hired. Thus if this threshold is met, the probability that individual 1 gets hired is equal to 0. This also explain the upper limit of the first integral. The lower limited is explained by the fact that the lower limit of t_1 is equal to zero. Thus in the first part of the equation the probability that individual 1 wins is equal to zero, because t_1 will not be large enough to compensate for the fact that $c_2 > c_1$ and the value of t_2.

After the plus the explanation of $(a), (b)$ and (c) remains the same. The explanation of (d) changes slightly. As you can see the upper and lower limit of (d) have changed in this scenario. That

can easily be understood by the explanation above, if $t_2 < t_1 - c_2 + c_1$ individual 1 does have a positive probability of being hired and therefore this is the lower limit. The upper limited is determined by the maximum value of t_1. This also indicates that the more t_1 increases, the larger the likelihood that individual 1 will actually be hired. $(t_1 + c_1 - c_2)$ is added to this part of the equation to reflect the probability that individual 1 will be hired for the job.

Equation (13) is equal to

$$2\int_0^1 \int_{c_1}^1 \int_0^{(c_2-c_1)} c_1 0 dt_1 dc_2 dc_1 + 2\int_0^1 \int_{c_1}^1 \int_{(c_2-c_1)}^1 c_1(t_1 + c_1 - c_2) dt_1 dc_2 dc_1 = \frac{6}{60} \qquad (17)$$

Which means that equation (12) and (17) together are equal to $\frac{1}{3}$. The result of these equations is intuitive. Similar to the previous paragraph, remember that the productivity of all applicants is determined by the same three parameters, which are all independently drawn from the same underlying uniform distribution. Thus all the applicants have an equal probability to be the best candidate, which equals $\frac{1}{3}$. It basically remains a random draw between three individuals and thus also the probability that the discriminated applicant will be drawn as the most productive is equal to $\frac{1}{3}$. This also equals the *ex ante* probability that the discriminated applicant gets hired.

This means that in a world without discrimination the number of applicants being interviewed does not influence the probability that an applicant gets hired. In any scenario there is a $\frac{1}{3}$ probability for every individual to have the highest productivity and thus be the best applicant, this is in no way influenced by the set-up of the hiring process. The analysis shows that the set-up also doesn't influence the *ex ante* hiring probability of the discriminated applicant. However, it would be possible that the applicant with the highest productivity, q_i, has the lowest c_i and thus does not advance through into the interview stage when only two applicants are interviewed. The *ex ante* probability that the discriminated applicant is hired is still equal to $\frac{1}{3}$, because by interviewing less applicants the probability that the firm does not hire the best applicant increases. Thus when only two applicants are interviewed the two non-best applicants have a positive probability to be hired, this was not the case when alle three applicants were interviewed. The probability that the best applicants get hired plus the probability that not the best applicant gets hired equal to $\frac{1}{3}$ and therefore the analysis shows that the set-up does not influence the *ex ante* hiring probability of the discriminated applicant.

5. Taste-based discrimination

5.1 Introduction

In the previous two chapters I have introduced my model and analysed two scenarios without discrimination. These can be used as a base or reference scenario when analysing the model under

discrimination. In both scenarios without discrimination the probability that the discriminated applicant gets hired equalled $\frac{1}{3}$.

In this chapter taste-based discrimination will influence the hiring probabilities of the discriminated applicant. I will model discrimination as a cost for the employer, which is the same as lowering the productivity of the discriminated applicant by the discrimination parameter $\beta(g_i)$.

First notice that $E(\varepsilon_i)$ from equation (3) can be ignored under taste-based discrimination as it is equal for all three applicants. Assume that $\beta(g_i) > 0$ for the discriminated applicant. As a consequence $E(\Pi_1)$ is lowered with $\beta(g_i)$. Thus the discriminated applicant will be hired if his or her expected productivity, $E(q_1)$, outweighs the negative impact of $\beta(g_i)$, such that $E(\Pi_1)$ will still be the largest. To model this is will subtract the discrimination parameter, $\beta(g_i)$, from the productivity of the discriminated applicant. The non-discriminated applicants will only need a productivity that is higher than $q_1 - \beta(g_i)$ to get hired.

Despite the discrimination, there is still a $\frac{1}{3}$ probability for every applicant to be the most productive worker, but the probability that the discriminated workers will be hired, despite having the highest underlying productivity, will now be lowered.

How much the probability will be lowered depends on the size of $\beta(g_i)$ and z_i. There are several situation in which the probability that the discriminated applicant gets hired is equal to zero for instance if $\beta(g_i) \geq 2$ or $\beta(g_i) > z_i$. In this case the expected productivity for the discriminated applicant will become smaller than zero and because by definition the two other applicants have a productivity which is larger than zero the discriminated applicant will never be hired. If $\beta(g_i) = 0$, we are back in the world without discrimination and thus the probability that the discriminated applicant will be hired is equal to $\frac{1}{3}$.

5.2 Three applicants with $\beta(g_i) \in (0,1)$

I will start with the scenario in which all three applicants are interviewed. Because all three applicants are interviewed Z_i will be influenced by the discrimination and not c_i. Discrimination cannot influence the interview decision.

Because $E(\varepsilon_i)$ can be ignored, z_i is only defined on the interval [0,2]. We can now have three different scenarios,

$$\begin{array}{ll} (a)\ z_i < 1, & z - \beta(g_i) < 1 \\ (b)\ z_i > 1, & z - \beta(g_i) < 1 \\ (c)\ z_i > 1, & z - \beta(g_i) > 1 \end{array} \qquad (18)$$

First, I analyse a scenario in which $\beta(g_i) \in (0,1)$. In the coming paragraphs I will also make some observations for $\beta(g_i) \in (1,2)$, however these paragraphs will not contain extensive analyses as most conclusion follow straightforward from this paragraph. The probability that the discriminated applicant gets hired conditional on being interviewed, $p(h_1|t_g)$ equals the following expression,

$$
\begin{aligned}
(1) \qquad & \overset{(a_1)}{} \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad \overset{(a_2)}{} \\
p(h_1|t_g) = & \int_0^{\beta} F^{<1}(z_1 - \beta)^2 f^{<1}(z_1) dz_1 + \int_{\beta}^{1} F^{<1}(z_1 - \beta)^2 f^{<1}(z_1) dz_1 + \\
& \overset{(b)}{} \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad \overset{(c)}{} \\
& + \int_1^{1+\beta} F^{<1}(z_1 - \beta)^2 f^{>1}(z_1) dz_1 + \int_{1+\beta}^{2} F^{>1}(z_1 - \beta)^2 f^{>1}(z_1) dz_1
\end{aligned}
\tag{19}
$$

Notice that the index one is to indicate that it relates to the probability of the discriminated applicant. The (1) above $p(h_1|t_g)$ refers to scenario 1 from Figure 1. Thus all three applicants are interviewed. The letters above the separate parts from equation (19) refer to the separate scenarios from equation (18). Note that dependent on the values of z_1 and β the cumulative distribution function can be zero. This can easily be understood when looking at Figure 3. If the value of z_1 is between zero and β, the productivity perceived by the employer will actually be below or equal to zero for the discriminated worker, because the perceived productivity equals $z_1 - \beta$. Because the two other candidates will always have a productivity that is larger than zero, one of them will be hired rather than the discriminated applicant.

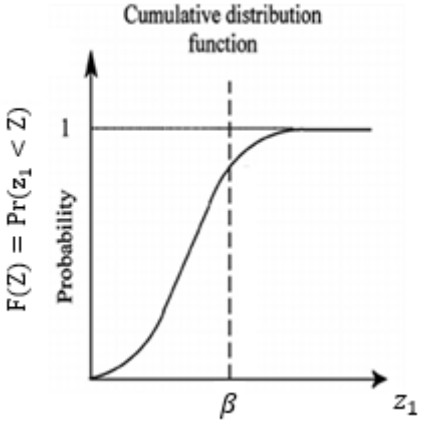

Figure 3: Cumulative distribution function

Figure 3 actually corresponds with (a_1) from equation (19) and thus (a_1) will equal zero. Equation (19) then gives the following result,

$$
p(h_1|t_g) = \frac{1}{3} - \frac{2}{3}\beta + \frac{1}{4}\beta^2 + \frac{1}{3}\beta^3 - \frac{1}{3}\beta^4 + \frac{1}{10}\beta^5 - \frac{1}{12}\beta^6 \tag{20}
$$

Equation (20) gives us the probability that the discriminated applicant gets hired conditional on being interviewed, however because everybody gets interviewed the probability that any applicant will be

interviewed equals one and thus the probability that the discriminated worker will be hired is equal to equation (20). The results is intuitive; it is decreasing in β indicating that the probability that the discriminated applicant gets hired is decreasing in the discrimination parameter. If we assume, on the other hand, that the discrimination parameter is equal to zero we end up in a scenario without discrimination and the probability that the discriminated applicant gets hired is equal to $\frac{1}{3}$. The same result as we calculated in the previous chapter. Equation (20) is visually represented in Figure 4.

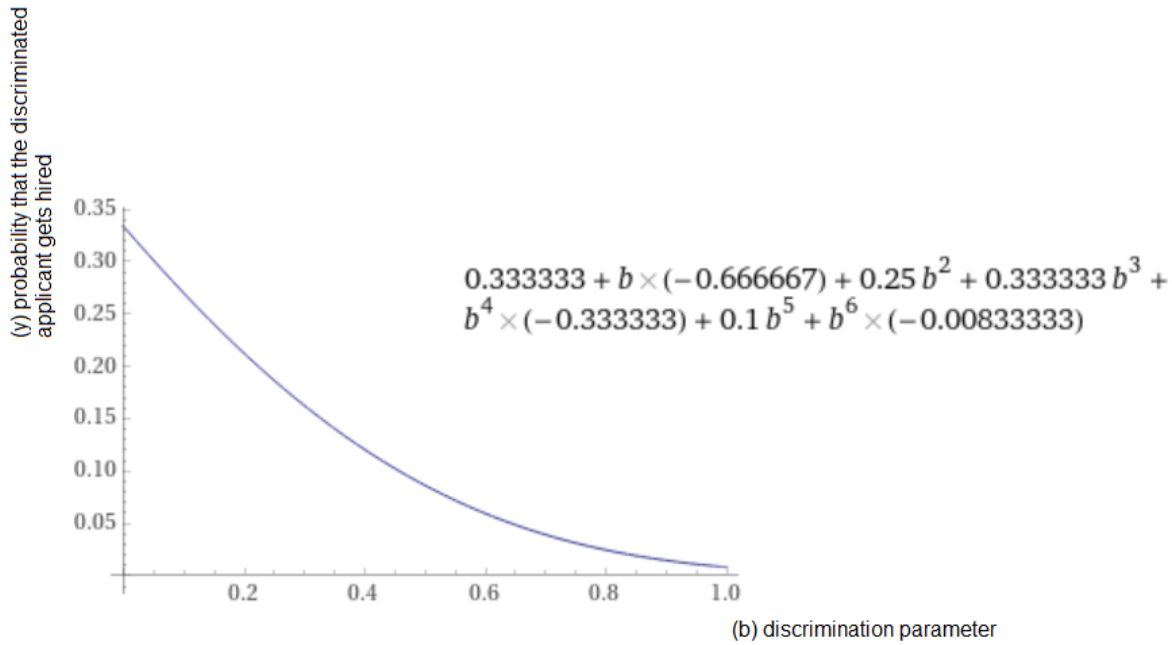

Figure 4 Probability that the discriminated applicant gets hired when all three applicants are interviewed and $\beta(g_i) \in (0,1)$

5.2.1 Anonymous application procedures

Finally, we can have a look at the impact of anonymous application procedures. If there is discrimination in the labour market, discriminated applicants are at a disadvantage at the interview stage even with anonymous application procedures, because the firm learns the group of the applicant during the interview.

However, in the scenario discussed in this paragraph anonymous application will not impact the hiring probabilities of the discriminated applicant, because every applicant will be interviewed by the firm anyway. Once the discriminated applicant is interviewed by the firm it can still discriminate despite the anonymous application. Thus the probability that the discriminated applicant will be hired still equals equation (19), because anonymous application only effects the invitation decision.

The result that the anonymisation cannot impact the hiring decision in itself (given that the firm has discriminatory preferences) is in line the findings of Åslund, & Nordström Skans (2012).

The main findings won't change much when $\beta(g_i) \in (1,2)$. The probability that the discriminated individual gets hired will become even smaller because β is larger relative to this paragraph. Moreover

anonymous application procedures will still not have an impact on the hiring probability of the discriminated applicant, because this will only effect the first stage of the hiring process whilst the discrimination can still take place in the second stage of the hiring process.

In the next paragraph I will analyse a scenario in which only two out three candidates are interviewed. Also in that paragraph $\beta(g_i) \in (0,1)$.

5.3 Two applicants with $\beta(g_i) \in (0,1)$

Previously, I have analysed a scenario in which all three applicants are interviewed. In this paragraph I analyse a scenario in which two applicants are interviewed.

In this scenario the firm can discriminate at two different stages, after receiving the resumé and after the interview (see Figure 2). The taste-based discrimination is still modelled as a decrease in productivity of the applicant and there is no anonymous application procedure.

There are several scenarios in which individual 1 (the discriminated individual) can never win. The first scenario is the case in which $c_1 < \beta$. In that case the probability that the discriminated individual will progress to the second stage (and thus be hired) is zero, because the values of c_2 and $c_3 > 0$ by definition. To put it in an equation,

$$\int_0^{\beta} 0 \, dc_1 = 0 \tag{21}$$

A second scenario in which individual 1 can never win is when $c_2 > c_3 > c_1 - \beta$ or $c_3 > c_2 > c_1 - \beta$. In that case individual 1 cannot progress to the second stage of the application procedure and thus can never be hired.

There are two different scenarios in which the discriminated individual does have a chance of being hired. First, a scenario in which $c_1 - \beta$ is larger than both c_2 and c_3. Second, a scenario in which $c_1 - \beta$ is larger than c_2 or c_3.

Consider the first case, so $c_1 - \beta > c_2 > c_3$ or $c_1 - \beta > c_3 > c_2$, because these two situation are symmetric there is a multiplication by two in the calculations below. The probability that the discriminated individual gets hired is equal to

$$(a)(b)(c) \quad (d) \quad (d) \quad (b)(d)(c)(b) \quad (a)(b)\,(c) \quad (d) \quad (b)(d)(d)(c)(b)$$

$$2\int_{\beta}^{1}\int_{0}^{c_1-\beta}\int_{0}^{(1-c_1+\beta+c_2)} (c_1 - \beta - c_2 + t_1)\, c_2 \, dt_1 dc_2 dc_1 + 2\int_{\beta}^{1}\int_{0}^{c_1-\beta}\int_{(1-c_1+\beta+c_2)}^{1} c_2 1 dt_1 \, dc_2 dc_1 \tag{22}$$

Part (a) as explained above refers to the possibility of individual 2 and 3 shifting in the order of c's. However in both scenarios it remains true that $c_1 - \beta$ is the largest.

Part (b) refers in its entirely (notice that (b) is also at the end of the first part of the equation) to the probability that the discriminated individual progresses into the interview stage. So the discriminated individual goes to the interview stage if at least c_2 or c_3 is lower, therefore in this part I calculate the

probability that c_2 is smaller than $c_1 - \beta$. The lower limit in this integral is equal to β, because I already proved that if $c_1 < \beta$ the discriminated individual will never be hired. The upper limit of the integral is equal to 1, because that is the maximum value c_1 can take on. c_2 is also included in this part in the equation because we want to know the probability that c_2 (or c_3, but that is taken into account by the multiplication) is below $c_1 - \beta$. This probability equals c_2 because it is an uniform distributed variable between zero and one.

Part (c) refers to the probability that we are actually in the scenario $c_1 - \beta > c_2 > c_3$ or $c_1 - \beta > c_3 > c_2$. And therefore also again includes the probability that c_2 is smaller than $c_1 - \beta$, because that is the scenario under investigation. So here the lower limit of the integral is determined by the lowest value $c_1 - \beta$ can take on, which is zero. The upper limit is equal to $c_1 - \beta$ because we already know that this is the largest value of $c_1 - \beta$, c_2 and c_3.

Finally (d) refers to the probability that the discriminated individual will be hired. And now the following becomes important. The discriminated individual will be hired when:

$$c_1 + t_1 - \beta > c_2 + t_2 \tag{23}$$

However, we also know that

$$c_1 - \beta > c_2 \tag{24}$$

Thus for individual 2 to win the following needs to hold

$$t_2 > c_1 - \beta - c_2 + t_1 \tag{25}$$

So if t_2 is below this value, individual 2 can never win and thus the discriminated individual will be hired. That means that if the value is below this threshold the probability that the discriminated individual will be hired is equal to 1. Now this also explain the upper limit of the integral in part (d). Because if $t_1 = c_1 - \beta - c_2$ the probability will equal 1, which also means that if $t_1 < c_1 - \beta - c_2$ the probability that the discriminated individual wins is not equal to 1. The lower limited is explained by the fact that the lower limit of t_1 is equal to zero. Finally $(c_1 - \beta - c_2 + t_1)$ provides the probability that the discriminated individual is hired.

Now in the second part of the equation (after the plus) the explanation of (a), (b) and (c) remains the same. The explanation of (d) changes slightly.

As you can see the upper and lower limit of the integral of part (d) have changed in this scenario. That can easily be understood by the explanation above, if $t_1 > c_1 - \beta - c_2$ the discriminated individual always wins. The upper limit of the integral is equal to the upper limit of t_2. So if t_1 is in between these values the probability that the discriminated applicant wins is no longer equal to $(c_1 - \beta - c_2 + t_1)$, but rather equal to 1.

The outcome of equation (22) represents the probability that the discriminated applicant will be hired and is equal to

$$\frac{1}{60}(\beta-1)^3(\beta^2-2\beta-9)+\frac{1}{12}(\beta-1)^4 \tag{26}$$

Now consider the second case, so when $c_2 > c_1-\beta > c_3$ or $c_3 > c_1-\beta > c_2$, again because these two situation are symmetric there is a multiplication by two in the calculations below.

$$\underset{(a)(b)(c)}{2\int_{\beta}^{1}\int_{c_1-\beta}^{1}\int_{0}^{(c_2+\beta-c_1)}(c_1-\beta)0dt_1dc_2dc_1} + \underset{(d)\quad (b)(d)(d)(c)}{2\int_{\beta}^{1}\int_{c_1-\beta}^{1}\int_{(c_2+\beta-c_1)}^{1}(c_1-\beta)(t_1-c_2+c_1-\beta)dt_1dc_2dc_1} \tag{27}$$
$(b)(a)(b)(c)\ (d) \qquad (b) \qquad (d) \qquad (d)(c)(b)$

The explanation of part (a) and (b) remain the same, except that in part (b) we no look at c_3 rather than c_2, because by the nature of this scenario (I take the first order I wrote down as starting point) c_2 is larger than $c_1-\beta$, thus I will have to look at the probability that c_3 is smaller than $c_1-\beta$ rather than c_2.

This time part (c) refers to the probability that we are actually in the scenario $c_2 > c_1-\beta > c_3$ or $c_3 > c_1-\beta > c_2$. So here the lower limit of the integral is determined by the lowest value $c_1-\beta$ (below that value is not possible otherwise the discriminated individual would not go to the second round). The upper limit is equal to 1 because that is the maximum value c_2 can take on.

Now for part (d) the line of reasoning remains very comparable to the previous scenario. Again the discriminated individual will be hired when:

$$c_1+t_1-\beta > c_2+t_2 \tag{28}$$

But we already know that

$$c_2 > c_1-\beta \tag{29}$$

The discriminated individual can never win if

$$t_2 \geq t_1-\beta-c_2+c_1 \tag{30}$$

In this scenario individual 2 will always be hired. Thus if this threshold is met, the probability that the discriminated individual gets hired is equal to 0. This also explain the upper limit of the first integral. If $t_1=\beta+c_2-c_1$ the probability that the discriminated individual wins is equal to zero. Which also means that if

$$t_2 < t_1-\beta-c_2+c_1 \tag{31}$$

The probability that the discriminated individual wins is not equal to zero. The lower limited is explained by the fact that the lower limit of t_1 is equal to zero. Thus in the first part of the equation the probability that the discriminated workers wins is equal to zero, because t_1 will not be large enough to compensate for the fact that $c_2 > c_1 - \beta$ and the value of t_2.

After the plus the explanation of $(a), (b)$ and (c) remains the same. The explanation of (d) again changes slightly. As you can see the upper and lower limit of (d) have changed in this scenario. That can easily be understood by the explanation above, if $t_2 < t_1 - \beta - c_2 + c_1$ the discriminated individual does have a positive probability of being hired and therefore is the lower limit. The upper limited is determined by the maximum value of t_1. This also indicates that the more t_1 increases, the larger the likelihood that the discriminated individual will actually be hired. $(t_1 - c_2 - c_1 + \beta)$ is added to this part of the equation to reflect the probability that the discriminated individual will be hired for the job.

The outcome of the integral (equation (27)) represents the probability that the discriminated applicant will be hired and is equal to

$$\frac{1}{30}(\beta - 1)^2(3 + 6\beta - 6\beta^2 + 2\beta^3) \tag{32}$$

Equation (26) and (32) together are equal to

$$\frac{1}{12}(\beta - 1)^2(\beta((\beta - 2)\beta - 1) + 4) \tag{33}$$

Which at $\beta = 0$ (no discrimination in the labour market) is equal to $\frac{1}{3}$. This is the result which we would expect, because if there is no discrimination in the labour market we are back to the situation in which it is just a random draw between three individuals and thus the probability that the 'discriminated' applicant will be hired is equal to $\frac{1}{3}$. Moreover equation (33) is also decreasing in β on a [0,1] interval (as shown in Figure 5) which also makes sense because if the discrimination parameter increases the probability that the discriminated individual gets hired will become smaller.

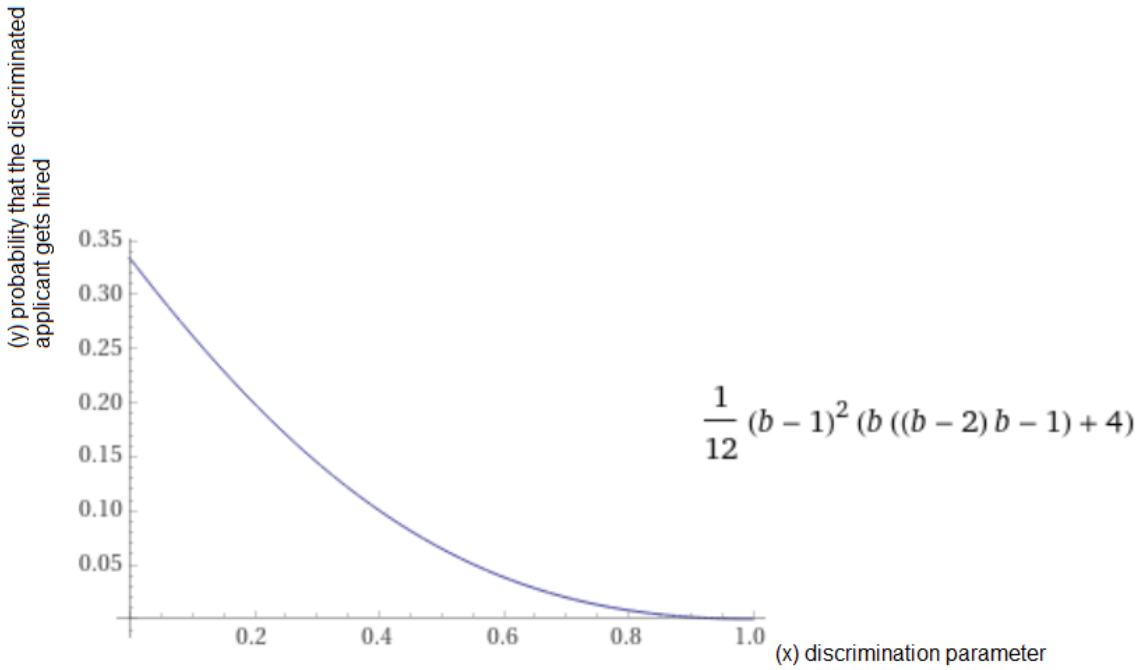

Figure 5: Probability that the discriminated individual gets hired under taste-based discrimination, with discrimination on the labour market and without anonymous application procedures

5.3.1 Anonymous application procedures

In this paragraph I analyse the impact of anonymous application procedures on the probability that the discriminated applicant will get hired for the job. The anonymous application procedure will prevent the firm from being able to discriminate in the first stage of the hiring process. That means that to get interviewed the discriminated applicant will only need to have a higher c_1 than one of the other candidates. So rather than $c_1 - \beta$ cannot be the lowest, c_1 cannot be the lowest to ensure that the discriminated applicant will be interviewed. The probability that the discriminated applicant gets interviewed is the same as in the scenario without discrimination and therefore equal to $\frac{2}{3}$. This does assume that anonymous application procedure functions perfectly to anonymize all the (group) characteristics that firms could use to discriminate against discriminated workers, it is questionable whether this holds in reality as Åslund and Skans (2012) show.

However, once the discriminated applicant is being interviewed I assume that, under taste-based discrimination, the discrimination will still impact the hiring probability of the discriminated individual.

Because the anonymous application procedures prevents that β can impact the first stage of there are more scenarios in which the discriminated applicant progresses to the interview stage, relative to the previous paragraph. However, the discriminated applicants still cannot be hired when c_1 is smaller than c_2 and c_3, because the discriminated individual cannot progress into the second stage of the hiring

process. So there is no difference between an anonymous application and non anonymous application procedure in that sense.

We consider two main cases which are separated in three more specific cases each. The first main case is $c_1 > c_2$. The second is when $c_2 > c_1$. The first main case can be separated in three cases. First, $c_1 - \beta$ is the largest and $c_1 > \beta$. Second $c_1 - \beta$ is the second largest. Third, $c_1 - \beta$ is the largest and $c_1 < \beta$. The second main case can also be separated in three cases. First, c_1 is the second largest and larger than β. Second, c_1 is still the second largest, but smaller than β. And thirdly, $c_2 > 1 + c_1 - \beta$.

Now consider the first scenario so when $c_1 - \beta > c_2 > c_3$ or alternatively $c_1 - \beta > c_3 > c_2$, a scenario we have seen before. This gives the following expression to determine the probability that the discriminated applicant gets hired,

$$2\int_{\beta}^{1}\int_{0}^{c_1-\beta}\int_{0}^{(1-c_1+\beta+c_2)} c_2\,(c_1-\beta-c_2+t_1)\,dt_1dc_2dc_1 + 2\int_{\beta}^{1}\int_{0}^{c_1-\beta}\int_{(1-c_1+\beta+c_2)}^{1} c_2\,dt_1dc_2dc_1 \qquad (34)$$

This equation is equal to equation (22) and therefore the explanation in paragraph 5.3 still applies and will not be repeated in this paragraph. Equation (34) is equal to

$$\frac{1}{60}(\beta^5 - 20\beta^3 + 50\beta^2 - 45\beta + 14) \qquad (35)$$

Consider the second scenario: $c_1 > c_2 > c_1 - \beta > c_3 > 0$ or $c_1 > c_3 > c_1 - \beta > c_2 > 0$. In this case, the probability that the discriminated applicant gets hired is equal to,

$$2\int_{\beta}^{1}\int_{c_1-\beta}^{c_1}\int_{0}^{(c_2+\beta-c_1)} c_2\,0\,dt_1dc_2dc_1 + 2\int_{\beta}^{1}\int_{c_1-\beta}^{c_1}\int_{(c_2+\beta-c_1)}^{1} c_2\,(c_1-\beta+t_1-c_2)dt_1dc_2dc_1 \qquad (36)$$

The explanation of part (a) and (b) do not change compared to the previous paragraph. The explanation of part (c) changes slightly as we now have to realize that we know that c_2 is between c_1 and $c_1 - \beta$. This explains the limits of the second integral. Now for part (d) the line of reasoning remains very comparable to the previous scenario. Again, the discriminated individual will be hired when:

$$c_1 + t_1 - \beta > c_2 + t_2 \qquad (37)$$

But we already know that

$$c_2 > c_1 - \beta \qquad (38)$$

And

$$c_1 > c_2 \tag{39}$$

The discriminated individual can never win if

$$t_2 \geq t_1 - \beta - c_2 + c_1 \tag{40}$$

In this scenario individual 2 will always be hired. Thus, if this threshold is met the probability that the discriminated individual gets hired is equal to 0. This also explain the upper limit of the first integral. If $t_1 = \beta + c_2 - c_1$ the probability that the discriminated individual wins is equal to zero. Which also means that if

$$t_2 < t_1 - \beta - c_2 + c_1 \tag{41}$$

The probability that the discriminated individual wins is not equal to zero. The lower limited is explained by the fact that the lower limit of t_1 is equal to zero. In the first part of the equation the probability that the discriminated workers wins is equal to zero, because t_1 will not be large enough to compensate for the fact that $c_2 > c_1 - \beta$ and the value of t_2.

After the plus the explanation of $(a), (b)$ and (c) remains the same. The explanation of (d) changes slightly. As you can see the upper and lower limit of (d) have changed in this scenario. That can easily be understood by the explanation above, if $t_2 < t_1 - \beta - c_2 + c_1$ the discriminated individual does have a positive probability of being hired and therefore equals the lower limit. The upper limited is determined by the maximum value of t_1. This also indicates that the more t_1 increases, the larger the likelihood that the discriminated individual will actually be hired. $(t_1 - c_2 - c_1 + \beta)$ is added to this part of the equation to reflect the probability that the discriminated individual will be hired for the job.

Equation (36) is equal to

$$-\frac{\beta^5}{12} + \frac{\beta^4}{12} + \frac{\beta^3}{2} - \beta^2 + \frac{\beta}{2} \tag{42}$$

Now consider the final scenario of the first main case, so when $c_1 > c_2 > c_3 > 0 > c_1 - \beta$ or $c_1 > c_3 > c_2 > 0 > c_1 - \beta$. Now the probability that the discriminated individual gets hired is equal to

$$2\int_0^{\beta}\int_0^{c_1}\int_0^{(c_2+\beta-c_1)} c_2\, 0\, dt_1 dc_2 dc_1 + 2\int_0^{\beta}\int_0^{c_1}\int_{(c_2+\beta-c_1)}^{1} c_2\,(c_1 + t_1 - c_2 - \beta) dt_1 dc_2 dc_1 \tag{43}$$

The different parts from the equation do not differ much compared to the previous scenario, therefore I will not repeat the explanation. Notice that the limits of part (b) have changed because now $c_1 < \beta$. As a consequence t_1 needs to be larger than in the previous scenario to provide the discriminated applicant with a positive probability to get hired.

Equation (43) is equal to

$$\frac{\beta^5}{10} - \frac{\beta^4}{4} + \frac{\beta^3}{6} \tag{44}$$

Now consider the three scenarios in which $c_2 > c_1$. Let us start with the scenario in which $c_2 > c_1 > \beta$. The probability that the discriminated applicant will be hired is equal to,

$$\begin{matrix}(a)(b)(c) & (d) & (b)(d)(d)(c) & (b) & (a)(b)(c) & (d) & (b) & (d) & (d)(c)(b)\end{matrix}$$

$$2\int_0^1 \int_{c_1}^1 \int_0^{c_2-c_1+\beta} c_1\, 0\, dt_1 dc_2 dc_1 + 2\int_0^1 \int_{c_1}^1 \int_{c_2-c_1+\beta}^1 c_1(c_1 - \beta - c_2 + t_1) dt_1\, dc_2 dc_1 \tag{45}$$

Part (a) in equation (45) refers to the possibility that c_2 can be replaced by c_3. Part (b) denotes the probability that the discriminated applicants moves on to the second round of the hiring process. In this scenario it refers to the probability that $c_1 > c_3$, otherwise the discriminated applicant will not progress to the second round. Notice also that c_1 has replaced c_2 inside the integral. Part (c) refers to the probability that $c_2 > c_1$ and the upper limit is equal to the upper limit of c_1. The explanation of part (d) is similar to the previous two paragraphs and is therefore not repeated. Similar to the previous paragraph depending on the value of t_1 the discriminated applicant does or does not have an opportunity of being hired, which is reflected in part (d).

Equation (45) is equal to

$$\frac{1}{60}(10\beta^2 - 15\beta + 6) \tag{46}$$

Consider the second scenario of the second main case which is $1 + (c_1 - \beta) > c_2 > \beta > c_1$. Notice that in this scenario $(c_1 - \beta) < 0$. Which means that without the anonymous application procedure the discriminated applicant would not have any chance of progressing into the second stage of the hiring process because c_2 and c_3 are both larger than zero. In this scenario the probability that the discriminated applicant gets hired is equal to

$$\begin{matrix}(a)(b)(c) & (d) & (b)(d)(d)(c)(b) & (a)(b)(c) & (d) & (b) & (d) & (d)(c)(b)\end{matrix}$$

$$2\int_0^{\beta} \int_{c_1}^{1+c_1-\beta} \int_0^{c_2-c_1+\beta} c_1\, 0\, dt_1 dc_2 dc_1 + 2\int_0^{\beta} \int_{c_1}^{1+c_1-\beta} \int_{c_2-c_1+\beta}^1 c_1(c_1 - \beta - c_2 + t_1) dt_1\, dc_2 dc_1 \tag{47}$$

The explanation of part (a), (b) and (d) is the same as in the previous scenario. Notice however that the upper limit of part (b) now equals β which is due to the fact that $c_1 < \beta$. The explanation of part (c) has changed slightly because the upper limit is now equal to $1 + c_1 - \beta$ rather than equal to 1. Equation (47) is equal to

$$-\frac{1}{12}(\beta - 1)^3\beta^2 \tag{48}$$

And finally, consider the third scenario of the second main case, so when $c_2 > 1 + c_1 - \beta$. However in this scenario the probability that the discriminated individual gets hired is actually equal to zero. Note that the upper limit of t_1 is equal to 1 and thus if c_2 is even larger than $1 + c_1 - \beta$ then it is impossible for the discriminated applicant to be hired because t_1 should be larger than 1 get the job.

So adding up all the scenarios the probability that the discriminated applicant gets hired is equal to,

$$(p_1) = \frac{1}{60}(20 - 30\beta + 5\beta^2 + 5\beta^3 + 5\beta^4 - 3\beta^5) \tag{49}$$

Which is visually represented in Figure 6.

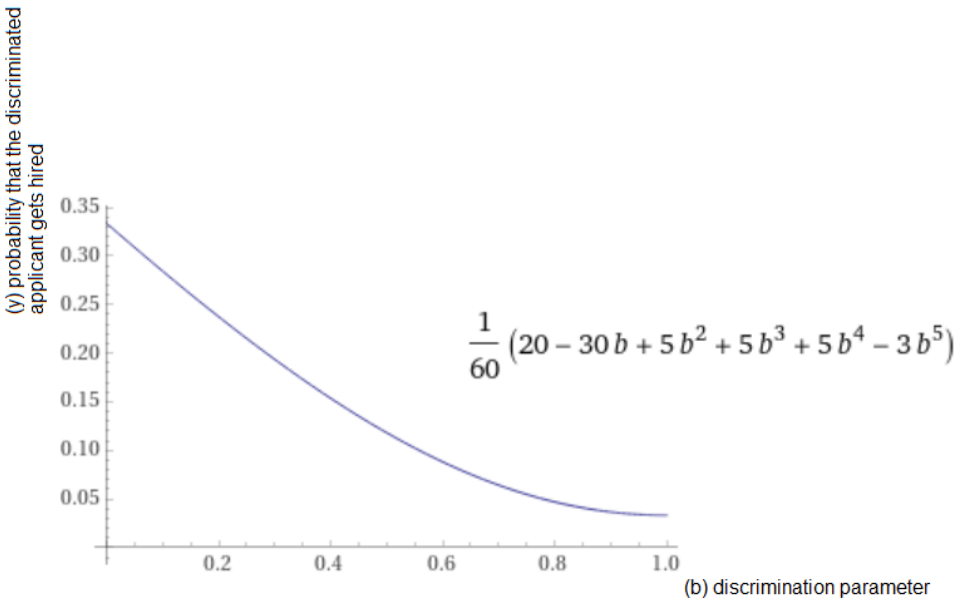

Figure 6: Probability that the discriminated individual gets hired under taste-based discrimination, with discrimination on the labour market and without anonymous application procedures

If we now combine equation (33) and (49) in one graph we can visually represent the effect of anonymous application procedures on the hiring probability of the discriminated individual.

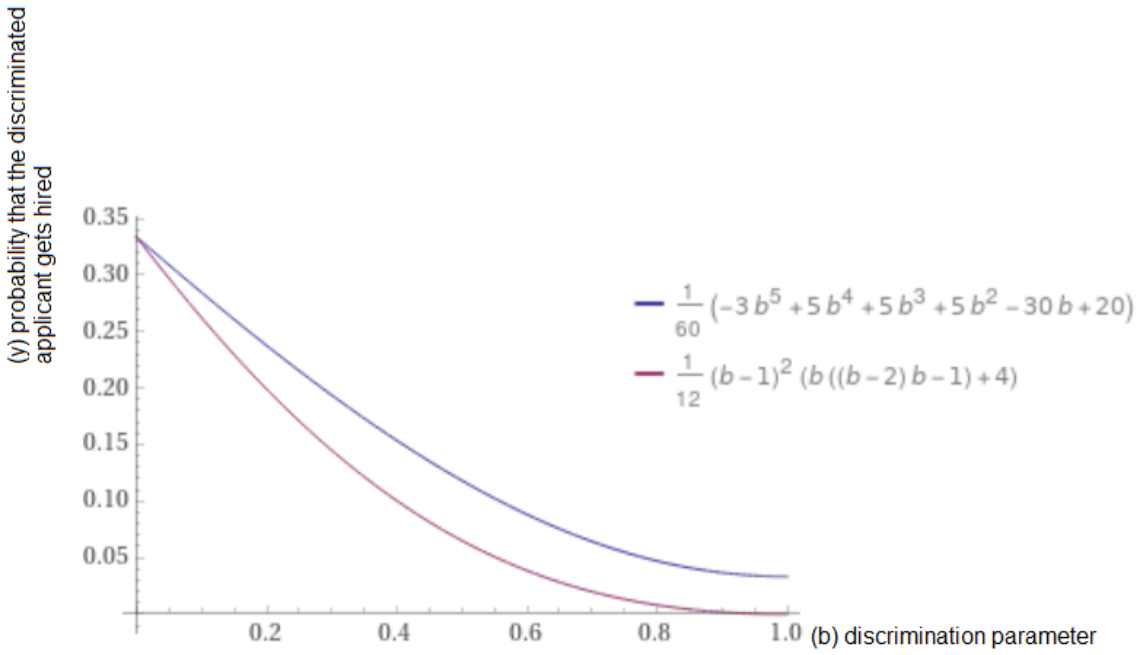

Figure 7 Probability that the discriminated individual gets hired under taste-based discrimination, with discrimination on the labour market, both with and without anonymous application procedure

Figure 7 shows that equation (33) and (49) both start at a value of $\frac{1}{3}$ when $\beta = 0$, which makes sense because that scenario is simply equal to the scenario without discrimination in chapter 4. We can also see that for any value of β the probability that the discriminated applicant gets hired is always larger with anonymous application procedures relative to a scenario without the anonymous application procedure. When β approaches 1 the probability that the discriminated applicant gets hired seems to go to 0 in a scenario without anonymous application procedures, however with anonymous application procedures the probability remains positive.

Having finished the analysis of this scenario I will now turn my attention again to a scenario in which $\beta(g_i) \epsilon (1,2)$, but now only two applicant will be interviewed.

5.4 Two applicants with $\beta(g_i) \epsilon (1,2)$

In this paragraph I will perform the same analysis as in the previous paragraph but now with $\beta(g_i) \epsilon (1,2)$. Note that the probability that the discriminated applicant gets hired, conditional on being interviewed, is equal to zero, because β is between one and two and c_i is between zero and one. Thus the probability that the discriminated applicant proceeds to the interview stage is zero and therefore the probability that he or she gets hired is zero.

5.4.1 Anonymous application procedures

In the previous paragraph I have determined that the probability that the discriminated applicant gets hired is equal to zero, because it is impossible for the discriminated applicant to proceed to the interview stage. However, anonymous application procedures prevent discrimination in the first stage of the hiring process. As a consequence, the probability that the discriminated applicant proceeds to the interview stage is equal to $\frac{2}{3}$.

If $\beta(g_i) \epsilon (1,2)$ and only two of the three applicants are interviewed the discriminated applicant has no chance to get hired without the anonymous application procedure. Therefore the discriminated applicant is always better off with the anonymous application procedure in this scenario. The impact of anonymous applications is likely even the largest in this scenario as it increases the probability that the discriminated applicant is hired from zero to (at least) a positive number.

Relative to paragraph 5.2.1 the result is different in this paragraph. In the scenarios in which all three applicants are interviewed anonymous application procedures actually have no impact on the hiring probabilities. This is different in the scenario analysed in this paragraph, because without anonymisation no discriminated applicant will ever be invited for an interview (and thus has no change of being hired). The anonymous application procedure provides discriminated applicants with the opportunity to progress into the interview stage and thus be hired.

5.5 Concluding remarks

In this chapter I have shown that taste-based discrimination can significantly harm the hiring prospects of the discriminated applicant. The larger the discrimination parameter, the lower the probability that the discriminated applicant gets hired. In a world without discrimination it does not matter whether two or three applicants are invited for an interview in my model, because *ex ante* every applicants has the same probability to receive a job offer which is equal to $\frac{1}{3}$.

Under taste-based discrimination the anonymous application procedure is not able to fully eliminate discrimination from the hiring process. As we have seen the most anonymous application procedures can do is eliminate the discrimination from the first stage of the hiring process. However, once the discriminated applicant participates in an interview he or she might be discriminated against, because the firm learns whether the applicant belongs to the discriminated or non-discriminated group and the firm experiences additional costs to employ a worker from the discriminated group. This even holds true when the discriminated applicant is not less productive than the non-discriminated individual due to the firm having a 'taste' for discrimination. I shortly return to this point after I have analysed my model under statistical discrimination.

The anonymous application procedure improves the hiring probabilities of the discriminated applicant under any situation. This can be explained by the fact that the discrimination is delayed to the second stage of the hiring process. So the impact of the discrimination on the hiring process is smaller.

We have seen that the impact of the anonymous application procedure is the largest when the discrimination is relatively high ($\beta(g_i) \epsilon (1,2)$) and only two applicants are interviewed. In this scenario, without the anonymous application procedure the probability that the discriminated applicant is hired

equals zero. The anonymous application procedure at least provides a positive probability to be hired to the discriminated applicant.

Now that I have analysed the impact of discrimination and the anonymous application procedures in my model under taste-based discrimination I will turn my attention to statistical discrimination and I perform a similar analysis.

6. Statistical discrimination

6.1 Introduction

In the previous chapter I have analysed my model under taste-based discrimination and the impact of anonymous application procedures on the probability that the discriminated applicant gets hired. Taste-based discrimination assumes some additional costs for the employer when working with discriminated workers, because the firm has a distaste for those type of workers. Although this will apply to some employers, it's questionable if this applies to all firms. A second model to explain discrimination in the labour market is the statistical discrimination model. In this model there is asymmetric information between employers and employees. The main assumption in these models is that employers make statistical interferences about the unobserved characteristics of the individual based on the group characteristics. Of course, these statistical assumptions might be wrong.

In this chapter I model discrimination by a shift of the distribution of ε_i or t_i. First I analyse the impact of statistical discrimination on the ε_i parameter. Afterwards I analyse what happens when the discrimination influences the distribution of t_i. The distribution of the concerned parameter will be shifted by the discrimination parameter, $\beta(g_i)$, to the left. Such that discrimination will have a negative impact on the perceived productivity of the discriminated applicant.

Remember that without discrimination both ε_i and t_i are uniformly distributed between [0,1]. However with discrimination these intervals will be shifted to [0-$\beta(g_i)$,1- $\beta(g_i)$]. Of course, this interval only applies to the discriminated applicant, the non-discriminated workers' ε_i and t_i still have an interval from [0,1].

The shift of the distribution with $\beta(g_i)$ negatively effects every point on the probability distribution. This also effects the mean of ε_i and t_i. In a situation without discrimination the means are equal to $\mu_{\varepsilon_i} = E(\varepsilon_i)$ and $\mu_{t_i} = E(t_i)$, which equals 0.5 because both ε_i and t_i are uniformly distributed on an interval from zero to one. However, due to the discrimination the new mean of the shifted distribution will equal $\mu_{\varepsilon_i} - \beta(g_i)$ and $\mu_{t_i} - \beta(g_i)$, which equals $0.5 - \beta(g_i)$ for both parameters of the discriminated applicant.

Figure 8 presents a graphical representation of the impact of the shift of the distribution.

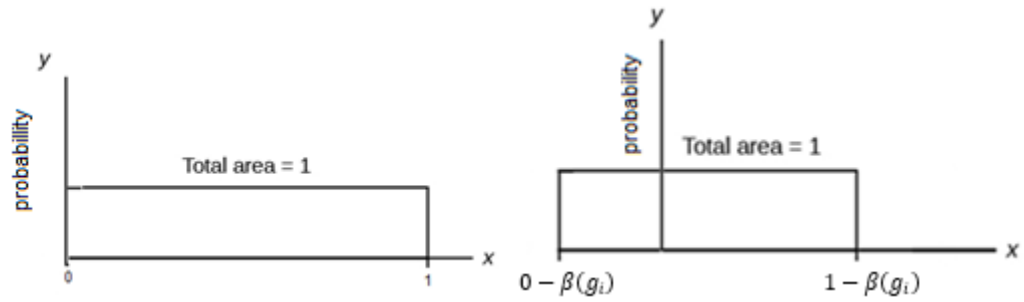

Figure 8: Shifted uniform distribution between zero and one

The left graph shows the distribution without discrimination, the right graph shows the impact of statistical discrimination on the distribution of the parameter. The shift to the left is clearly visible. Figure 8 also shows that discrimination shifts the borders of the uniform distribution of ε_1 and t_1 to $1-\beta(g_i)$ and $0-\beta(g_i)$.

6.2 Discrimination influences ε_i's distribution

In this paragraph I analyse what impact statistical discrimination on the distribution of ε_i has on the hiring probability of the discriminated applicant.

For the discriminated applicant to be hired q_1 needs to be larger than q_2 and q_3. Because c_i, t_i and ε_i are all randomly and uniformly distributed for all three applicants and unknown to the firm before the hiring process starts they all take on the expected value $E(c_i)$, $E(t_i)$ and $E(\varepsilon_i)$ until the firm receives more information on these parameters. Similar to the previous chapter I explore different scenarios.

Important to remember throughout this scenario is that ε_i is unobservable for the firm.

6.2.1 Two applicants with discrimination

As said, before the hiring process starts the firm has to make assumptions on the values of the three different productivity parameters. The firm will do so by taking the expected value of all three parameters. Therefore q_1 will be equal to,

$$q_1 = E(c_1) + E(t_1) + (E(\varepsilon_1) - \beta) \tag{50}$$

Under taste-based discrimination q_1 is equal to the following,

$$q_1 = (E(c_1) - \beta) + E(t_1) + E(\varepsilon_1) \tag{51}$$

If we ignore the brackets, then it is obvious that equation (50) and (51) are exactly equal to each other. That means that my model with statistical discrimination on the ε_i parameter is actually equal to my model under taste-based discrimination model as analysed in the previous chapter. That means that for

any scenario the results from the previous chapter also applies to this scenario and therefore this will not be repeated.

6.2.2 Anonymous application procedure

Although I have proved in the previous paragraph that my model with statistical discrimination on the ε_i parameter is similar to my model under taste-based discrimination, the effects of the anonymous application procedures are readily different under statistical discrimination relative to taste-based discrimination.

By nature ε_i is unobservable and therefore the discrimination influencing this variable cannot be eliminated. Moreover the firm cannot learn whether the discriminated applicant in reality is less productive or not, because the true value of ε_i cannot be learned, and therefore the statistical prejudices can never be eliminated by anonymous application procedures. In short, the anonymous application procedure will not have any impact on the hiring probability of the discriminated applicant and therefore the results will not change relative to the previous paragraph.

We have now analysed a scenario in which discrimination is correct (in the sense that discriminated applicants are less productive on average) and focussed on ε_i, but what happens when the discrimination is focussed on t_i instead; and what if the discrimination could be correct or incorrect? These questions will be explored in the comings paragraphs.

6.3 Discrimination influences t_i's distribution

In the previous paragraph I have shown that shifting the distribution of ε_i is equal to analysing my model under taste-based discrimination and therefore the results from the previous chapter are also applicable to that paragraph. In this paragraph I analyse a different form of statistical discrimination, namely focused on the t_i parameter. This is different compared to when the discrimination is focused on the ε_i parameter, because t_i is observable and ε_i is not. Because t_i is observable the firm can actually learn the true value of t_i and as a consequence it might also learn that their expected value of t_i might be (in)correct. This was not possible when the discrimination was focussed on ε_i. In the following paragraphs I explore two different scenario's, one in which the firm learns that their expected value of t_i is correct and one in which it learns that their assumption is incorrect. In the former scenario the discriminatory assumptions made by the firm are correct, however in the latter they are incorrect.

Similar to before, for the discriminated applicant to be hired q_1 needs to be larger than q_2 and q_3. In this scenario the firm will expect q_1, before the hiring process starts, to be equal to,

$$E(q_1) = E(c_i) + (E(t_i) - \beta) + E(\varepsilon_i) \tag{52}$$

Equation (52) is actually the same as equation (51) (the equation is a simple addition of three parameters and one parameter is being subtracted) and therefore the analysis from the previous paragraph and chapter (partly) applies.

However, with the statistical discrimination on the distribution of the t_i parameter there can actually be two different interesting scenario's. Namely a scenario in which the discrimination is merely a 'statistical mistake', that means that a firm assume that a certain applicant is less productive because that applicant is part of a discriminated group, however in reality the applicant is as or even more productive than a non-discriminated applicant. In the second scenario the statistical assumption on the productivity does reflect reality. So in that case the group of the discriminated applicant is actually negatively associated (or correlated) with the productivity of the individual. Thus the workers from the discriminated group are in reality less productive than non-discriminated applicants. In this scenario the 'statistical discrimination' does not really constitute discrimination, it actually entails economic reasoning because the firm wants to hire the most productive applicant and the firm wants to determine who is the most productive applicant in the least costly way.

In the previous paragraph I have not made this distinction because it is not relevant, because ε_i is unobservable it is not possible for the firm to learn the true value of ε_i, therefore it is also not possible for the firm to learn whether the discrimination is (in)correct. Thus, it does matter whether the discrimination is focused on the ε_i or the t_i parameter, because if the discrimination focusses on the t_i parameter the applicant has the opportunity to show to the firm that their expected value is incorrect.

In the following paragraphs I have a closer look at both scenarios when the discrimination focusses on t_i.

6.3.1 Statistical assumptions are correct

As explained in the previous paragraph there can be two different scenario's. The scenario in which the discrimination actually reflects reality in the sense that discriminated applicants are indeed less productive than non-discriminated applicants is discussed in this paragraph.

The discrimination now focusses on t_1 and is 'correct'. The distribution of the t_i is thus lowered by β. This also impacts the base scenario relative to the scenario in which the discrimination is 'incorrect'. Even without discrimination the distribution of t_1 would still be lowered by β, because the discriminated applicant is less productive. If the discrimination is incorrect the distribution of the discriminated applicants' t_1 is not actually lowered by β in the base scenario.

From the moment the firm learns the group of the discriminated applicant it assumes that he or she will have a lower productivity, as the discriminated group (according to the experiences of the firm) has a lower productivity on average. The expected productivity of the discriminated applicant will thus equal equation (52). That means that the applicant will be in a disfavoured position due to this discrimination, however because this discrimination reflects reality, it ultimately has to do with the lower productivity of the applicant's group. *Ex ante* the discriminated applicant has less skills than the non-discriminated applicants and therefore in the base scenario without discrimination the discriminated applicant also has a lower probability to be hired than the non-discriminated applicants.

As I have already shown in paragraph 6.2 and 6.3 this scenario is ultimately equal to my model under taste-based discrimination and therefore the results from chapter 5 are applicable. However, there

is a different effect of anonymous application procedures when the discrimination is statistical rather than taste-based.

6.3.2 Anonymous application procedures

An anonymous application procedure increases the probability that the discriminated applicant is invited for an interview. However, once the applicant is invited to an interview the firm visually receives new information and learns to which group the applicant belongs. Based on this information the firms updates its beliefs about the productivity of the applicant. This is the same as before. Because the expectations of the firms, that are discriminatory (at least before the interview takes place) are correct the applicant is not able to prove that the discrimination is incorrect. Nor is the anonymous application policy able to eliminate the discrimination from the hiring process. The anonymisation is only able to delay the discrimination to the interview stage. Mathematically this situation is identical to my taste-based model, therefore the results from the previous chapter are also applicable to this paragraph.

This result nicely aligns with in the empirical research by Åslund, & Nordström Skans (2012) and the Dutch-based pilot. Both showed that anonymous application procedure can impact the interview decision (both researches showed an increase in interviewed minorities), however the anonymisation cannot (or only marginally) impact the hiring decision, which might be explained by the fact that the firm learns the group of the applicant during the interview and thus is still able to discriminate.

In interesting question that can be asked in this scenario is actually to what extend the behaviour by the firms reflects discrimination? It might be discrimination at first, but is it fair to argue that the behaviour by the firm after the interview still constitutes as discrimination? In a sense, the behaviour of the firm actually reflects intuitive economic reasoning. Based on limited information the firm tries to form a ‘correct’ expectation about the productivity of the applicant and despite the fact that it might use discriminatory means (with low costs) to reach that goal, the firm does seem to succeed at forming a correct expectation about the productivity of the discriminated applicant based on the group information. The firms uses readily available information on the group of the applicant to determine the productivity of that applicant which allows the firm to make profit-maximising decisions at lower cost than the costs of interviewing the applicant. As a consequence the behaviour of the firm in this scenario is actually optimal and leads to higher welfare than when the applicants are interviewed.

Nevertheless, it is possible to ask questions about the procedural fairness of this outcome. The procedural fairness relates to the rules of the hiring process that led to the outcome. One of the elements of the procedural fairness is whether all the agents have an equal opportunity for economic advantage. This means that discrimination should not be able to influence the procedure. In this case, that is obviously not the case. One applicant is subject to discrimination before the hiring process starts and therefore has a lower probability to be hired. However, one can argue that in this case the discrimination is eventually rooted in the fact that the applicants have different skills, leading to different productivities and therefore different hiring probabilities. Therefore, one might still argue that the hiring process does not conflict with the principals of procedural fairness in this case. However, people do tend value fairness as is shown in many experiments using for instance ultimatum games (Nowak, Page & Sigmund, 2000).

Therefore policy makers might still need to take the fairness of the hiring process into account, when developing policies to mitigate discrimination in the labour market.

An interesting difference compared with the taste-based discrimination model is that discrimination in that model effects the utility of the firm (likely represented by the utility of the manager), whilst under statistical discrimination the profit of the firm is hurt when a less productive applicant is hired. This has consequences for the outcome when the discrimination is incorrect, which will be explored in the next paragraph.

6.3.3 Statistical assumptions are incorrect

In the previous paragraph I have analysed the scenario in which the discrimination does reflect 'reality' and I have argued that the impact of anonymous application procedures in this scenario will be limited to none. In this paragraph I analyse the scenario in which the discrimination does not reflect reality. In this scenario the impact of anonymous application procedures is much larger and the discriminated applicant benefits (a lot) from the anonymous application procedure.

When the statistical discrimination is incorrect the true productivity of the discriminated applicant is equal to,

$$q_1 = c_i + t_i + \varepsilon_i \tag{53}$$

Which is also different from the scenario in which the discrimination is correct, because in that case also the true value of t_i follows from a distribution that is lowered by the discrimination parameter. This also influences the base scenario in which there is no discrimination. When the discrimination is correct the probability that the discriminated applicant will be hired will be lower, because that applicant has lower skills than the non-discriminated applicants. If the discrimination is incorrect all the individuals have a similar probability to get hired in the base scenario, because their distributions are also similar.

Similar to the previous paragraph, without anonymous application procedures and with discrimination the probability that the discriminated applicant gets hired will be lowered, because the expected distribution of t_1 is lowered by the discrimination parameter. However, in this scenario this 'discrimination' truly reflects statistical discrimination in the purest sense, because the firm's assumption based on statistical information is incorrect.

This actually conflicts with 'normal' or 'common' economic reasoning. In general in economics it is assumed that all actors in a model behave rational based on full and relevant information. However, in my model this seems to go wrong. The firm has incorrect expectations about the productivity of the discriminated applicant and therefore does not have full and relevant information. Moreover, the anomaly is persistent. The firm does act rational based on the information is possesses, however that information is systematically incorrect. That means that without any policy to combat discrimination in the labour market (rational) economic actors (firms) are always incorrect when forming expectations about the productivity of the discriminated applicant.

Similar to the previous paragraph once the firm receives the resumé of the discriminated applicant it will assume that his or her productivity is lower on average and therefore the probability to get hired for the job will be lowered. However, this is incorrect and anonymous application procedure can have a large impact.

6.3.4 Anonymous application procedures

The anonymisation increases the probability that the discriminated applicant will be invited for an interview. If the applicant is invited for the interview the firm will learn the true value of t_1 and as a consequence will also learn that the expected value was incorrect. Because the firm can learn the true value of t_1 the discrimination will no longer have an impact on the productivity of the discriminated applicant, as the discrimination only impacts the expected value. Based on this new information the firm will make a hiring decision and thus in this scenario the anonymous application procedure increases the probability that the discriminated applicant is hired for the job. Because the discrimination will no longer impact the productivity of the applicant, this scenario is mathematically equal to the scenarios in chapter 4 when there was no discrimination on the labour market. The probability that the discriminated applicant gets hired again is equal to the probability that any of the two non-discriminated applicants get hired and therefore equal to $\frac{1}{3}$.

The result in this paragraph is very different compared to the result in the previous paragraph. Although in both paragraphs the statistical discrimination focusses on t_1 the impact of the anonymisation is readily different due to the (in)correctness of the statistical relation. The anonymous application procedure provides the applicant with an opportunity to prove to the firm that he or she is actually not less productive than the non-discriminated applicants on average. In the previous paragraph the applicant could not do this, because he or she was actually less productive on average than other applicants.

An interesting difference with the taste-based modelling arises. Under taste-based modelling it is the utility of the firm (manager) that is hurt by being associated with discriminated workers. Under statistical discrimination the profit is impacted, because less productive applicants (might) be hired. So under taste-based discrimination even if the discriminated applicant would be as productive as the non-discriminated applicant the utility of the firm would still be lowered which has a negative effect on the hiring probability of the discriminated applicant even though the profit would not be hurt. If the discrimination is 'incorrect' the firms' profit is actually not hurt by hiring the discriminated applicant and thus there is also no longer a negative effect on the hiring probability of the discriminated applicant.

An interesting similarity between taste-based discrimination and incorrect statistical discrimination is the impact of competitive forces. We have seen that taste-based discrimination will be eliminated from the labour market if there is perfect competition (which results in segregation). In the scenario in this paragraph the discriminated applicant will start working for another (non-discriminatory) firm, if it is not hired by the discriminatory firm. Therefore this will also result in segregation, the non-discriminatory firms hire discriminated applicants and the discriminatory firms hire non-discriminated applicants. Because the discriminated applicant in reality is very productive the profit of the non-

discriminatory firm will start to rise. Eventually the discriminatory firm might lose the competition from this non-discriminatory firm and therefore can be pushed out of the market. Thus competitive forces in this scenario might also be able to eliminate discrimination from the labour market, by either segregating the discriminated and non-discriminated applicants or pushing the discriminatory firms out of the market.

The result in this paragraph also provides an interesting explanation for the result of Craigie (2019) that showed that BTB policies can actually increase the hiring probabilities of discriminated applicants. BTB policies try to eliminate statistical discrimination from the labour market. Firms assume, based on statistics, that certain groups are overrepresented in criminal records and as consequence they assume that the specific individual from that group will also have a criminal record. The result from my model shows if the discrimination is incorrect anonymisation of the resumé can actually increase the hiring probability of the discriminated applicant. This could indicate that although the participants in Craigie's experiment had criminal records, the prejudices of the firm were incorrect. The BTB policies allowed the discriminated applicants to progress into the interview stage and the firm thus gets the opportunity to learn that their expectations were incorrect. Craigie (2019) shows that incorrect beliefs by firm might have a large impact on the hiring probability of (discriminated) applicants. In the next paragraph these incorrect beliefs will be discussed more extensively.

6.3.5 Short vs long term

Although we have seen that the effect of anonymous application procedures strongly depend on the scenario we are analysing there is one interesting effect of the policy. In general it increases the probability that the discriminated applicant progresses into the second stage of the hiring process. This increases the number of interactions a firms has with a discriminated applicant and it also allows the firm to learn about the productivity of the discriminated applicant. In the scenario which was analysed in paragraph 6.3.4 it even allows the firm to correct their incorrect expectations on the productivity of the discriminated applicant.

In economics generally it is assumed that all the actors are rational, which also means that the assumptions of a firm in the market shouldn't be able to be consistently wrong (which does happen in the scenario in the previous paragraph(s)). This equilibrium can only be persistent when the firm is not able to update their assumption, which can only be explained by the lack of interaction between the firm and the discriminated applicant. An interesting side-effect of the anonymous application procedure is that it, rather than only directly increasing the hiring probability of the discriminated applicants, also in the long term decreases the discrimination parameter (or bias) of the firm. Which in the long term of course also has a positive effect on the hiring probabilities of the discriminated applicants. The anonymous application procedures increase the interactions between the discriminated workforce and the firm, which allows the firm to update their beliefs and to learn that discriminated applicant are not less productive that non-discriminated workers. It means that firm learns that the distribution of the t_1 parameter is actually not decreased with the value of the discrimination parameter. If the discrimination is large enough this can only be achieved with the anonymous application procedure, because the firm would (almost) never invite a discriminated applicant for an interview, meaning that the firm will keep their discriminatory assumptions. The anonymous application procedure will increase the probability that

the discriminated applicant will be invited for an interview, increasing the interactions even if the discrimination parameter is (relatively) large.

6.3.6 Concluding remarks

The analysis of this chapter has shown that under certain conditions the anonymous application procedure is able to eliminate the statistical discrimination from the labour market and thus increase the hiring probability of the discriminated applicant. My analysis has also shown that modelling the discrimination in my model as statistical or taste-based often does not lead to large differences. When the statistical discrimination focusses on the ε_i parameter the result is even identical to the taste-based scenario.

When the discrimination focusses on the t_i parameter there are two different scenarios possible. First of all the discriminated applicant can in reality be less productive than the two non-discriminated applicants, in which case the results from the taste-based modelling also apply. The other option is that the discriminated applicant in reality is as or even more productive than the two non-discriminated applicants. In the latter situation the anonymous application procedure is able to fully eliminate the discrimination from the hiring process and mathematically the scenario is equal to the scenario in chapter 4. In the former this is not possible, as the discrimination will still be possible after the interview and the applicant is not able to 'correct' this.

The results from this chapter nicely fit in with the results from Åslund & Nordströum Skans, (2012) and the Dutch and German pilots. These experiments showed that in general more discriminated applicants were invited for an interview, but only for some groups the hiring probability also (significantly) increased. This might be explained by the fact that firm statistically discriminate, but in some cases their prejudices are correct and in others they are incorrect. The anonymous application procedure would then allow them to update their believes which results in increased hiring probabilities for some discriminated applicants, but not for all.

7. Discussion

In this section I discuss some of the most important assumptions of my model and I will provide several suggestions for future research. I have made several simplifying assumptions. In this section I will discuss the productivity parameter(s), the costs for the firm of an interview, the applicant as a passive actor, the number of applicants and job offers and finally the anonymisation of the resumé.

In both models I assumed that the productivity parameter consists of only three parameters which are added together to determine the productivity of the individual applicant. Moreover all three parameters come from the same distribution and are identical for all three applicants. However, it might be unrealistic to assume that a firm values the resumé as much as the interview, in the sense that the maximum values are equal. The firm might value the interview more than the resumé and this could impact the hiring process, especially when a discriminated applicant might have higher or lower maximum values for its resumé productivity parameter. If this is indeed the case it might become harder or easier for the discriminated applicant to progress into the interview stage. Moreover some applicants

might not have an impressive resumé but have excellent interview skills, which also justifies different maximum values for these parameters (e.g. experienced vs. unexperienced applicants). For future research it might be interesting to analyse the impact of different maximum values of the productivity parameters for the different applicants.

Assuming that one discriminated and one non-discriminated applicant made it to the interview state, allowing for different maxima for c_i and t_i can have interesting effects. For now assume that the maximum of t_i is larger than that of c_i. For a given value of t_2 between [0,1] the probability that the discriminated applicant will be hired increases, as the probability that t_1 is large enough to be the best applicant increases, relative to a scenario in which t_1 is also maxed at 1. Thus the probability that the discriminated applicant will be hired increases and therefore the anonymous application procedure will likely also have a larger impact. However, the probability that t_2 is larger than 1 also increases, which has a negative effect on the hiring probability of the discriminated applicant. Meaning that anonymous application procedures would have less of an effect on the hiring probability of the discriminated applicant. For now, the effect of allowing differences in maxima of variables and the impact anonymous applications can have in that scenario are ambiguous.

I have assumed that the costs for an interview for the firm are identical regardless of the type of applicant the firm interviews. This also enabled me to exclude the costs from my analysis. However, it might be that the costs of an interview are larger when the firm interviews a discriminated applicant. This might be the case because it is harder to engage with a discriminated applicant than with a non-discriminated applicant for the firm. As a consequence it might be interesting for future analysis to investigate the impact of different costs. Assume that the costs of an interview are higher for the discriminated applicant, how would this impact the probability to get hired?

Moreover, when introducing interview costs into the model an interesting trade-off arises for the firm. In general, interviewing less applicants increases the probability that the most productive applicant is not hired. However, interviews come with a (large) cost. Therefore, the firm needs to make a trade-off between these increased costs and the increased probability of hiring the most productive applicant. If the firm expects the discriminated applicants to have a lower chance of being the most productive applicant the introduction of the interview costs might actually significantly harm the hiring probability of the discriminated applicant. This will likely also result in a larger impact of the anonymous application procedure.

In my model I have also assumed that the applicant is a passive agent. All the applicants apply for the job and if they are invited for an interview they always participate. However, for future research it would be interesting to analyse what happens when the applicant becomes an active agent inside the model. Would it be possible that anonymous application procedures discourage some discriminated applicants from applying? Assume that there are costs of going to an interview for instance travelling to the firm, prepare the interview or perhaps take a day off from their current job. If the costs are high enough discriminated applicants might want to accept the invitation for an interview if the employer is already aware of their background, but if the firm is unaware that an applicant belongs to a discriminated group the applicant might decide to decline the invitation (or not apply at all). The issue is that applicants

will have to make costs, whilst it might not impact the decision of the discriminatory firm (because the firm will likely not hire a discriminated applicant), so the costs are superfluous. Future research can investigate which applicants apply under anonymous application procedures to analyse the impact of anonymous application procedures on the probability that the discriminated applicant is hired. The applicant will have to make a trade-off between the costs and the probability that he or she will be hired. A constrain could be introduced into the model, for instance the discriminated applicant only applies if the costs are sufficiently low or the probability to get hired is sufficiently high.

In addition to the above, anonymous application procedures might have other disadvantages, as they might result in more needless interviews and thus costs for both the firm and the applicant. Firms might already know that they do not want to engage with discriminated applicants, but due to the anonymous application procedure the firm does not know which applicant is the discriminated one. The firm might end up inviting the discriminated applicant for the interview, which can never result in a job offer. As a consequence both the firm and the applicant will have to make needless costs which is inefficient. Therefore the anonymous application procedure might hurt both the discriminated applicant and the firm. Exactly the opposite of what the policy is supposed to do.

The decision of the applicant to apply for the job might also depend on whether the discrimination is (in)correct. In case the discrimination is correct the discriminated applicant might not be willing to apply for the job, because the probability that he or she will be hired is likely low. However, if the discrimination is incorrect the discriminated applicant might actually be more willing to apply for the job. This also constitutes an interesting positive signal. If we assume an applicant in general knows whether the group he or she belongs to is discriminated, but despite the discrimination the applicant still applies this gives a signal to the firm that the applicant is convinced he or she has a reasonable chance of being hired. This might be explained by the fact that relative to the other (non-discriminated) applicants the discriminated applicants have superior skills and thus increased productivity. If this is the case, the hiring probability of the discriminated applicant might actually be higher and anonymous application procedures might hurt the discriminated applicant, because the firm no longer has information on the group of the individual. As a consequence, an application by a discriminated applicant can also not be understood as a positive signal. In general the results might become very different once the applicant is no longer a passive agent.

Obviously I have made a simplifying assumption by limiting the number and the type of applicants and the job offer. This allowed me to analyse the impact of discrimination and anonymous application procedure on the hiring probability in an isolated way. However, in reality there will be many more jobs and applicants and by increasing those numbers the macro-economic impact of the policy can be studied. For future research it would be interesting to look at a continuum of type of applicants rather than just two types, similar to Lang and Manove (2003). Moreover, an continuum of job types would also be a helpful addition to the model.

Finally, I assumed that the anonymisation of the resumé is perfect, thus the firm is not able to determine the (group) characteristics of the individual based on the non-anonymous information on the resumé. However as Åslund and Skans (2012) show, it is questionable whether this assumption holds true in reality. Therefore it might be interesting to assume that the anonymisation is not perfect but rather

imperfect. As a consequence the discrimination will not be fully eliminated at the first stage of the hiring process, but rather it will be mitigated.

8. Conclusion

The persisting racial disparities in the labour market have led to an interesting discussion about the best policy to combat this issue. One of the policies that is often mentioned as a possible solution is the anonymisation of the application procedure. It was even mentioned by Dutch political parties such as D66, PvdA and GroenLinks in the Dutch national elections of 2021 as a possible solution for (racial) discrimination in the labour market. However, the empirical evidence on the impact of anonymous application procedures is mixed. In some circumstances the chances of getting hired as discriminated applicant is higher under anonymous application procedure, however in other circumstances the anonymous application procedure has exactly the opposite effect. There is not much theoretical research done into the effects of anonymous application procedure and therefore I have analysed the effects of anonymous application procedures for the hiring probability of the discriminated applicant.

I have analysed several different scenarios, using one model and two different types of discrimination: taste-based and statistical discrimination. I analysed scenarios in which two or three applicants were interviewed.

Under taste-based discrimination the firm has a distaste against certain type of workers and working with those people comes at a cost. I have modelled this by lowering the productivity of the discriminated applicant.

The results from my model under taste-based discrimination indicate that discriminated applicants can benefit from the anonymous application procedures. For any value between 0 and 1 of the discrimination parameter the anonymous application procedure provides the discriminated applicant with a higher hiring probability relative to non-anonymous application procedures. This is because the discrimination can be eliminated from the first stage of the hiring process, which increases the probability that the discriminated applicant progresses to the second stage of the hiring process and thus gets hired.

My analysis has also confirmed the results from the Dutch anonymous application pilot and Åslund, & Nordström Skans (2012): although anonymisation is able to eliminate discrimination from the first stage, it is not possible to fully eliminate discrimination from the hiring process. Meaning that once the applicant is invited for an interview, the firm will learn whether or not the applicant is a discriminated applicant and then discrimination will affect the hiring probability of the discriminated applicant. This confirms the empirical results that although anonymous application procedure will likely increase the percentage of minorities and women that are invited for an interview, it often does not results in (much) higher hiring percentages of those same groups.

Under statistical discrimination, discrimination arises because the firm and the applicant have limited (and/or asymmetric) information. The firm does not have full information on the productivity of the applicant and to obtain full information is costly. Therefore the firm forms an expectation on the

productivity of a certain applicant based on group characteristics. Some groups might be more productive than others, however this is a mere statistical correlation and does not say anything about the individual productivity of an applicant.

In my model I have analysed two different scenarios under statistical discrimination. First of all, when the discrimination focusses on ε_i. I have shown that this situation is actually similar to my model under taste-based discrimination and thus the results from this model also apply in this scenario. Secondly, I have analysed the scenario in which the discrimination focusses on the distribution of t_i. Although this latter scenario is also very similar to the taste-based scenarios there is an important difference. In this scenario the anonymous application procedure is actually capable of fully eliminating the discrimination from the labour market.

If the discrimination reflects reality, meaning that the discriminated applicant is actually less productive than the non-discriminated applicants the anonymization is not able to eliminate the discrimination because the firm would learn during the interview that the applicant is actually less productive relative to non-discriminated applicants. However, it could also be possible that the discrimination does not reflect reality and then the firm learns during the interview that the applicant is actually not less productive than non-discriminated applicants. As a consequence the discrimination is eliminated and will not impact the probability that the discriminated applicant is hired. The hiring probability of the discriminated applicant then becomes equal to the situation without discrimination in the labour market. Meaning that the discriminated applicant has a fair chance of being hired for the job.

This is an interesting and important difference with the taste-based scenario. If the discrimination is incorrect under taste-based discrimination, meaning that on average discriminated applicants are not less productive than non-discriminated applicants, the firm would still bear a 'cost' of working with discriminated applicants resulting in lower utility. As a consequence, the hiring probability of the discriminated applicant would still be negatively affected under taste-based discrimination, despite the discriminated and non-discriminated applicant being as productive *ex ante*.

The anonymous application procedures increase the number of interactions between the firm and the discriminated applicant. If the statistical discrimination is incorrect, the increased number of interactions allows the firm to update their prior beliefs. This will have a long term beneficial effect on the hiring probability of the discriminated applicant.

The different types of discrimination led to mixed results and indicate that the impact of the anonymous application procedure is heavily dependent on the circumstances. If the discrimination is taste-based the anonymisation can never fully eliminate the discrimination from the labour market. If however the discrimination is based on statistical relations the anonymous application procedure is able to fully eliminate the discrimination from the labour market if the discrimination is incorrect. It is up to policy makers to determine which kind of discrimination is present in the (local) labour market and whether or not discriminated applicant are less, as or even more productive than non-discriminated applicants. The policy makers can then determine whether or not implementing the anonymisation policy could be beneficial.

Of course the studied model is limited by the simplifications I made, especially when it comes to the assumptions underlying the studied model. For future research it can be interesting to replicate my analysis but change the distributions of the different productivity parameters. In the studied model it was assumed that the costs of an interview are identical for any type of applicant and therefore in my analysis these costs are irrelevant. However it might be that costs of interviewing a discriminated applicant are actually higher than the costs of interviewing a non-discriminated applicant. If the anonymous application procedure results in more discriminated applicants progressing into the interview stage without actually having a chance of being hired, the costs will increase for the firm and for the applicant and this is inefficient and might hurt the economy. Moreover, anonymous application procedures might withhold some discriminated applicants from even applying for the job in the first place. If the applicant would be an active agent this might also significantly impact the results. In my analysis the amount of firms and applicants is limited, however it would be interesting to analyse the results when the amount of firms is unlimited and the applicant's types are continuous. And finally it was assumed that the anonymisation will perfectly eliminate all the group characteristics from the resumé, however research shows that based on the non-anonymous characteristics firms are able to (imperfectly) determine the group of the applicant. Therefore rather than modelling the anonymous application procedure as a perfect anonymisation it might be interesting to model it as an imperfect anonymisation. As a consequence the discrimination will not be fully eliminated from the first stage of the hiring process, but only mitigated.

This thesis confirms and provides some explanations for the results that have already been shown in the empirical literature. Anonymous application procedures can eliminate discrimination from the first stage of the hiring process, however it depends on the circumstances whether or not the discrimination can be fully eliminated from the hiring process.

9. Literature

Abella, M. (2000). *Documenting discrimination against migrant workers in the labour market: A comparative study of four European countries*. International Labour Organization.

Agan, A., & Starr, S. (2017). Ban the Box, Criminal Records, and Racial Discrimination: A Field Experiment*. *The Quarterly Journal of Economics*, *133*(1), 191–235.

Aigner, D. J., & Cain, G. G. (1977). Statistical theories of discrimination in labor markets. *Ilr Review*, *30*(2), 175-187.

Altonji, J.G., & Charles R.P. (2001). Employer Learning and Statistical Discrimination. *Quarterly Journal of Economics, 116*(1), 313–350.

Arrow, K. J., Ashenfelter, O., & Rees, A. (1972). *The theory of discrimination* (pp. 1-33). Princeton University Press.

Åslund, O. & Nordströum Skans, O. (2012). Do Anonymous Job Application Procedures Level the Playing Field? *ILR Review, 65*(1), 82-107.

Becker, G. S. (1957). *The economics of discrimination*. University of Chicago press.

Behaghel, L., Crépon, B. & Le Barbanchon, T. (2015). Unintended Effects of Anonymous Resumés. *American Economic Journal: Applied Economics, 7*(3), 1-27.

Bertrand, M. & Mullainathan, S. (2004). Are Emily and Greg More Employable Than Lakisha and Jamal? A Field Experiment on Labor Market Discrimination. *American Economic Review, 94*(4), 991-1013.

Black, D. A. (1995). Discrimination in an equilibrium search model. *Journal of labor Economics*, *13*(2), 309-334.

Blommaert, L., Coenders, M. & van Tubergen, F. (2014). Discrimination of Arabic-Named Applicants in the Netherlands: An Internet-Based Field Experiment Examining Different Phases in Online Recruitment Procedures. *Social Forces, 92*(3), 957-982.

Borjas, G.J., & Bronars S.G. (1989). Con- sumer Discrimination and Self-Employment. *Journal of Political Economy, 97*(3), 581–605.

Bowlus, A.J., & Eckstein, Z. (2002). Discrimination and Skill Differences in an Equilibrium Search Model. *International Economic Review, 43*(4), 1309–1345.

Charles, K.K., & Guryan J. (2007). Prejudice and the economics of discrimination, *NBER Working Paper No. 13661. Cambridge, MA: NBER*.

Charles, K.K., & Guryan J. (2008). Prejudice and wages: An empirical assessment of Becker's the economics of discrimination. *Journal of Political Economy*, 116(5), 773–809.

Coate, S, & Loury, G. C. (1993). Will Affir- mative-Action Policies Eliminate Negative Stereo- types? *American Economic Review, 83*(5), 1220–1240.

Cooter, R. (1994). Market affirmative action. *San Diego L. Rev.*, *31*, 133.

Cornell, B., & Welch, I. (1996). Culture, Information, and Screening Discrimination. *Journal of Political Economy, 104*(3), 542–571.

Craigie, T. A. (2020). Ban the box, convictions, and public employment. *Economic Inquiry*, *58*(1), 425-445.

Donohue III, J. J. (1986). Is Title VII Efficient?, 134 U. *Pa. L. Rev*, *1411*, 1415-20.

Donohue, J. J. (2007). Antidiscrimination law. *Handbook of law and economics*, *2*, 1387-1472.

Fryer, R. G., Goeree, J. K. & Holt, C.A. (2005). Experience-Based Discrimination: Classroom Games. *Journal of Economic Education, 36*(2), 160–170.

Fryer, R. G. (2007). Belief Flipping in a Dynamic Model of Statistical Discrimination. *Journal of Public Economics, 91*(5–6): 1151–1166.

Galenianos, M., & Kircher, P. (2009). Directed Search with Multiple Job Applications. *Journal of Economic Theory, 144*(2), 445–471.

Goldin, C. & Rouse, C. (2000). Orchestrating Impartiality: The Impact of 'Blind' Auditions on Female Musicians. *American Economic Review, 90*(4), 715–741.

Guryan, J. & K. Charles. (2013). Taste-based or Statistical Discrimination: The Economics of Discrimination Returns to its Roots. *The Economic Journal*, *123*(572), 417-432.

Kahn–Lang, Ariella. (2018). Missing Black Men? The Impact of Under-Reporting on Estimates of Black Male Labor Market Outcomes. Unpublished. https://scholar.harvard.edu/files/ariellakahnlang/files/kahn-lang_jmp_20181110.pdf

Lang, K., & Manove, M. (2003). Wage Announcements with a Continuum of Worker Types. *Annales d'Economie et de Statistique,* 71(72), 223–244.

Lang, K., M. Manove, and W. Dickens. (2005). Racial discrimination in labor markets with posted wage offers. *American Economic Review*, 95(4), 1327–1340.

Lang, K, & Manove, M. (2011). Education and Labor Market Discrimination. *American Economic Review, 101*(4), 1467–1496.

Lang, K. & Lehmann, J. K. (2012). Racial Discrimination in the Labor Market: Theory and Empirics *Journal of Economic Literature, 50*(4), 959-1006.

Lehmann, J. K. (2011). Job Assignment and Promotion Under Statistical Discrimination: Evidence from the Early Careers of Lawyers. Accessed by: http:// www.uh.edu/~jlehman2/papers/promotion_lawyers_lehmann.pdf

Loury, G.C. (2002). The Anatomy of Racial Inequality. Harvard University Press, Cambridge, Mass.

Lippens, L., Vermeiren, S. & Baert, S. (2021). The State of Hiring Discrimination: A Meta-Analysis of (Almost) All Recent Correspondence Experiments. *IZA Institute of Labor Economics*.

Lundberg, S. J., & Startz, R. (1983). Private discrimination and social intervention in competitive labor market. *The American Economic Review*, *73*(3), 340-347.

NOS. (2018). Anoniem solliciteren, waarom stoppen gemeenten ermee? Retrieved from: https://nos.nl/artikel/2236699-anoniem-solliciteren-waarom-stoppen-gemeenten-ermee

Nowak, M.A., Page, K.M. & Sigmund, K. (2000) Fairness Versus Reason in the Ultimatum Game. *Science, 5485*(289), 1773-1775.

Pęski, M. & Szentes, B. (2013). Spontaneous Discrimination. *American Economic Review*, *62*(4), 659-661.

Peters, M. (2009). Noncontractible Heterogeneity in Directed Search. http://microeconomics.ca/michael_peters/mixed_equilibrium.pdf (accessed 29 September 2021)

Phelps, E. S. (1972). The statistical theory of racism and sexism. *The american economic review*, *62*(4), 659-661.

Rosén, A. (1997). An Equilibrium Search-Matching Model of Discrimination. *European Economic Review, 41*(8), 1589–1613.

Sasaki, M. (1999). An Equilibrium Search Model with Coworker Discrimination. *Journal of Labor Economics, 17*(2), 377–407.

Shi, S. (2009). Directed Search for Equilibrium Wage-Tenure Contracts. *Econometrica, 77*(2), 561-584.

Thijssen, L., Coenders, M., & Lancee, B. (2019). Etnische discriminatie op de Nederlandse arbeidsmarkt. *Mens en maatschappij*, *94*(2), 141-176.