Article

The Cost of Work Discrimination: A Market Capture Differential Game Model

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Abstract: Discrimination in the workplace can be a source of opportunity costs for firms that desire to enter a new market. In this article, we model how an exogenous technological change introduces both new potential workers in the labor market and, as the economy grows, a new set of consumers for firms to conquer. We then use a differential model to show how the payoff of a firm that discriminates in the labor market loses potential market from this same demographic. Our results imply that anti-discriminatory policies within the firm constitute an important element for the solution of this problem, and that there might be incentives for the firms to apply such policies.

Keywords: discrimination; information asymmetry; differential games

1. Introduction

Labor market discrimination bears a cost not only to the discriminated worker, but also to the firm. Even when such costs are evident, most work related to discrimination is focused on its effects on the worker and not the firm. For instance, Lang and Spitzer [1] review economic theory and evidence on discrimination. The articles reviewed show the problem of discrimination as a problem that is exclusive to the person being discriminated, but not much is shown on how this directly affects the firm. For instance, Giuliano, Levine and Leonard [2] show how discrimination can be related to employee turnover, but the issue is not addressed in detail since their main focus is on the discriminated individual.

However, if we are interested in addressing the problem of discrimination, it is important to also note the costs that the firm is bearing when it engages in such practices. For instance, turnover can yield higher hiring costs, the firm might be missing on higher productivity from hiring talented individuals from diverse backgrounds or the firm might be missing out on a very lucrative market because they need people in the organization that can send the right branding signals to potential buyers. It is easier to face these issues if we understand that discrimination is as much a problem for the firm as it is for the individual.

In this paper we focus on the opportunity cost that firms bear when they engage in labor market discrimination. For this, we consider an example of an emerging market with specific preferences and show how a more diverse workforce can help a firm to capture this new market. In Section 2, we present a theoretical background for understanding labor market discrimination and its effects on discriminated individuals and firms. In Section 3, we introduce a game theoretical model where firms try to capture a new demographic while at the same time attracting a workforce.

2. Discrimination

Discrimination is a very important topic nowadays. Although Title VII of the Civil Rights Act in the United States makes it illegal to discriminate against a person on the basis of race, color, religion, sex or nation of origin since 1964, labor discrimination remains an important issue in this country and worldwide.

There are many reasons people get discriminated all over the world: race, gender, socioeconomic status, sexual preferencia and disability are just some of the most common

examples. One way we can classify discrimination is by the context in which it is exercised: there is discrimination in employment, housing, criminal justice or credit. Our interest in this paper is to focus on discrimination in the labor market. Specifically, to determine what drives a company to discriminate between applicants.

Discrimination in the labor market can take many forms. It can be found as differences in hiring, wage gaps or workplace power. For example, Elliott and Smith [3] used survey data to find differential access to workplace power among women and minorities relative to white men in the United States.

All forms of discrimination have different implications and they are not exclusive to each other. In fact, it is possible that the existence of one form of discrimination is correlated with the rest. In this work, I focus mainly on differences in hiring discrimination for two reasons. The first reason for this choice is that it allows for simplicity in the model. The second reason is the availability of literature and models surrounding differential hiring in the labor market. This previous research is presented in the sub-section ahead.

2.1. Reasons behind Differential Treatment in the Labor Market

Most research on discrimination is focused on either taste-based discrimination or statistical discrimination. Under taste based discrimination, people discriminate when the association with a member of a group posits an additional cost [4]. From a labor market perspective, this means that a firm will impose additional signaling costs to applicants from a minority in order to admit them with a similar payment. The result would be less employment for minority groups and a wage gap for those that are employed.

While elegant, Becker's explanation of discrimination sources was deemed unsatisfactory due to its need to include discriminatory tastes exogenously. Becker himself argued for a healthy skepticism for the use of preferences to explain behavior [5]. This criticism motivated the work of Arrow [6] and Phelps [7] to explain discrimination as the outcome of rational behavior from optimizing agents.

This line of thought is known as statistical discrimination. In essence, a member of a group might be discriminated based on the observed characteristics of its social group. There are many ways in which an individual can be unfairly treated by a discriminating agent without an explicit intention to harm. On the other hand, both of these perspectives try to justify discriminating behavior as a conscious decision.

Sociologists don't share this perspective. While there is no unified vision of rational decision agents and microeconomic foundation that explains it, there is an understanding in sociology that some discriminatory behavior can be subconscious; this is called implicit discrimination [8]. Under this vision, discrimination does not require people to have an explicit justification for their discriminatory behavior.

This explanation enters the fields of psychology. Bertrand et al. (*ibid.*) used the implicit association test [9] in a pilot test to propose this hypothesis. In this study they found encouraging results that imply that some discrimination may be implicit.

An example of implicit discrimination can be found in the work of Bertrand & Mullainathan [10]. In their seminal work, the authors performed a field experiment where they answered to help-wanted ads using fictitious resumes in Chicago and Boston newspapers. In this experiment, they applied to similar job posts with resumes identical in everything except the name of the applicant. Since the name was supposed to be "very African American sounding" or "very white American sounding" names, the researchers accounted only for the difference in callbacks from both groups.

There is another important reason behind occupational segregation: identity. As an example, consider nursing: although it is a job with stability and good opportunities, there seems to be an important underrepresentation of male nurses. This may seem particularly puzzling if we consider that it is a job that sometimes requires significant physical strength, where men would show good performance. However there is a perception that it is not a career for men [11]. As a result, coping with being a male nurse seems to require some amount of maturity and resilience.

Another important issue that affects the set of opportunities in the labor market has to do with social interaction. Managers and employees hang out outside of the office, take lunch together and talk about common interests. Sometimes, this interaction can lead to the creation of new ideas, to promotions and joint projects. This interactions are studied by Cullen and Perez-Truglia [12] in an event-study analysis of manager rotation to estimate causal effect of managers' gender on their employees' career. In this study they find that male employees assigned to male managers are promoted faster in the following years than male employees assigned to female managers. On the contrary, female employees' career was no different regarding the gender of the manager.

Similarly, family roles play an important role on the work dynamics. Bertrand, Goldin and Katz [13] studied the careers of MBAs from Chicago business school through time. They were young professionals in Business, Consulting and Finance with very promising careers. At the beginning of their professional life, men and women seem to show very similar outcomes, but their paths diverge with time. A very important factor for this divergence comes from motherhood: the arrival of a child is followed by a reduction in the mother's working hours and income. An intriguing result is that men tend to have more incentives to have children, since their lifestyle is barely modified.

Some of the reasons behind labor market discrimination may have long lasting effects, even when the underlying reasons that originated them is removed. For example, consider the role of women in the care of children (*ibid*). It is possible to argue for the existence of natural reasons for it. After all, it's women who has the natural capability of lactation. However, as described by Stevens [14], the invention of baby bottles and formula opened an opportunity for mothers to liberate them from that task. This opens the opportunity for fathers to be a part of the infant's raising and leads to policies such as the Swedish *Daddy month* reform.

However, as Ekberg, Eriksson and Friebel [15] find, technology in the form of technical advances or policy reforms sometimes is not enough to make overnight changes in behavior. In their analysis they didn't find an increase in the number of hours spent caring for sick children or increases in wages for women.

An important reason why behavior in organization towards minorities is slow to change may be that historical data is biased. This historical bias yields suboptimal choices by firms, even when they are actively trying to be inclusive and have onboarding processes for diverse people. This is explored in the next section.

2.2. Algorithmic Discrimination in the Labor Market

Algorithms and machines are increasingly replacing labor in different areas of our lives [16]. According to a survey by Pew Research Center, one in five Americans think that it is a very realistic scenario that machines will do most human jobs [17]. One area that is increasingly being assisted by computers is recruitment and human resources.

The recruitment process being done by artificial intelligence and machine learning models involve the use of data mining to score the applicants according to different characteristics [18]. This is helpful for recruiters, since they can rank candidates in a more efficient way in order to find the best workers.

However, reliance on algorithms can also yield bias and discrimination. This may even happen when the algorithm is designed for fairness and programmers have good intentions. This is because algorithms are usually made under the assumption that historical data is accurate [19].

This problem can be identified as a problem of social learning that may be improved by consciously using an exploration algorithm like a multi-armed bandit for improving outcomes (cf. ref. [20] and Li et al., 2020).

2.3. Identification Problems in Discrimination

Discrimination is a sensitive issue. This implies that when a survey on the matter is answered, we can count that some of the answers might conceal the real animus. This

highlights the importance of implicit association tests, which may be more difficult to manipulate than survey-based research. That is one reason why Bertrand et al. [8] use an implicit association test instead of surveys to identify racial animus. Using this technique, they found that implicit discrimination is not fixed and depends largely on the context and exposition from subjects. By exposing the participants to pictures of admired African-Americans, they observed an important decrease of racial animus for at least 24 h before exposition.

A participant in a survey might not express any racial animus in it, but be part in activities that contradict this results. In a study, Stephens-Davidowitz [21] uses Google search queries to estimate racial animus by measuring the use of racially charged language. The author finds that in areas where people use a high rate of racially charged search terms, the votes for presidential candidate Barack Obama in 2008 and 2012 are substantially lower. Furthermore, the estimation of racial animus using search queries are 1.5 to 3 times larger that the ones used in surveys.

2.4. Technology Enables Diversity in the Workplace

A central argument for why firms engage in discrimination even when it leads to less than optimal results is that when they form their strategies, the decisions are optimal. However, as time passes, the hiring rules become outdated as technology allows people from different backgrounds to become competitive in the labor market.

For instance, when the birth control pill was introduced and the legal environment allowed young, unmarried women to obtain it, more of them entered professional programs and the age of first marriage soared [22]. Since birth control is translated into lower personal costs of engaging in a long-term career, more women were able to study more and delay marriage in order to get better jobs. This changed the lives of young women who would otherwise have no option but to become housewives, but it also meant that the workplace changed dramatically in just a few years.

The effect on the birth control pill on the labor market was enabled by both a technological innovation and an innovation in the legal system that allowed its purchase and distribution. Technological innovations are big enablers of diversity: innovations in transport enable migration; innovations in household appliances allow women to spend less time doing housework and care and more time studying and working and building a career; medical innovations can help people with disability to participate in the labor market when otherwise they wouldn't.

An instance of the last kind of technology-enabled diversity can be found in the case of people with visual impairment. A screen reader user survey by WebAIM [23] finds that 46.8% of respondents have a full time job, in contrast with 37.3% that is reported in the 2017 Disability Status Report of the United States (Erickson & von Schrader, 2021). While the number is much lower than the 79.4% of people without disability holding full time positions, there seems to be a difference in employment that can be attributed to the use of this technology.

Legal innovation can also spur diversity in the workplace which can be found to have positive effects on firms' performance. For instance, anti-discriminatory laws in the U.S. prohibiting discrimination in the workplace based on sexual orientation and gender identity allowed people from the LGBT community to be introduced in the workplace. This inclusion has been found to have positive effects on firm innovation and firms' productivity [24].

However, diversity can also bring conflict within the organization and lead to some undesirable consequences. For example, Bonaventura and Biondo [25] use an agent based model to show how the disclosure of sexual orientation can lead to absenteeism, low productivity and a less motivated workforce.

This effect has been found also with race by Inzlicht, et al. [26]. In an experiment, the authors asked African-American college students to fill out a test and measured their performance. They found that, when they were reminded of stereotypes from their own

race, their performance was impaired. This is due to the use of mental resources for self regulation needed for coping with stigma.

While we might argue that this problems entail a cost for employers, we argue that the cost of not allowing diversity in the workplace is even higher. In the next section we show our model to illustrate the workings of this idea.

3. The Costs of the Firm from Discrimination

Let us use a simple model to exemplify why discrimination yields immediate loss for a firm in a market economy. Consider the case of a firm in a market with N workers. Let workers be a part of either social group A or B and let us suppose that the social group is an observable feature by firms.

The firms hire workers based on their perception of ability. This perception is modeled as a linear parameter θ with a threshold value of θ' decided exogenously by the company. If a certain worker $i \in \{1, \ldots, N\}$ signals $\tilde{\theta}_i > \theta'$ the company will hire her.

However, $\tilde{\theta}_i$ is a noisy signal of the worker's ability, which depends on the social group she belongs to. Let θ_A and θ_B be the perceived ability of workers that come from social group A and B, respectively, where $\theta_A > \theta_B$. Since the perception is noisy, a feasible distribution of θ_x, with $x = A, B$ is

$$\theta_x \sim N(\bar{\theta}_x, \sigma_x^2). \tag{1}$$

Consider that $\theta' > \bar{\theta}_A > \bar{\theta}_B$. This implies that a larger number of workers from group A will be hired than those of group B. This is shown in Figure 1.
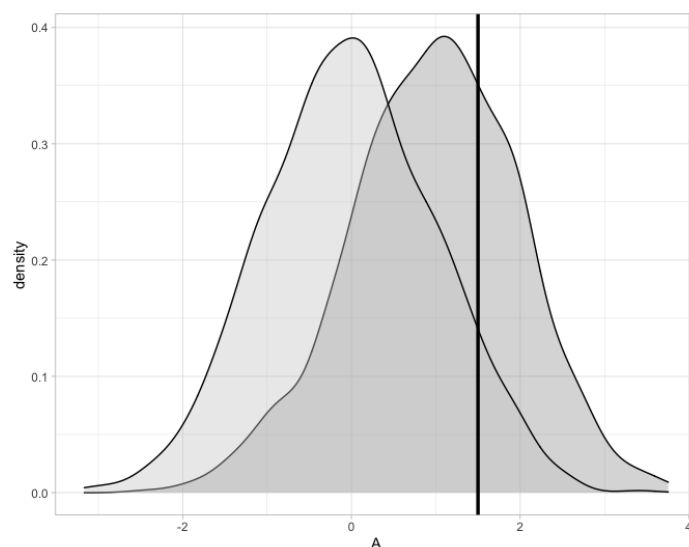

Figure 1. Two normally distributed ability indicators. Only the workers right of the vertical line can be hired.

Though θ is a measure of the worker's ability, it can also be a measure of cultural fit in the company. Cultural fit is a complex feature of companies, but it can be indeed a source of labor market discrimination that is similar to the statistical discrimination models of Arrow [6] and Phelps [7]. Admittedly, company culture can mean very different things depending on the company, but it can be a measure of the perceived fit for a certain job. This perception might not be real at all too: as we discussed in previous sections, identity in the labor market has an important impact on the segregation of workers for reasons beyond productivity (See Akerlof & Kranton, in [27], chapters 7 and 8).

However, what happens if an exogenous technology change suddenly allows for a new demographic to enter the market?

New Markets and a More Diverse Labor Force

There are two changes to be considered with exogenous technological changes. The first is on the labor market: the ability of people from social group *B* might encounter a boost on their productivity. As an example, consider people with visual impairment mentioned on previous section. The introduction of screen readers can allow then to do many office jobs that were impossible previously. We can also think of the previous example of the birth control pill: after its appearance, women were able to study more and engage in longer career paths, which is reflected in higher levels of ability.

The second change that can be expected is the appearance of a new market with different tastes and preferences than those of the existing market. This is due to an expansion of purchasing power from those people with increased abilities. Let *m* denote the size of the new market measured in individuals with capacity and desire to purchase a generic product.

The process that generates this new purchasing power is beyond the scope of this article. Therefore, *m* is generated exogenously. Thus the objective of the firm is to capture this new market. A problem that arises from this objective is that this new market has a different taste and their preferences might not align with current products that the firm is offering.

This is not a new problem. When Daymond John decided to get into the clothing business, one of his main advantages was the lack of clothes for fans of rap music. His cultural background allowed him to capture a market no one ever noticed before [28]. Thus, we will assume for this model that it is necessary to include people from the social group of the market to be able to capture it. The idea behind this is that only a member of this social group has the information necessary to align the product with the new market taste.

Thus, for a firm to get market share in such a market, it must incur exploring costs. The idea behind this is that, even though the new technology increases social group *B*'s real ability, the current signal is biased towards hiring a member of group *A*. The firms are not ignorant of this situation, though hiring a member of group *B* means exploring for different candidates, instead of exploiting current models and data.ñ The explore-exploit paradigm in hiring can be found in the work of Li [29] and Komiyama [20].

Exploration costs can come in the form of risk or in the creation of new onboarding procedures. We can thus represent the exploration efforts with u and $X(u)$ is the number of individuals from the new market that purchase the product offered by the firm.

In the next section, we build upon this idea to show the effects of discrimination in the capture of the market and the cost that is born by firms. For this, instead of considering a single firm, we suppose there are two firms competing to capture the newly created market. We also consider the model to be dynamic, with a rate of product adoption from the market for each firm in each moment of time.

4. A Model of New Market Capture

Consider a model where 2 firms desire to capture a new market. We can think that this new market comes from a technological advance that allows to market an existing group previously ignored. This allows us to set *m* as the fixed size of the potential market. Let $x_i(t)$ be a continuous variable that denotes the number of individuals that have adopted (bought) the product that firm $i \in \{I, II\}$ offer at time period *t*.

In this oligopoly model, firm *i* assumes a hiring exploration cost $u_i(t)$ in each moment in time to try to get as many clients from this new market as possible. We use a marketing model inspired by the seminal paper by Bass [30] and adapted for oligopolies by Horsky and Simon [31].

In this model, the effectiveness of the advertising is assumed to be a linear function of the marketing efforts, but reality can be way more complex. For example, marketing efforts may be directed towards increasing the goodwill of the consumer towards the brand [32]. This means that hiring a diverse workforce is a marketing effort from the firm in order to increase sales from the new market. For instance, when Nestlé wanted to introduce Kit

Kat chocolates to the Japanese market, sales were plummeting. It was not until they made extensive research on the Japanese culture that they were able to adapt their marketing campaigns to the market [33]. Our simple model identifies this kind of deep research as part of the marketing process that is needed for the firm to be successful.

While the process of recruitment described in previous section has a stochastic component, let us assume that the exploration costs from firms is driven by an optimization problem where market capture is described by

$$\dot{x}_j(t) = [\alpha + \beta \ln u_j(t) + \gamma X(t)](m - X(t)), \quad j \in \{I, II\}, \tag{2}$$

where α, β and γ are all positive constants and $X(t) = x_I + x_{II}$ are the cumulative sales of the oligopoly for this particular product. The planning period for the firms runs from initial time $t_0 = 0$ to T. The specification of the effects of logarithmic effects of marketing on the sales reflect the idea that the adoption of new products is increasing and concave, i.e., they present diminishing returns. Further, the $m - X(t)$ coefficient on the right hand side of the equation reflects that the new demographic is fixed and both players will explore for knowledge in the new market until all of it is captured.

The linear function $\alpha + \beta \ln u_j(t) + \gamma X(t)$ is deterministic, but as [31] explains, it can also be interpreted as the probability that any member of the social group B becomes a client of firm j in any particular moment of time, given the new hires from this same group that the firm recruits.

Thus, the payoff functional of firm j is

$$J_j = \int_0^T e^{-\rho t}[\pi_j \dot{x}_j(t) - u_j(t)]dt, \quad j \in \{I, II\}, \tag{3}$$

where π_j is the constant unit margin from sales of firm j. In our model, π_j represents the marginal contribution of a new hire from social group B to the capture of new clients. It is possible to identify an open-loop Nash equilibrium for the game to find the optimal hiring rate u_j for $j = I, II$. For this purpose we use a transformation that uses $X(t)$ as a new state variable. Thus the Hamiltonian $H_j(\cdot)$ of firm j is

$$
\begin{aligned}
H_j(u_j, X, \lambda_j) = {} & \pi_j(\alpha + \beta \ln u_j + \gamma X)(m - X) - u_j \\
& + \lambda_j 2(\alpha + \beta \ln[u_j u_k] + \gamma X)(m - X),
\end{aligned}
\tag{4}
$$

where λ_j denotes the co-state variable, normally interpreted as the shadow price of the product. In this case, it is associated with the whole industry's sales $X(t)$. We assume that advertising rates are positive, thus we can derive the optimal advertising rates from players in the game by getting first order conditions of the Hamiltonian in Equation (4). This yields optimal hiring rates for firm j:

$$u_j^*(t) = \beta[\pi_j + \lambda_j](m - X). \tag{5}$$

Under these optimal conditions, advertising can only be positive if $\pi_j + \lambda_j > 0$. Theorem 2.2 in [34] requires the costate variable dynamics to satisfy

$$\dot{\lambda}_j(t) = \rho_j \lambda_j(t) - \frac{\partial H_j^*(t, X(t), \lambda_j(t))}{\partial x}. \tag{6}$$

This yields

$$
\begin{aligned}
\dot{\lambda}_j(t) \quad & = \pi_j[\alpha + \beta \ln u_j(t) + \gamma X(t) - \gamma(m - X(t))] \\
& + \lambda_j(t)[2\alpha + \beta \ln[u_1(t)u_2(t)] + 2\gamma(2X(t) - m)]
\end{aligned}
\tag{7}
$$

Differentiating equilibrium strategy from Equation (5) with respect of time and using adjoint equations yields

$$\dot{u}_j(t) = -2\gamma(m - X)^2\beta(\pi_j + \lambda_j(t)) + \xi_k(t)\beta(m - X)\pi_j \tag{8}$$

where

$$\xi_k(t) = -\beta \ln u_k(t) - [\alpha + 2\gamma + \gamma m],$$

For $k \neq j$. Equation (8) represents the optimal response of each firm in order to capture the market. It's straightforward to verify that this is a negative value as long as $\pi_j + \lambda_j(t) > 0$, which can be explained by the fixed nature of the new market. Firms hiring strategies ensure a position in the new markets which can be soon saturated if they do not act soon. The oligopolists' capture efforts are diminishing in time, reflecting that there is no salvage value attached to the cumulative sales in time T.

While a firm might be interested in capturing the market as soon as possible, a difference in marginal effects of hiring people from diverse backgrounds may delay the capture of the market. For instance, let $\pi_I < \pi_{II}$; under this scenario, firm I does not absorb workers from social group B quite as effectively.

This may be due to different reasons. For instance, there might be present some kind of taste-based discrimination [6] in the firm. This discrimination can manifest itself as unequal compensation for the discriminated individuals. Another possibility is that ideas from people of diverse background might not be heard or can even be systematically quieted down by the dominant group. Although the work dynamics that cause this delay are beyond the scope of this work, the effects are clear: the firms where discrimination is present have a clear disadvantage against competitors with effective on-boarding processes.

5. Discussion

The acknowledgement of discrimination costs on the side of the firm can lead to identifying a set of possible strategies to be adopted in order to identify and reduce them. Such strategies might find full support of the firm when they are focused on increasing their chances of capturing new markets and reducing opportunity costs, instead of only solving an abstract social issue which might not be part of their mission.

There is plenty of room for implementation of anti-discrimination policies within the firms. For example, Goldin and Rouse [35] use a natural experiment in which symphony orchestras switched to "blind" auditions and found that females are substantially more likely to be hired when auditions are blind than when employers observe gender during auditions. This hints at the possibility of the implementation of gender blind policies in hiring.

Another important implication is the creation of anti-discrimination policies within the firm. This may allow for historically discriminated social groups to fully grow within the firm and show their full capacity in creating value for the firm and for society.

There is at least one more kind of cost that I did not review in this work. These are costs linked to the personal pain that a discriminated worker has when she suffers from discrimination in the workplace. For example, Giuliano, Levine and Leonard [2] studied the racial composition of a U.S. retail firm and the ethnicity of hiring managers. They found that non-black managers are more likely to hire more white workers and that workers are less likely to quit their job when there are people from their own ethnicity in the workplace. This may be reflected in a personal cost for the discriminated individuals, but employee turnover is a cost for the firm in which discrimination may be an important factor.

Lastly, there is still important issues to be addressed in identification strategies for costs of discrimination from the firm. In particular, it is important to consider collider bias and other forms of misspecification that may arise when dealing with data on discrimination. As we saw earlier though, facing these constraints may be worthwhile if they lead to a world in which diversity is considered and proper policies for promoting it and managing it are considered cost-effective by firms.

Abbreviations

The following abbreviations are used in this manuscript:

OECD   Organization for Economic Co-operation and Development
WMS   World Management Survey

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