Employer discrimination and market structure: Does more concentration mean more discrimination?*

Josh Ederington[†] Jeremy Sandford[‡]

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Abstract

We formalize Gary Becker's dynamic conjecture that competitive forces drive discriminating employers from the market in the long run, using a dynamic model of a monopolistically competitive industry characterized by sunk costs and sequential entry. An advantage of this formalization is that it demonstrates the importance of the structure of production costs, as well as market power, in explaining the long-run survival of discriminatory firms. In addition, we show that, despite decades of empirical research on this connection, there is no consistent theoretical relationship between the degree of market concentration within an industry and the degree of discrimination. However, we do find an indirect link in which market liberalization has a more pronounced effect in reducing discrimination in more concentrated markets.

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[†]Department of Economics, University of Kentucky, ederington@uky.edu

[‡]Federal Trade Commission, email:jsandford@ftc.gov, web:www.jasandford.com

1 Introduction

One of the central predictions of Gary Becker's canonical model of taste-based discrimination (Becker, 1957) is that product market competition reduces employer discrimination. As explained by Hellerstein and Neumark (2006) in their survey article, this prediction arises from two separate conjectures. The static conjecture is that some degree of market power is necessary for a firm to be able to afford to discriminate even in the short run. The dynamic conjecture is that, even in markets characterized by a small degree of imperfect competition, employers with a taste for discrimination do not survive in the long run. The intuition behind the dynamic prediction is simply based on the fact that as long as wage differentials exist, non-discriminating employers would outperform discriminating employers because they are willing to hire the cheaper but equally productive workers. Thus, non-discriminating employers would expand while discriminating employers contract until only non-discriminating employers are left in the market. The Becker framework has had enormous influence on the debate about the efficiency of anti-discrimination legislation. As many opponents of anti-discrimination legislation have argued, if the Becker model of discrimination is accurate, then a legal regime to reduce discrimination by interfering in the market can be harmful in the short run and will be unnecessary in the long run as competitive pressures alone will serve to drive discriminators from the market.[1] Thus, as noted by Gersen (2007), Becker's taste-based model of employer discrimination is commonly viewed as the foundation of the efficiency critique of a legislative approach to discrimination.

Given the centrality of the Becker framework to the discussion over the efficiency of anti-discrimination legislation, it is perhaps not surprising that, since the publication of Becker (1957), there have been several decades of empirical research looking for a link between product market competition and discrimination with varying levels of success. A common prediction being tested within this literature is whether the degree of discrimination varies with market structure: specifically, whether discrimination is positively correlated with the degree of product market concentration (i.e., is discrimination more prevalent in "less-competitive" industries featuring a small number of firms and high levels of market concentration?). The typical approach to testing this prediction is a cross-sectional analysis comparing employment discrimination in highly concentrated markets to discrimination in markets with a less concentrated market structure where the degree of product market concentration is measured by either an n-firm concentration ratio or the Herfindahl-Hirschmann Index (HHI). An incomplete list of papers that have adopted this approach includes Shepard (1969), Haessel and Palmer (1973), Oster (1975), Fujii and Trapani (1978), Ashenfelter and Hannan (1986), Jones and Walsh (1991), Black and

[1]See in particular the well-known debate between Richard Posner, John Donohue III and Richard Epstein (Donohue (1986); Posner (1987); Donohue (1987) and Epstein (1992)).

Strahan (2001), Hellerstein et al. (2002), Black and Brainerd (2004) Heywood and Peoples (2006), Kawaguchi (2007), and Gersen (2007). Empirical results have been mixed, with some finding a positive correlation, some finding no correlation and some even finding a negative correlation between concentration and discrimination. This empirical literature considers both hiring discrimination (as measured by the fraction of women or minorities employed in an industry) and wage discrimination (as measured by the ratio of male to female wages within a job category).[2]

However, this discussion about the connection between product market structure and discrimination has occurred without a formal theoretical foundation. The Becker model of taste-based discrimination is inherently static in nature, and thus the dynamic conjecture (that product market competition drives discriminators out of the market in the long run) has never been formalized. While Becker and others (see especially Hellerstein and Neumark (2006)) point out that the elimination of discriminatory firms depends on the nature of product market competition, such as the absence of barriers to entry, this discussion is not well- developed. Thus, in this paper we formalize Becker's dynamic conjecture of the link between product market competition and the long-run survival of discriminatory firms in a model of monopolistic competition with endogenous entry and exit, and derive the product market conditions under which discriminatory firms are most likely to survive.

Our most surprising result is that the long-assumed positive correlation between the degree of market concentration and the degree of discrimination is not inevitable. We find that there is no general relationship between market concentration and discrimination; the most concentrated industries may even exhibit the *lowest* levels of employment discrimination.

The relationship between concentration and discrimination depends on the source of variation in concentration. For example, industries with high fixed costs tend to be more concentrated since large fixed costs result in greater economies of scale. However, high fixed costs also make the long-run survival of discriminatory firms — who are at a cost disadvantage relative to non-discriminatory firms — less likely. As another example, industries whose products are more differentiated tend to be unconcentrated, because differentiation allows for the long-run survival of a larger number of small firms. However, differentiation mitigates the effect of competition in the Becker model, in which discriminatory firms are driven out by product market competition due to their cost disadvantage. Finally, industries with high entry costs tend to be more concentrated, but there is no clear relationship between entry costs and discrimination. If entry costs are sufficiently low, abundant entry of non-

[2]Papers taking the former approach include Shepard (1969), Haessel and Palmer (1973), Oster (1975), Ashenfelter and Hannan (1986), and Jones and Walsh (1991). Hellerstein et al. (2002) and Kawaguchi (2007) study the empirical relationship between profitability and the fraction of women employed, to test the hypothesis that non-discriminatory firms have lower costs because of their greater willingness to hire women. Fujii and Trapani (1978), Black and Strahan (2001), and Black and Brainerd (2004) use a male-female wage gap as a measure of discrimination.

discriminatory firms will drive out all discriminatory firms. However, conditional on entry costs being high enough to allow some discriminatory firms to remain, a further increase in entry costs makes it tougher for discriminatory firms to survive, as fewer will enter in the first place relative to lower-cost non-discriminatory firms. These three examples, discussed in detail in section 4, demonstrate that empiricists should not expect any particular relationship between concentration and the level of discrimination.

Another large branch of the empirical competition and discrimination literature uses panel data to compare rates of discrimination before and after some type of market liberalization event. It is common in this literature to hypothesize that the effects of market liberalization will be more pronounced in the most concentrated industries (e.g., see Borjas and Ramey (1995), Black and Brainerd (2004), Berik et al. (2004) and Ederington et al. (2010)). However, if there is no direct theoretical link between market concentration and discrimination, should researchers expect to observe an indirect link in which the effects of liberalization on discrimination vary consistently across different market structures? We address this question within our dynamic framework by modeling a market liberalization event (specifically, an exogenous increase in the number of potential entrants) to observe whether such liberalization reduces discrimination, and whether this discrimination-reducing effect is larger in more concentrated markets. In this case, our theoretical results are consistent with the empirical literature. Specifically, we consistently find that market deregulation reduces levels of discrimination within an industry, and that such reductions are highest in the most concentrated industries.

This paper fits within a long literature that attempts to provide a formal explanation for the long-run persistence of discrimination in a competitive environment.[3] Such explanations invariably rely on introducing market frictions into the Becker (1957) framework. It is instructive to note that the previous papers in this literature generate long-run persistence of discriminatory firms by introducing search frictions into either the product or labor markets (see Akerlof (1985), Black (1995), Bowlus and Eckstein (2002) and Rosen (2003)). In contrast this paper uses a more conventional model of product competition, first set out in Götz (2002), where the market frictions emerge from the introduction of product differentiation, sequential entry and sunk costs. The focus in this paper on market structure allows us to derive some novel conditions about those industry characteristics that are more conducive to discriminatory behavior.

[3]There is evidence that the mere survival of discriminatory firms has deleterious effects for the discriminated-against group, even if that group works only for non-discriminatory firms. Several papers (cf. Black (1995), Lang et al. (2005), and Borowczyk-Martins et al. (2013)) point out that if workers must engage in costly search to locate jobs, then even the non-discriminatory firms will pay these workers less in equilibrium, as they will have a lower reservation wage. There is empirical support both for discriminated-against groups searching less (cf. Whatley and Sedo (1998)) and for non-discriminatory firms paying discriminated-against groups a relatively lower wage (cf. Flabbi (2010))

The paper proceeds as follows. In section 2, we lay out our dynamic model of competition and discrimination and discuss the mechanism by which competition can eliminate employer discrimination in the long run. In section 3, we derive and discuss the conditions under which discriminatory firms can survive in a long-run equilibrium, and also discuss the links between market structure and the degree of discrimination within an industry. In section 4, we derive the relationship between the level of market concentration and discrimination within an industry and demonstrate how more concentrated industries typically exhibit lower levels of discriminatory behavior. In section 5, we model the effects of market liberalization on competition and demonstrate that increased competition results in a more pronounced decrease in competition in more concentrated industries. In section 6, we consider three extensions to the main model: endogenizing the wage differential, endogenizing entry costs, and allowing for capital transfer between discriminatory and non-discriminatory firms. Finally, section 7 concludes.

2 Model

In this section, we derive a model of employer discrimination in a monopolistically competitive industry. We assume the existence of two types of firms: discriminatory firms and non-discriminatory firms. Importantly, we assume that potential entrants arrive sequentially and that each firm must pay a sunk cost of investment in order to enter the market. Thus, we adapt a standard model of sequential entry and industry evolution, set out in Götz (2002), to the question of the long-run survival of discriminating firms. As we describe later, it is the combination of product differentiation, sequential entry, and sunk costs that allows discriminatory firms to survive in the long-run equilibrium of our model.

2.1 Market Demand Conditions

We assume that the economy has two sectors: one sector consists of a numeraire good, x_0, while the other sector is characterized by differentiated products. The following intertemporal utility function defines the preferences of a representative consumer:

$$U = \int_0^\infty (c_0(t) + logC(t))e^{-rt}dt \tag{1}$$

where $c_0(t)$ is consumption of the numeraire good in time t and $C(t)$ represents an index of consumption of the differentiated goods. We assume a CES specification which reflects a taste for variety in consumption and implies a constant (and equal) elasticity of substitution between every pair of goods:

$$C(t) = \left[\int_0^{n(t)} y(j,t)^\rho dj \right]^{1/\rho} \tag{2}$$

where $y(j,t)$ represents consumption of brand j at time t and $n(t)$ represents the number of varieties available at time t. Given the quasi-linear structure of preferences, it is straightforward to solve for the demand functions of a differentiated good, $y(i,t)$, with the elasticity of substitution between any two products given by $\sigma = 1/(1-\rho) > 1$:[4]

$$y(i,t) = \frac{p(i,t)^{-\sigma} E}{\int_0^{n(t)} p(j,t)^{1-\sigma} dj} \tag{3}$$

where $p(i,t)$ is the price of good i in time t and E represents the total number of consumers in the economy, hereafter normalized to 1. Note that the quasi-linear nature of the utility function results in demand for the differentiated product good to be independent of consumer income (see the online appendix for details) and thus we suppress any discussion of consumer income.

2.2 Firm Production

We assume consumers are endowed with l units of labor which they supply inelastically, and that there are two types of consumers: male and female. The numeraire good technology transforms labor inputs into product at a rate $y_o = w_m l_m + w_f l_f$, where l_m and l_f are male and female labor units. Given this constant returns to scale production, numeraire product firms receive zero profits and demand for labor is perfectly elastic at prices w_m and w_f respectively. Thus, provided the numeraire good is produced in equilibrium, the labor market clearing conditions are automatically satisfied and any economy-wide wage gap between male and female workers is determined by productivity differences in the numeraire sector.

In contrast, we assume that production of the differentiated product good requires a sequence of tasks to be performed. Letting a be the index for tasks and letting the cost of task a be given by $w(a)$, the marginal cost of producing a variety of the differentiated product good is given by:

$$c = \int_0^1 w(a) da \tag{4}$$

A firm can hire a male employee to complete a task at the economy-wide wage rate w_m, or a

[4] A formal derivation is provided in an online appendix, available at www.jasandford.com/discriminationappendix.pdf.

female employee at cost w_f. We assume that $w_m = \phi w_f$ and $\phi > 1$.[5] Male and female employees are equally productive in producing the differentiated product, but an exogenous wage differential exists in the economy due to productivity differentials in the numeraire sector. Thus, we are explicitly modeling a case of employment discrimination (not wage discrimination) in the differentiated product sector.[6] Note that comparative advantage efficiency considerations would entail hiring only female workers in the differentiated product sector (where men and women are equally productive), however the presence of discriminatory employers in the differentiated product sector could result in a misallocation of labor within the economy (thus reducing aggregate productivity).

The assumption of a wage differential arising from the numeraire sector does require some discussion since Becker's theories on the link between competition and discrimination involves several components. Part of Becker (1957) involves showing that if the share of non-discriminatory firms is sufficiently large in a competitive labor market then any wage differentials tend to disappear (i.e., discrimination on average does not necessarily imply discrimination in the margin) and the equilibrium involves segregation across firms. However, Becker (1957) also shows that, when firms are faced with an exogenous wage differential, product market competition will tend to eliminate discriminatory firms (in the long run) since they are at a competitive disadvantage. It should be apparent that, in this paper, we are looking at only this second prediction as we model an exogenous wage differential which imposes a cost disadvantage to discriminatory firms. Thus, in the calculations that follow, we are analyzing a "small" industry which takes wages as given and determined by the rest of the economy (i.e., the numeraire sector). However, this raises the question of how our calculations would be affected if either the industry were large enough to influence economy-wide wages or wages were determined at the industry level. Thus, in section 6.1 we consider the case where the male-female wage differential is a function of the share of discriminatory firms in the industry.

2.3 Firm Behavior - Discrimination

In this model, firms have four choices to make: whether to enter, how much to discriminate, what price to charge, and whether (and when) to exit. We assume that discrimination is costly; by limiting

[5]Our model of employer discrimination is similar to that used in Ederington et al. (2010), which involves a static model of discrimination in a monopolistically competitive industry and simply assumes the presence of discriminating firms. In contrast, this paper employs a dynamic framework to derive the conditions under which discriminatory firms will continue to exist in the long run.

[6]Our model would also be applicable to firms choosing between equally productive workers with different reservation wages such as between immigrants and native labor. The idea of divergent reservation wages between natives and immigrants yielding a wage gap is widely supported by the empirical evidence. See, for example, Algan et al. (2010). We are grateful to an anonymous referee for pointing out this application and literature.

themselves to hiring, say, only men, discriminatory firms increase their marginal costs above those of non-discriminatory firms. In what follows, we study conditions under which discriminatory firms survive in equilibrium despite their cost disadvantage.

Defining $z_i \in [0, 1]$ as the fraction of females employed by firm i, the marginal cost of firm i is given by:

$$c_i = w_m - z_i(w_m - w_f) \tag{5}$$

Given the existence of a wage differential, a cost-minimizing firm chooses to hire only women (i.e., sets $z_i = 1$). However, we assume that firms maximize a utility function that encompasses both profits and a taste for discrimination, which we capture by assuming that the firm owner (or manager) derives disutility from hiring female workers. This disutility is defined as $\psi_i(z_i)$. Thus, firms choose price p_i and the female share of the labor-force z_i to maximize:

$$\max_{p_i, z_i} (p_i - c_i)y_i - \psi_i(z_i) \tag{6}$$

From the first-order condition with respect to p_i, one can derive that firms use a constant mark-up pricing rule where:

$$p_i = \frac{\sigma}{\sigma - 1} c_i \tag{7}$$

From the first-order condition with respect to z_i, one can derive that z_i is implicitly defined by:

$$\psi_i'(z_i) = \frac{\sigma - 1}{\sigma} \frac{(w_m - w_f)[w_m - (w_m - w_f)z_i]^{-\sigma}}{\int_0^n (c_j)^{1-\sigma} dj} \tag{8}$$

The left hand side of (8) represents the marginal cost to the firm of increasing its female share, while the right hand side represents the marginal benefit (in the form of lower costs of production). Firms choose to employ men (i.e., $z_i < 1$) if and only if the disutility of hiring women is sufficiently high, outweighing the cost of the wage differential. Thus, a firm's marginal cost of production c_i will be increasing in the fraction of men in its workforce z_i. Firms who discriminate relatively more will have higher costs. For analytical simplicity, we consider two types of firms: discriminatory and non-discriminatory. Non-discriminatory firms have no preference for discrimination ($\psi_i(z_i) = 0$) and thus, given the wage differential, hire only women (i.e., set $z_i = 1$). Discriminatory firms are assumed to have $\psi_i(z_i) = \psi_D \cdot z_i$ where:

$$\psi_D > \frac{\sigma - 1}{\sigma} \frac{(w_m - w_f)}{w_m} \frac{1}{n} \tag{9}$$

As a result of this assumption, discriminatory firms hire only male workers (i.e., set $z_i = 0$). Given this setup, we have that the constant marginal cost of production for a non-discriminatory firm is $c_N = w_f$, while the marginal cost of production for a discriminatory firm is $c_D = w_m$ where $c_D = \phi c_N$ and $\phi > 1$ represents the wage differential.

The operating profits of each type of firm can then be determined as a function of its own and rivals' behavior, resulting in profits of:

$$\pi_i(t) = \frac{(\frac{\sigma}{\sigma-1})^{1-\sigma} c_i^{1-\sigma}}{\sigma \int_0^{n(t)} p(j,t)^{1-\sigma} dj} \tag{10}$$

To characterize the denominator of this expression, let $n_N(t)$ represent the number of non-discriminatory firms and $n_D(t)$ the number of discriminatory firms at time t. Then the price index is given by:

$$\int_0^{n(t)} p(j,t)^{1-\sigma} dj = (\frac{\sigma}{\sigma-1})^{1-\sigma} [c_N^{1-\sigma} n_N(t) + c_D^{1-\sigma} n_D(t)] \tag{11}$$

Substituting (11) into (10) gives profits as:

$$\pi_i(t) = \frac{c_i^{1-\sigma}}{[c_N^{1-\sigma} n_N(t) + c_D^{1-\sigma} n_D(t)]\sigma} \tag{12}$$

Note that profits decrease as firms enter the market. This feature of the model allows us to explore the Becker prediction that market forces — in this case the arrival of new competitors into the market — have the potential to drive discriminating firms out of the market.

2.4 Entry

Following Götz (2002), a key assumption of our paper is that there is not an unlimited number of potential entrants at the inception of the industry. Rather, entry happens gradually, with a fixed number of potential entrants in each period. Specifically, we assume that potential entrants arrive at the constant rate g_N for non-discriminatory firms and g_D for discriminatory firms. This assumption of sequential entry is not uncommon in the industrial organization literature, and is simply based on the empirical evidence that the early stages of most industries are characterized by the gradual entry of new firms. This phase of gradual entry is often attributed to the fact that firms need a certain expertise to enter an industry, and this relevant knowledge is often only available to agents with experience in related technologies (e.g., see Klepper and Graddy (1990)). Upon arrival, firms must choose whether or not to enter the market. We assume that firms can enter the differentiated goods sector by paying a sunk entry fee of F_0 and also incur per-period fixed costs of F.

It is direct to derive that, while the gradual entry of non-discriminatory firms can result in the exit of discriminatory firms, it will not cause the exit of "older" non-discriminatory firms. Specifically, entry results in a decline in the per-period profits of all firms and will continue until the present discounted profits of the final entrant (a non-discriminatory firm) is equal to F_0. However, this implies that the per-period profits of non-discriminatory firms will never become negative, and thus no non-discriminatory firms will exit. In contrast, the exit of discriminatory firms is a distinct possibility.

Thus, we will concentrate our analysis on two cases: one in which all discriminatory firms exit the market, and one in which there is long-run survival of discriminatory firms. We begin with the case in which no discriminatory firms are active in the long run (i.e., the dynamic Becker prediction holds, and market forces drive all discriminatory firms out of the market).

2.5 Long-Run Elimination of Discriminatory Firms

For all discriminatory firms to exit the market, period profits for discriminatory firms must be negative in the long run:[7]

$$\pi_D(n_N = \overline{n}_N, n_D = 0) \leq F \tag{13}$$

where $\overline{n}_N$ is the number of non-discriminatory firms active in the long run when there are no discriminatory firms active. Non-discriminatory firms will enter the market until the present discounted value of profits are zero, and thus $\overline{n}_N$ is given by

$$\int_0^\infty e^{-rt}[\pi_N(\overline{n}_N, 0) - F]dt = F_0$$
$$\Rightarrow \overline{n}_N = \frac{1}{\sigma[F + rF_0]} \tag{14}$$

Substituting (14) into (13), all discriminatory firms exit in the long run if and only if the following holds:

$$\frac{rF_0}{\phi^{\sigma-1} - 1} \leq F \tag{15}$$

If (15) holds, industry evolution is first characterized by the arrival and entry of both discriminatory and non-discriminatory firms.[8] Since profits monotonically decrease with entry (and thus over time), there exists a time period, labeled t_1, in which the last discriminatory firm is willing to enter. However, the lower costs and higher profits of non-discriminatory firms result in continued entry of

[7]The implicit assumption in this calculation is that the outside option provides utility of zero and thus discriminatory firm owners exit when utility/profits become negative. Note that assuming the outside option provides negative utility would be more consistent with a story of nepotism as in Goldberg (1982).

[8]A positive number of both types of firms will always enter the market initially. The revenue accruing in the first ϵ periods to a firm of either type entering in period a is proportional to $\int_a^{a+\epsilon} \frac{e^{-rt}}{t}dt$, which becomes infinite as $a \to 0$, for any ϵ. Thus, a firm with an opportunity to enter the market early on can do so profitably, regardless of its costs. This unboundedness is a consequence of assuming continuous time and atomistic firms in a model derived from Dixit and Stiglitz (1977).

In a discrete time model with discrete firms, it is possible that even firms arriving in the first period would choose not to enter. In this case, it is possible that no discriminatory firms would enter the industry (or even that no firms at all enter). In order for there to be entry of both types of firms, as in our model, an assumption of low rate of arrival $g_D = g_N$, low entry costs F_0, and low fixed costs F would be required.

non-discriminatory firms, driving profits of discriminatory firms down until time period t_2, in which the first discriminatory firms begin to exit. Given that condition (15) holds, such exit continues until the time period, labeled t_3, in which the last discriminatory firm exits. Finally, non-discriminatory firms continue to enter until the time period, labeled t_4, when the present discounted value of their profits is zero and the industry has achieved the long-run equilibrium number of firms, $\overline{n}_N$.

To solve for the equilibrium industry evolution, note first that, given the constant arrival rate of potential entrants, $t_4 = \frac{\overline{n}_N}{g_N}$ and $t_1 < t_2 < t_3 < \frac{\overline{n}_N}{g_N}$. Second, the time period in which the last discriminatory firm exits the market, t_3, is defined by when per-period profits of the final discriminatory firm is driven to zero:

$$
\begin{aligned}
F &= \pi_D(n_N = g_N t_3, n_D = 0) \\
\Rightarrow F &= \frac{1}{\sigma[g_N t_3 \phi^{\sigma-1}]} \\
\Rightarrow t_3 &= \frac{1}{\sigma[F g_N \phi^{\sigma-1}]} \qquad (16)
\end{aligned}
$$

Recall that the Becker prediction is that market forces will drive firms with a taste for discrimination out of the market "in the long run." However, the original Becker model provides no insight into how long such a process will take. One of the interesting aspects of our model is that we can derive some insight into the determinants of the length of this process. We do this in the following proposition:

Proposition 1. *The total amount of time in which discriminatory firms can survive in the market, t_3, is decreasing in:*

1. *per-period fixed costs, F,*
2. *the arrival rate of non-discriminatory firms, g_N,*
3. *the wage gap, ϕ.*
4. *product substitutability, σ.*

Proof Follows directly from comparative statics on t_3. ■

The intuition behind the above proposition is straightforward. Higher fixed costs, F, make it more difficult for discriminatory firms to earn positive profits (recall that their higher costs and the resulting higher prices force them to operate on a smaller scale than their non-discriminatory competitors). The faster arrival of competing non-discriminatory firms, g_N, directly increases the exit rate of discriminating firms. Larger wage gaps, ϕ, place discriminatory firms at a greater cost disadvantage and thus increase the speed of exit. Finally, a greater degree of product substitutability, σ, implies that the entry of new (lower-priced) non-discriminating competitors results in greater demand being taken from the remaining discriminating firms and thus a faster rate of exit. Indeed, corollary 2 shows that the results of proposition 1 are consistent with the static conjecture of the Becker model (some degree of market power is necessary for discrimination), since as $\sigma \to \infty$ (i.e., perfect substitutability), $t_3 \to 0$ in the limit (i.e., discriminatory firms cannot survive even in the short run):

Corollary 2. *Some degree of market power is necessary for a firm to discriminate, even in the short run.*

Finally, industry evolution can be fully described by solving for t_1 (the time period of last entry by discriminating firms) and t_2 (the time period of first exit of discriminating firms). Discriminating firms enter the market until the present discounted value of their profits is zero, and thus t_1 is determined by

$$\int_{t_1}^{t_2} e^{-rt}(\pi_D(g_N t, g_D t_1) - F)dt = e^{-rt_1}F_0 \tag{17}$$

Discriminating firms begin exiting the market once their per-period profits are driven to zero, and thus t_2 is given by:

$$\pi_D(g_N t_2, g_D t_1) = F \tag{18}$$

While (17) and (18) do not admit a closed-form solution, one can calculate the evolution of the industry through numerical simulations. Figure 1 considers a numerical example and plots both the total number of firms in the market and the fraction of these firms which are non-discriminatory over time. Until t_1, firms of both type enter. From t_1 to t_2, only non-discriminatory types enter. From t_2 to t_3, non-discriminatory types continue to enter, while discriminatory types exit, at a rate faster than g_N. The last discriminatory firm exits the market at time t_3; between t_3 and t_4, non-discriminatory firms continue to enter the market. From time t_4, the market is in long-run equilibrium, with no discriminatory firms and $\frac{1}{\sigma[F+rF_0]}$ non-discriminatory firms. Thus, figure 1 is a graphical representation of the dynamic Becker conjecture in which market forces drive discriminatory firms out of the market and result in a long-run equilibrium involving only non-discriminatory firms.[9] However, is the above evolutionary pattern the only possibility? As we argue in the section 3, the long-run survival of discriminating firms is also possible.

[9]Any parameters satisfying (15) will produce a figure of similar shape, though the time required to reach long-run equilibrium varies in the model's parameters. The parameters in figure 1 were chosen to provide a clear illustration.

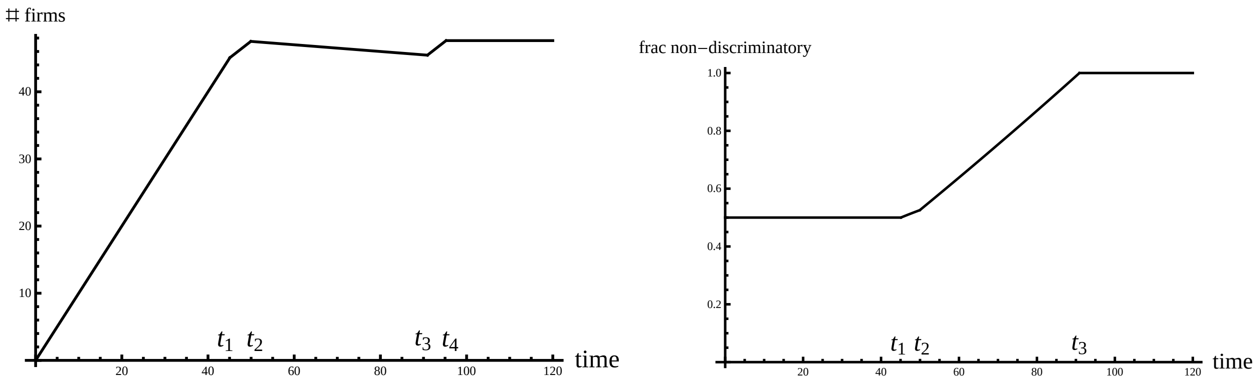


Figure 1: For $\phi = 1.1$, $\sigma = 2$, $g_N = g_D = .5$, $r = .01$, $F = .01$, $F_0 = .05$, the number of firms increases until t_2, when discriminatory firms begin to exit the market. The fraction of non-discriminatory firms increases until reaching 1 at t_3.

3 Long Run Survival of Discriminatory Firms

In this section, we consider the case in which discriminatory firms survive in the long run, contra the Becker hypothesis. Much of the theoretical discussion is derived from Götz (2002), which studied the long-run survival of firms producing undesirable products. For discriminatory firms to survive, it must be the case that they earn positive profits in the long run (i.e., $\pi_D(n_N = \overline{n}_N, n_D = \overline{n}_D) > F$, where $\overline{n}_D$ is the number of discriminatory firms active in the long run). As we establish in lemma 3, which is analogous to Proposition 4 in Götz (2002), if discriminatory firms are active in the long run, then those who enter the market at any time never exit.

Lemma 3. *If discriminatory firms exist in the long-run equilibrium, then all discriminatory firms that enter remain in the market indefinitely.*

Proof. Suppose not. Then discriminatory firms begin to exit at some time $\hat{t}_1$ and cease exiting at $\hat{t}_2 > \hat{t}_1$. Call the time when non-discriminatory firms stop entering $\hat{t}_N$. There are three possibilities. One, $\hat{t}_N \leq \hat{t}_1 < \hat{t}_2$. Two, $\hat{t}_1 < \hat{t}_N \leq \hat{t}_2$. Three, $\hat{t}_1 < \hat{t}_2 < \hat{t}_N$.

The first ($\hat{t}_N \leq \hat{t}_1 < \hat{t}_2$) is impossible, as once non-discriminatory firms stop entering, profits are constant, and so there would be no reason for discriminatory firms to continue to exit.

The second ($\hat{t}_1 < \hat{t}_N \leq \hat{t}_2$) is impossible as a simple calculation shows that non-discriminatory profits are constant in $[\hat{t}_1, \hat{t}_2]$. Thus, since $\int_0^\infty e^{-rt}[\pi_N - F]dt > F_0$ at $\hat{t}_1$ it cannot be that non-discriminatory firms will decide to stop entering prior to (or at) $\hat{t}_2$.

The third ($\hat{t}_1 < \hat{t}_2 < \hat{t}_N$) is impossible because $\pi_D = F$ at time $\hat{t}_2$, yet as π_D is decreasing in n_N, discriminatory firms would continue to exit following $\hat{t}_2$ as non-discriminatory firms continue to enter (i.e., $\pi_D < F$ for $[\hat{t}_2, \hat{t}_N]$). ■

Since non-discriminatory firms never exit the market, industry evolution is described by two time periods: t_D (the last period of entry for discriminatory firms) and t_N (the last period of entry for non-discriminatory firms). Given lemma 3, in the long run there are then $\overline{n}_D = g_D t_D$ discriminatory firms active and $\overline{n}_N = g_N t_N$ non-discriminatory firms active. Clearly, $\overline{n}_N > \overline{n}_D$ and $t_N > t_D$, and $n_N(t) = g_N t$ for $t \in [t_D, t_N]$. Then, t_D and t_N are defined by:

$$\int_0^{\infty} e^{-rt} \left(\pi_N(g_N t_N, g_D t_D) - F\right) dt = F_0 \tag{19}$$

$$\int_{t_D}^{t_N} e^{-rt} \left(\pi_D(g_N t, g_D t_D) - F\right) dt + \int_{t_N}^{\infty} e^{-rt} \left(\pi_D(g_N t_N, g_D t_D) - F\right) dt = e^{-rt_D} F_0 \tag{20}$$

(19) requires that the last non-discriminatory entrant make zero profits, while (20) requires that the last discriminatory entrant make zero profits. Using (12), (19) reduces to:

$$\overline{n}_N(\overline{n}_D) = \frac{1}{[rF_0 + F]\sigma} - \phi^{1-\sigma}\overline{n}_D \tag{21}$$

Substituting (21) into the necessary and sufficient condition for discriminatory firms to be active in the long run, $\pi_D(\overline{n}_N, \overline{n}_D) \geq 0$, gives an alternate derivation of (15). That is, discriminatory firms will survive in the long-run equilibrium if and only if:

$$\frac{rF_0}{\phi^{\sigma-1} - 1} \geq F \tag{22}$$

Equation (22) is analogous to assumption A1 in Götz (2002). The cases of long-run elimination or survival of discriminatory firms are uniquely determined by condition (22) (and, inversely, (15)). Note that as $\phi \to 1$ (no wage differential), the left hand side of (22) blows up to infinity, meaning that discrimination must be costly in order to drive discriminatory firms out of the market. Equation (22) allows us to derive the characteristics of markets in which discriminatory firms are likely to survive in the long run:

Proposition 4. *The long-run survival of discriminatory firms is more likely in industries characterized by:*

1. *high sunk start-up costs,* F_0*,*

2. *low fixed costs,* F*,*

3. *low product substitutability,* σ*.*

Proof Follows directly from comparative statics on (22). ■

As discussed in proposition 1, the presence of low fixed costs and low product substitutability allows discriminatory firms a greater ability to earn positive profits. In addition, higher sunk costs of entry make it easier for discriminating firms to survive in the long-run equilibrium. Intuitively, this is due to the fact that high sunk costs of entry reduce entry by late-arriving non-discriminatory firms. Basically, early-arriving discriminatory firms are willing to enter the market given the profit opportunities provided by entering when the market is empty. The presence of this early entry (which fills the market) and the sunk costs of entry will in turn prevent subsequent entry by later-arriving firms (in this sense, the model exhibits path dependence). It should be clear that, in the absence of sunk costs of entry, non-discriminatory firms will simply enter until their per-period profits are zero, thus completely driving the higher-cost discriminatory firms out of the market.

3.1 Determinants of the long-run share of discriminatory firms

We now examine how the long-run market share of discriminatory firms varies in model parameters. Discriminatory market share is 0 if $\frac{rF_0}{\phi^{\sigma-1}-1} < F$, and is computed numerically from (3), (7), (19), and (20) if $\frac{rF_0}{\phi^{\sigma-1}-1} \geq F$. Returning to the numerical example of figure 1, but increasing F_0 from .05 to .2 so that (22) is satisfied, figure 2 plots the combined market share of all discriminatory firms active in the long run. Inspection of figure 2 reveals the characteristics of industries in which discriminatory firms are more likely to be active.[10]

First, note from figure 2a that the market share of discriminating firms is decreasing in the fixed per-period operating costs of the industry. As discussed before, this is because higher fixed costs make it more difficult for the (higher-cost and lower-scale) discriminatory producers to be profitable. Note that the non-continuous nature of the relationship is due to the fact that when fixed costs are sufficiently high, condition (22) is violated and discriminating firms can no longer survive in the long-run equilibrium. Likewise, note from figure 2b that the fraction of discriminating firms decreases in the wage gap. Once again, larger wage gaps place the discriminating firms at a greater competitive disadvantage.

Next, from figure 2c, the market share of discriminatory firms is non-monotonically related to the sunk cost of entry. That is, for very low values of F_0 there are no discriminatory firms active in the long run as (22) is not satisfied. However, for F_0 large enough so that (22) is satisfied, the market share of discriminatory firms is actually decreasing in the sunk-costs of entry. This non-

[10] Any parameters satisfying (22) will produce dynamics qualitatively like those depicted in figure 2. As in figure 1, the time required to reach long-run equilibrium varies as parameters vary.

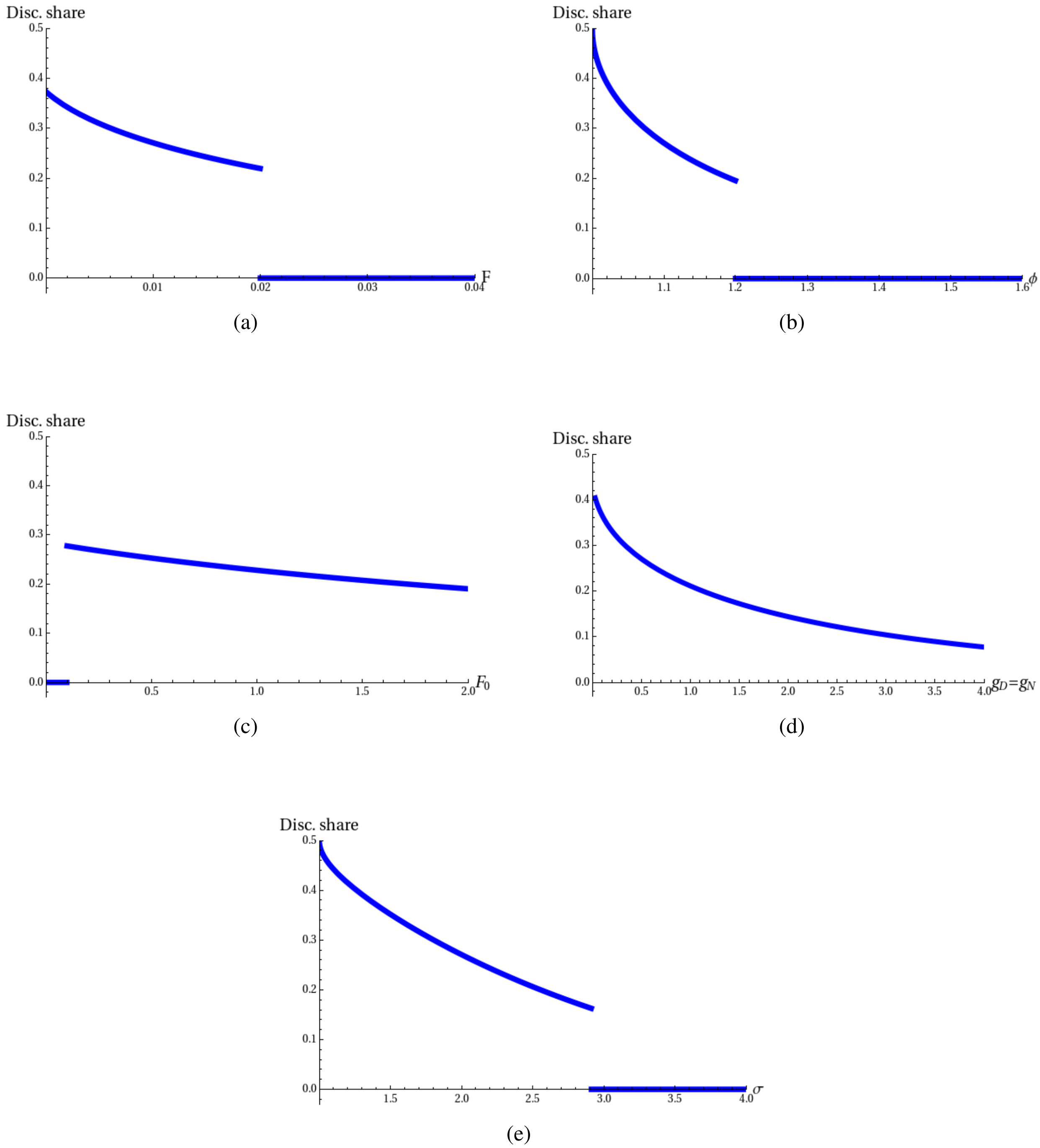


Figure 2: Figures are drawn for initial values of $\phi = 1.1$, $\sigma = 2$, $g_N = g_D = .5$, $r = .01$, $F = .01$, and $F_0 = .2$. In each panel, one parameter is varied. As can be seen, the fraction of discriminatory firms active in the long run is decreasing in F, g_N, g_D, ϕ, and σ, and non-monotonic in F_0. Also note that if F, ϕ, or σ are sufficiently large or if F_0 is sufficiently small, the Becker conjecture holds and no discriminatory firms are active in the long run.

monotonicity occurs because sunk costs must be sufficiently high to allow for the long-run survival of discriminating firms, but as these fixed costs continue to increase, it disproportionately chokes off the entry of discriminating firms. Intuitively, this is due to the fact that, since discriminating firms operate with higher costs and thus lower scale than their non-discriminating competitors, they are less able to recoup the higher sunk costs of entry.

Figure 2d demonstrates that discriminatory market share is decreasing in the arrival rate of potential entrants. This figure points to the importance of our assumption of limited, sequential entry. As the number of potential entrants goes to infinity, the fraction of discriminating firms decreases to zero (and the length of time that they survive also goes to zero — see proposition 1). In this situation, it is instructive to consider the theoretical argument for limited entry. It is true that in an industry where "imitative" entry is possible (i.e., a firm can copy the product and strategy of an incumbent firm), then the number of potential entrants should be infinite. However, as is well known in the industrial organization literature, the existence of product differentiation establishes a barrier to such imitative entry. Entry into such markets is only possible for innovative entrants (i.e., firms who have ideas for new products), which necessarily limits the number of potential entrants. Thus, the degree of product differentiation within an industry may serve as a proxy for the arrival rate of potential entrants, with industries characterized by greater degrees of product differentiation associated with lower rates of entry and thus a larger fraction of surviving discriminatory firms.

Finally, from figure 2e, the market share of discriminatory firms is decreasing as product substitutability increases. This result is a function of the intuition discussed previously. When product substitutability is low, discriminating firms are insulated from the competition provided by the lower-cost non-discriminatory competitors and thus can profitably operate in equilibrium. Indeed, as we can see from the above analysis, in industries characterized by low product substitutability, discriminating firms are likely to survive longer (proposition 1), more likely to survive in the long run (proposition 4), and more likely to represent a higher fraction of output (figure 2).

4 Market Concentration and Discrimination

A large empirical literature considers the relationship between discrimination and market structure (specifically measures of market concentration). As our model characterizes the long-run survival of discriminatory firms, we can revisit this issue theoretically. As a measure of market concentration we calculate the differentiated good industry's Herfindahl-Hirschman Index (HHI) under various parameter values. Recall that the HHI is defined as the sum of the squares of the market share of each firm, and that the index is increasing as the market becomes more concentrated and is equal to one in a monopoly.[11] In the following exercise, we vary parameter values and observe how both the level of market concentration (i.e., the HHI index) and the level of discrimination (i.e., the market share of discriminatory firms) change. The question of interest is whether a positive correlation exists between market concentration and discrimination. That is, do industry conditions which lead to a more concentrated market also result in more discrimination (i.e., a larger market share for discriminating firms)? The calculation of discriminatory market share was discussed in detail in section 3. Calculating shares using equations (3) and (11) yields an expression for HHI as a function of the number of firms:[12]

$$HHI = \frac{n_N + n_D \phi^{-2\sigma}}{(n_N + n_D \phi^{-\sigma})^2} \tag{23}$$

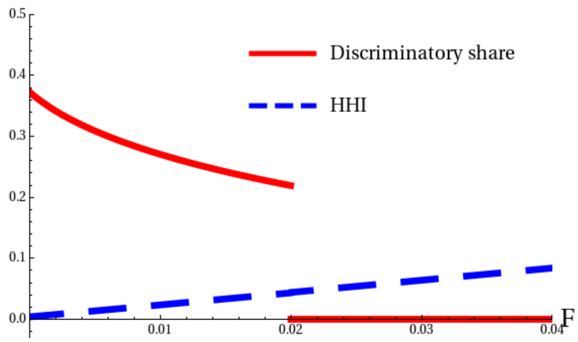
Figure 3 displays three graphs, each plotting both the long-run fraction of discriminatory firms and market concentration. More specifically, figure 3 returns to the numerical example of figure 2, and numerically solves for HHI and discriminatory market share for given parameter values, and then varies parameters F (per-period fixed costs), F_0 (sunk entry costs), and σ (degree of product substitutability) individually.[13]

Figure 3a varies F, the fixed cost of production firms pay each period. Not surprisingly, the level of market concentration (HHI) increases in F. With high fixed costs, fewer firms enter, unable to recoup their startup costs with future profits, and more firms exit as their profits are eroded by the entry of lower-cost competitors. Both effects result in a high level of market concentration in high fixed-cost industries. However, note that high fixed costs also reduce the level of discrimination in the market as, in industries with high fixed costs, the discriminatory firms with higher marginal costs and thus lower scale are less likely to survive in the long-run. Indeed, assuming standard Dixit-Stiglitz preferences, within an industry characterized by some degree of product differentiability and no fixed costs, there would not exist any mechanism by which discriminatory firms would be forced to exit the market since they could always cover their variable costs. As a result, in contrast to the commonly assumed positive correlation between market concentration and discrimination, the relationship can actually be negative, as seen in Figure 3a: high fixed costs increase the degree of market concentration while simultaneously discouraging discrimination by encouraging the exit of (high-cost, low-scale) discriminatory firms.

[11] Due to data limitations, many of the previous empirical papers calculate 4-firm concentration ratios as an alternative to the HHI. However, HHI is regarded as a superior measure of market concentration, and is straightforward to calculate within our theoretical framework. In addition, the intuition behind our results extends naturally to alternative measures of industry concentration.

[12] See the online appendix, at www.jasandford.com/discriminationappendix.pdf, for a full derivation of equation (23).

[13] In this exercise we do not display the effects of varying g (the growth rate of firms) and ϕ (the wage gap), since such changes had little appreciable impact on the level of market concentration.



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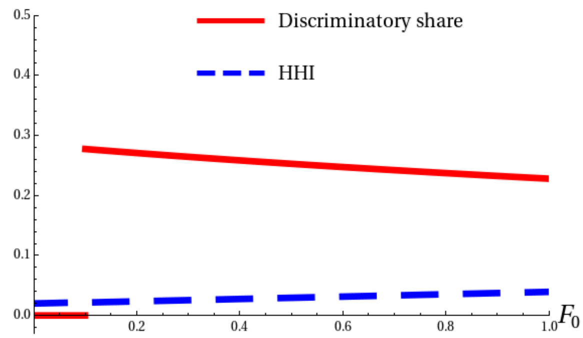

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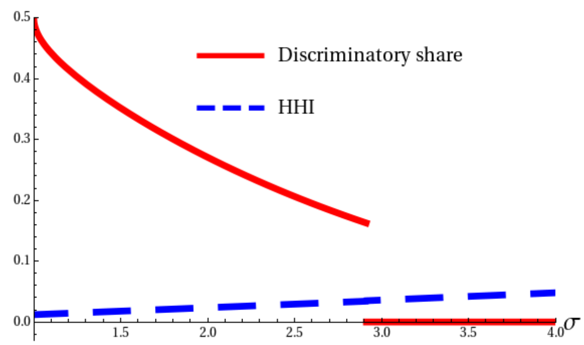


(c)

Figure 3: HHI and the market share of discriminatory firms for $\phi = 1.1$, $\sigma = 2$, $g_N = g_D = .5$, $r = .01$, $F = .01$, and $F_0 = .2$. HHI increases in F, F_0, and σ. The market share of discriminatory firms decreases in F and σ and is non-monotonic in F_0.

Figure 3b varies F_0, the startup costs new firms pay upon entering the market. As can be seen, an increase in sunk entry costs monotonically increases the degree of market concentration (HHI), since higher startup costs deter entry. However, as discussed in the previous section, entry costs have a decidedly non-monotonic effect on the level of discrimination within an industry. First, some degree of sunk entry cost is necessary for the long-run survival of discriminatory firms (otherwise, the continual entry of non-discriminators would drive them from the market). Thus, in this figure, one does observe the commonly assumed positive correlation between market concentration and discrimination, as industries with sufficiently low entry costs exhibit both low levels of discrimination and low levels of market concentration. However, as can be seen in figure 3b, this correlation can turn negative for sufficiently high entry costs. The intuition behind this result is similar to that for changes in F, the per-period fixed costs. Specifically, sufficiently high entry costs not only increase market concentration, but also reduce discrimination by deterring the entry of high-cost discriminating firms.[14]

The elasticity of substitution, σ, varies in figure 3c. As discussed previously, an increase in the elasticity of substitution reduces discrimination by making discriminatory firms more susceptible to competition from low-cost, low-price, non-discriminating competitors. However, within a standard monopolistically competitive industry, an increase in the elasticity of substitution also increases market concentration by increasing the relative importance of achieving economies of scale. Intuitively, when the elasticity of substitution among products is low (e.g., high-end micro brews), demand for variety among consumers allows a large number of firms to charge high prices and operate on a small scale; thus resulting in both low levels of market concentration and the long-run survival of discriminatory firms. In contrast, when consumers perceive the products as more substitutable (e.g., budget beers), firms compete more on price, resulting in a smaller number of firms utilizing greater economies of scale. This type of market structure tends to result in both higher levels of market concentration (due to the necessity of achieving economies of scale) and lower levels of discrimination (since discriminatory firms are less insulated against price competition). Thus, once again, one observes a negative correlation between market concentration and the degree of discrimination.

The results of this section point to an obvious problem with using a positive correlation between market concentration and discrimination as a test of the Becker link between discrimination and competition. As we have shown, in an model of market structure and discrimination, no robust positive correlation between the two variables exists. Indeed, in two of the three comparative statics exer-

[14] It should be noted that the ability of sunk entry costs to reduce discrimination relies heavily on a very literal interpretation of Becker's taste-based model of discrimination in which employers rationally forgo profits in order to indulge their preference for discrimination. Thus, in our dynamic model, employers rationally foresee that their discriminatory actions will result in lower per-period profits, and thus are deterred from entering high entry-cost industries as they perceive they will be unable to recoup their initial investment.

cises, the correlation between market concentration and discriminatory firms' long-run market share is negative and in the third case, it is negative over a portion of the parameter space. This fact might explain the conflicting results that the large empirical literature has produced in investigating the link between market structure and discrimination, and suggests that measures of fixed cost, entry costs, and elasticity of substitution would be appropriate control variables in future empirical work.

Finally, a subset of the literature looks at within-industry evolution of concentration and discrimination over time (see for example Black and Strahan (2001), Black and Brainerd (2004), and Gersen (2007)). Looking at the same industry across time, our model again predicts an ambiguous relationship between market concentration and the degree of discrimination. On average, markets in our model deconcentrate over time, as they move from an initial stage with a limited number of participants to maturity with many participants. Since discriminatory market share is weakly decreasing in time, the average within-market relationship between concentration and discrimination is a positive one: as markets become less concentrated over time, they also become less discriminatory.

However, we show that the Becker case, in which discriminatory firms are driven from the market, generates both a positive and a negative relationship between concentration and discrimination, depending on the maturity of the market. In particular, recall that if $\frac{rF_0}{\phi^{\sigma-1}-1} \leq F$ there exists an interval $[t_2, t_3]$ in which discriminatory firms exit while non-discriminatory firms continue to enter. We show that in the interval $[t_2, t_3]$, HHI may be increasing, even as all discriminatory firms exit the market. Although discriminatory firms with smaller shares exit (increasing HHI), the overall number of firms decreases (decreasing HHI). Under the example used in figure (1), the former effect dominates, meaning that HHI increases while discriminatory firms are exiting the market. For $t \in [t_1, t_2]$, the market share of discriminatory firms is decreasing (as non-discriminatory firms continue to enter while the number of active discriminatory firms is constant), while concentration is decreasing. For $t < t_1$ and $t > t_3$, the discriminatory market share is constant, while concentration is weakly decreasing. Figure 4 demonstrates.[15] Here, on the left axis, we reproduce the fraction of discriminatory firms over time from figure 1. On the right axis, we plot HHI over time. HHI is generally decreasing, but increases between t_2 and t_3. There is thus no clear theoretical relationship between concentration and discrimination over time within an industry, and so an ambiguous or negative empirical relationship between concentration discrimination is fully consistent with a Beckerian view of discrimination.

[15]From (23), HHI is defined piecewise over five intervals. For $t < t_4$, $n_N = gt$, while for $t \geq t_4$, $n_N = \frac{1}{\sigma[F+rF_0]}$. In $[0, t_1]$, $n_D = gt$, and so $HHI = \frac{1+\phi^{-2\sigma}}{gt(1+\phi^{-2\sigma})}$. In $[t_1, t_2]$, $n_D = gt_1$, so $HHI = \frac{t+t_1\phi^{-2\sigma}}{g(t+t_1\phi^{-\sigma})^2}$. In $[t_2, t_3]$, $n_D = gt_1\frac{t_3-t}{t_3-t_2}$, and $HHI = \frac{t+t_1\phi^{-2\sigma}\frac{t_3-t}{t_3-t_2}}{g(t+t_1\phi^{-2\sigma}\frac{t_3-t}{t_3-t_2})}$. In $[t_3, t_4]$, $n_D = 0$, and so $HHI = \frac{1}{gt}$. Finally, for $t > t_4$, $HHI = \sigma(F + rF_0)$.

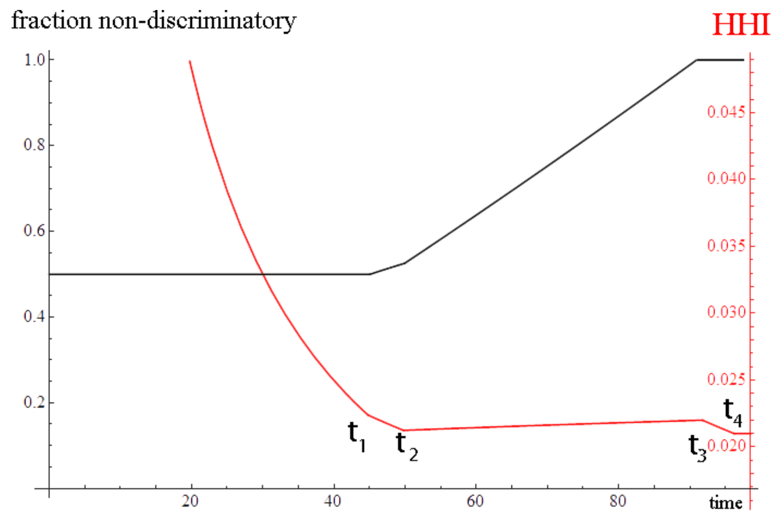


Figure 4: Repeating the example of figure 1, with $\phi = 1.1$, $\sigma = 2$, $g_N = g_D = .5$, $r = .01$, $F = .01$, and $F_0 = .05$, we have the fraction of non-discriminatory firms (left axis) and the HHI (right axis) over time as the market moves towards a long-run equilibrium with no discriminatory firms. The relationship between HHI and the discriminatory share is ambiguous; positive between t_1 and t_2 and negative between t_2 and t_3, when discriminatory firms are exiting.

5 Market Liberalization and Discrimination

The lack of a link between market concentration and levels of discrimination raises an additional question about another common approach in the empirical discrimination literature. Specifically, it is common in the literature to hypothesize that an increase in market liberalization will reduce discrimination, and that the effects of such liberalization will be more pronounced in more concentrated markets. A good illustration of this approach can be found in Black and Brainerd (2004) which investigates whether trade liberalization across industries succeeds in reducing the degree of gender discrimination. They divide their sample into more and less concentrated industries under the explicit assumption that concentrated industries face less competitive pressure, and thus an increase in competition from foreign trade should result in a greater reduction in the gender wage gap in such industries. Thus, they use unconcentrated industries (as measured by low four-firm concentration ratios) as a control group for evaluating the effects of competitive pressures on the gender wage gap.[16] Other papers that have utilized this approach include Berik et al. (2004) and Ederington et al. (2010). However if, as suggested in the previous section, there is no consistent relationship between market concentration and the level of discrimination, should researchers expect to observe more pronounced

[16]They borrow this technique from Borjas and Ramey (1995).

effects on market liberalization in more concentrated markets and should such results be interpreted as consistent with a Becker-type link between competition and discrimination?

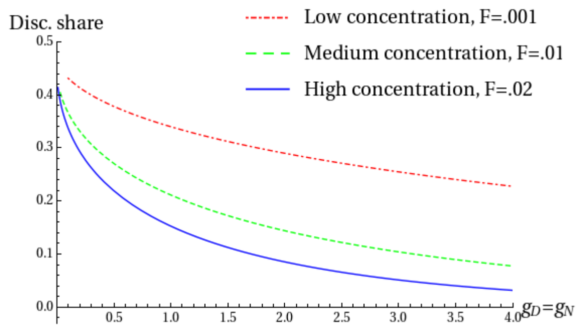
To investigate this question, we now consider how the market share of discriminatory firms changes as a result of market liberalization, and whether this change is largest for concentrated or unconcentrated industries. In this section we model market liberalization as an exogenous increase in the growth rate of potential entrants (i.e., $g_D = g_N$ increases). Intuitively, we are modeling market deregulation as allowing more potential firms/entrepreneurs to enter the market.[17] We know from figure 2d that this liberalization will cause the long-run discriminatory market share to decrease. The question of interest is whether this decrease in the degree of discrimination is more pronounced in the the most concentrated industries.

Returning to the numerical examples of figures 2 and 3, we perform a series of comparative statics exercises, summarized in figure 5. Each of three graphs shows the rate at which discriminatory market share decreases as the growth rate of new firms increases. We consider three different proxies for market concentration, fixed costs F, startup costs F_0, and elasticity of substitution σ. Recall from section 4, that market concentration is increasing in all three parameters. In each graph, the rate of decrease is largest for the most concentrated industries, and smallest for the least concentrated industries. For example, an increase in the growth rate of new firms from .5 firms/period to 4 firms/period will lower the discriminatory market share from about 20% to almost 0 in a concentrated industry ($\sigma = 2.9$), but will only decrease long-run discriminatory market share from about 48% to about 45% in an unconcentrated industry ($\sigma = 1.01$).

Why is this the case? Consider figure 5c first. Here, the low σ industry is unconcentrated precisely because firms are not competitive with one another and firms therefore price well above marginal cost, encouraging prodigious entry. In such an environment, increasing the arrival rate of new firms does not drive out many discriminatory firms because firms' products are not very substitutable, and so the discriminatory firms are not hurt by the new entrants. Now consider figure 5a. Again, it is unconcentrated (low-fixed-cost) industries for which a policy change (increasing the arrival rate of new firms) has the smallest effect. In this case it is because when fixed costs are low, it is very difficult to drive out discriminatory firms, who remain as long as they can cover their fixed costs. With relatively little exit, the discriminatory firms that enter in the nascent stages of the industry are more likely to remain indefinitely.

Thus, while the previous section found little consistency in the direct link between market concen-

[17] Alternatively, we could model market liberalization as a reduction in the sunk costs of entering the market. However, many episodes of market liberalization (such as trade liberalization) are more closely modeled as an exogenous increase in the number of firms. In addition, the non-monotonic effects of a reduction in sunk costs on discrimination make such a policy experiment more difficult to interpret (i.e., an increase in the number of potential entrants as a cleaner exercise).



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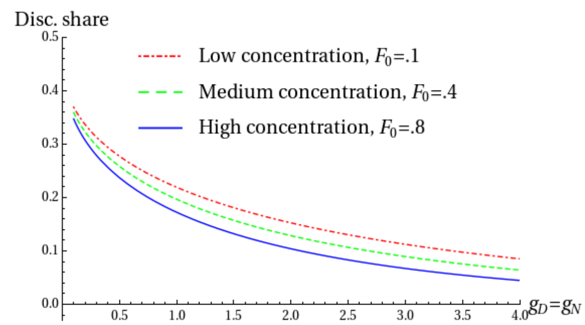

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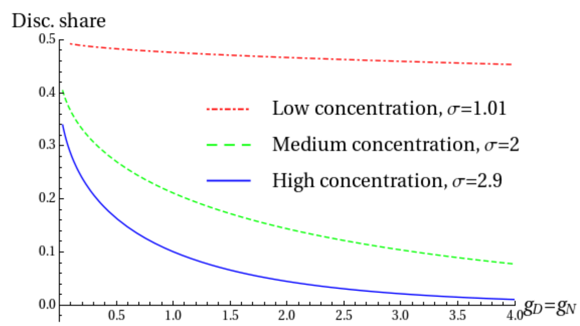

(c)

Figure 5: The market share of discriminatory firms decreases as the policy variable $g_D = g_N$ increases, and the rate of decrease is greater for more concentrated industries. In each figure, $\phi = 1.1$, $\sigma = 2$, $r = .01$, $F = .01$, and $F_0 = .2$ unless otherwise noted.

tration and discrimination, this section does find consistency in an indirect link. Specifically, we show that that market liberalization has a more pronounced impact on discrimination in more concentrated markets, and that such a link is robust across a broad range of comparative static exercises.

6 Extensions

For purposes of both clarity and tractability, the model makes various simplifying assumptions which allow for explicit calculations of the industry dynamics. In this section, we consider various extensions and how they would both affect the dynamics and impact the probability of the long-run survival of discriminatory firms. First, if we allow the wage differential to depend on the number of active discriminatory and non-discriminatory firms (as may be the case if the industry under study is large in relation to the economy as a whole), how do industry dynamics change and what is the analogue of condition (15), under which all discriminatory firms exit in the long run? Second, we consider the issue of endogenous entry costs. If firms of either type are allowed to lower their marginal cost of production by paying a higher entry cost, would this make the survival of discriminatory firms more or less likely? Surprisingly, we show that discriminatory firms are more likely to survive, despite non-discriminatory firms seemingly having a greater incentive to trade a higher entry cost for a lower marginal cost. Finally, we consider the case of capital transfer in which discriminatory firms could be bought-out by non-discriminatory owners.

6.1 Endogenous Wage Differential

In order to allow for an explicit calculation of the industry dynamics this paper assumed an exogenous male-female wage differential (ϕ) and thus an exogenous cost differential across firms. The justification for this assumption was that we were analyzing a "small" industry which took wages as given and determined by the rest of the economy (i.e., the numeraire sector). However it seems possible, either in large industries or in cases where wages are determined at the industry level, that the wage differential could be an endogenous function of the industry dynamics discussed in the previous section. Thus, in this section we consider the case where the male-female wage differential is a function of the share of discriminatory firms in the industry.[18] Specifically, we assume that $\phi(\frac{n_d}{n_n+n_d})$ where $\phi'() > 0$ and $\phi(0) = \overline{\phi}$.

[18] In this section, we do not endogenously determine ϕ; instead, we note that ϕ is likely to be increasing in any plausible model. A model fully endogenizing ϕ, perhaps within a search model in which employers have a taste for hiring men such as Black (1995), would be an interesting area for future research.

As in section 2.4, we can calculate the condition in which no discriminatory firms survive in the long-run equilibrium. As before, this requires that period profits for discriminatory firms are negative in the long-run equilibrium (13) and that non-discriminatory firms enter until the present discounted profits are zero (14). Substituting (14) into (13), all discriminatory firms exit in the long run if and only if the following holds:

$$\frac{rF_0}{\overline{\phi}^{\sigma-1} - 1} \leq F \tag{24}$$

Note that this is the same condition as (15) with the exception that the exogenous wage differential, ϕ, has been replaced by the lower bound on the wage differential, $\overline{\phi}$ (i.e., the wage differential that holds in the absence of discriminatory firms. Note that this is an important distinction as, if the wage differential entirely arises from discriminatory behavior within the industry then it is reasonable to assume that $\overline{\phi} = 1$ (no wage differential in the absence of discriminatory firms). However, if this is the case then it is direct to see that the necessary condition for the long-run elimination of discriminatory firms cannot be satisfied. Thus, assuming an endogenous wage differential that declines as discriminatory firms exit the industry sharply decreases the probability that discriminatory firms will be eliminated in the long-run (although it also reduces the costs of such discrimination). While the explicit calculation of industry dynamics is complicated (and relies heavily on function form assumptions about ϕ) the main dynamic is that the entry of non-discriminatory firms now has two opposing effects: on the one hand directly reducing discriminatory firm market share and profits and, on the other hand, reducing the wage gap/cost differential and thus indirectly increasing discriminatory firm profits. However, in the absence of a lower bound to the wage gap, one can unambiguously derive that the entry of non-discriminatory firms will eventually reduce the wage gap to a point at which discriminatory firms stop exiting (thus ensuring the survival of discriminatory firms in the long-run equilibrium).

6.2 Endogenous costs

Our model's results are driven by exogenous differences in the marginal cost of production between discriminatory and non-discriminatory firms, with the former hiring only men by preference, and thus having higher costs. A natural extension, much studied in the literature,[19] is to allow firms to incur higher entry costs in exchange for a lower marginal cost of production. For example, a man-

[19] See especially Sutton (1991), who points out that allowing firms to vertically differentiate themselves by paying a higher initial cost yields a flat relationship between market size and market concentration, as firms increasingly compete on quality. Ellickson (2007) applies Sutton's model to the supermarket industry, finding that markets of wildly varying sizes all tend to have between four and six competitors, with supermarkets in larger markets offering greater product variety. Berry and Waldfogel (2010) argue that newspaper quality, produced via upfront fixed costs, is increasing in market size.

ufacturer could build a larger, more expensive plant that can produce more efficiently then a smaller plant, or a company could hire a more experienced and sought-after CEO in the hopes of future cost reductions.

Since non-discriminatory firms earn higher profits than discriminatory firms, non-discriminatory firms are more willing to trade off a higher entry cost for a lower marginal cost. Our first result demonstrates that in any period in which a discriminatory entrant chooses higher entry costs, all non-discriminatory entrants in that same period also choose higher entry costs.

The greater willingness of non-discriminatory firms to invest in a higher entry cost would seem to further disadvantage discriminatory firms and make long-run discrimination less likely. Our second result shows that, surprisingly, allowing firms to endogenously choose the form of the cost function makes the long-run survival of discriminatory firms more likely. The reason is that in our model of gradual entry, endogenous costs guarantee the existence of some low marginal cost discriminatory firms while at the same time increasing the barrier to entry by forcing new entrants to choose between either a higher entry cost or having to compete with lower cost rivals.

Suppose that each entrant chooses between two possible entry costs, F_0 (as in the baseline model) and αF_0, with $\alpha > 1$. If a firm chooses to pay F_0, its marginal cost remains c_N or c_D, depending on whether it is a discriminatory or non-discriminatory firm. However, if it chooses the higher entry cost αF_0, its marginal cost is βc_N or βc_D, with $\beta \in (\frac{c_N}{c_D}, 1)$ representing the ongoing cost savings from incurring a higher startup cost.[20]

Hereafter, we refer to firms with a low entry cost and high marginal cost as Type I firms, and firms who pay the higher entry cost to get the lower marginal cost as Type II firms. When choosing whether to become a Type I or Type II firm, an entrant weighs the higher entry cost of Type II entry against profits that, from (12), are higher by a factor of $\frac{1}{\beta^{\sigma-1}}$ in every period after entry.

Proposition 5 demonstrates that in any period in which a discriminatory firm chooses Type II entry, all non-discriminatory entrants will also choose Type II entry. In this sense, non-discriminatory firms have a greater incentive to become Type II firms, and are thus more likely than discriminatory firms to be Type II.

While much of this literature is concerned with allowing firms to improve quality in exchange for a higher sunk cost, for simplicity we consider the closely related possibility of firms being able to lower costs in exchange for a higher startup cost. Ellickson (2013) argues that these two types of models are theoretically equivalent.

[20]It is without loss of generality to assume that $\alpha > 1$. Were α below 1, an entrant would choose whether to pay a lower entry cost in exchange for a higher marginal cost of production. For any $\alpha' < 1$, $\beta' \in (1, \frac{c_D}{c_N})$, and cost parameters F_0' and c_i', $i \in \{N, D\}$, letting $F_0 = \frac{1}{\alpha'} F_0'$, $c_i = \frac{1}{\beta'} c_i'$, $\alpha = \frac{1}{\alpha'}$ and $\beta = \frac{1}{\beta'}$ produces the case described in the text.

The assumption that $\beta \in (\frac{c_N}{c_D}, 1)$ ensures that non-discriminatory firms have higher profits than discriminatory firms, and is used in the proof of proposition 5, but is unnecessary for the proof of proposition 6.

Proposition 5. *In any time period, discriminatory entrants prefer Type II entry only if all non-discriminatory entrants also prefer Type II entry.*

Proof Recall that a Type II firm's variable profit is equal to $\frac{1}{\beta^{\sigma-1}}$ times that of a Type I firm. Assume a non-discriminatory firm and a discriminatory firm enter in the same period. The former becomes a Type II firm if and only if:

$$\int_0^\infty e^{-rt}(\beta^{1-\sigma}\pi_N(t) - F)dt - \alpha F_0 > \int_0^\infty e^{-rt}(\pi_N(t) - F)dt - F_0$$
$$\iff \int_0^\infty e^{-rt}(\beta^{1-\sigma} - 1)\pi_N(t)dt > (\alpha - 1)F_0 \tag{25}$$

Suppose that a contemporaneous Type I discriminatory entrant will exit T time periods in the future, while a Type II discriminatory entrant will remain in the market for $T' \geq T$ periods. Then, the discriminatory firm will choose Type II entry if and only if:

$$\int_0^{T'} e^{-rt}(\beta^{1-\sigma}\pi_D(t) - F)dt - \alpha F_0 > \int_0^{T} e^{-rt}(\pi_D(t) - F)dt - F_0$$
$$\iff \int_0^{T} e^{-rt}(\beta^{1-\sigma} - 1)\pi_D(t)dt + \int_T^{T'} e^{-rt}(\beta^{1-\sigma}\pi_D(t) - F)dt > (\alpha - 1)F_0 \tag{26}$$

We demonstrate that inequality (26) implies inequality (25). First, suppose $T = T' = \infty$; here, since $\pi_N(t) > \pi_D(t)$, the claim holds. Next, suppose $T = T' < \infty$. Here, again, (26) implies (25) because $\pi_N(t) > \pi_D(t)$. Finally, suppose $T < T'$. Then, that a discriminatory firm prefers to exit after period T implies $\pi_D(t) < F$ for $t > T$, and thus:

$$\int_0^{T} e^{-rt}(\beta^{1-\sigma} - 1)\pi_D(t)dt + \int_T^{T'} e^{-rt}(\beta^{1-\sigma}\pi_D(t) - F)dt < \int_0^{T'} e^{-rt}(\beta^{1-\sigma} - 1)\pi_D(t)dt$$
$$< \int_0^{\infty} e^{-rt}(\beta^{1-\sigma} - 1)\pi_N(t)dt$$

Conclude that, in any period, non-discriminatory entrants have a greater incentive to become Type II firms than discriminatory entrants. ■

Thus, the presence of endogenous cost functions will lead to some industry sorting with many non-discriminatory firms choosing to be Type II and discriminatory firms choosing to be Type I resulting in an increase in the profit disadvantage for many discriminatory firms. However, does this imply that the presence of endogenous costs reduces the probability of the long-run survival of discriminatory firms? As we show below, the answer is surprisingly no.

First, note that one aspect of our model is that the early entrants are facing an "empty" market and thus making higher profits than later entrants. Indeed, it is possible to show that profits for period t

entrants grow unboundedly as t approaches zero (see footnote 8). It follows that both discriminatory and non-discriminatory entrants who arrive sufficiently early will enter as Type II firms.[21] This implies that, should all discriminatory firms exit in the long run, the last discriminatory firm to exit must be Type II (since the Type I firms will be the first to exit). Therefore, endogenous costs not only ensure the existence of at least some Type II discriminatory firms, they also make entry less attractive for non-discriminatory firms, as these firms must either compete with lower-cost rivals (if Type I) or incur a higher entry cost (if Type II). Indeed, Proposition 6 demonstrates that endogenous cost functions make it more likely that discriminatory firms will survive in the model's long-run equilibrium, in the sense of relaxing condition (15).

Proposition 6. *Endogenous entry costs make the long-run elimination of discriminatory firms less likely, meaning that condition (15) is less likely to hold.*

Proof Under exogenous entry costs, the marginal discriminatory firm (i.e., the last surviving discriminatory firm) prefers to exit if its long-run variable profits are less than its fixed costs, or, from (13), if $\pi_D(\overline{n}_N, 0) = \frac{c_D^{1-\sigma}}{\sigma \overline{n}_N c_N^{1-\sigma}} < F$. This proof proceeds by showing that the marginal discriminatory firm's profit is greater than $\pi_D(\overline{n}_N, 0)$ under endogenous entry costs.

Note first that the unbounded nature of profits in the initial periods implies the existence of both Type II discriminatory and non-discriminatory entrants. Thus, the marginal discriminatory firm is a Type II firm, since any active Type I discriminatory firms will have higher marginal cost, and will thus exit before any Type II discriminatory firms exit. Note that the long-run equilibrium involves $\overline{n}_I \geq 0$ type I non-discriminatory firms and $\overline{n}_{II} > 0$ type II non-discriminatory firms. Then, the marginal discriminatory firm's profit is given by:

$$\pi_D(\overline{n}_I, \overline{n}_{II}; 0) = \frac{(\beta c_D)^{1-\sigma}}{\sigma[\overline{n}_I c_N^{1-\sigma} + \overline{n}_{II}(\beta c_N)^{1-\sigma}]} \tag{27}$$

Non-discriminatory firms enter until the present discounted value of profits are zero:

$$\max\left\{\frac{(\beta c_i)^{1-\sigma}}{\sigma[c_N^{1-\sigma}\overline{n}_I + (\beta c_N)^{1-\sigma}\overline{n}_{II}]} - r\alpha F_0 - F, \frac{c_i^{1-\sigma}}{\sigma[c_N^{1-\sigma}\overline{n}_I + (\beta c_N)^{1-\sigma}\overline{n}_{II}]} - rF_0 - F\right\} = 0 \tag{28}$$

In the case where this last entrant is a Type II firm, it must be that $\overline{n}_I = 0$.[22] Then, (28) implies:

$$\overline{n}_{II} = \frac{1}{\sigma[F + \alpha r F_0]}$$

[21] As explained in footnote 8, unbounded profits for early entrants is a feature of Dixit-Stiglitz style models with continuous time and atomistic firms. Our results in this section depend on the entry of at least some Type II discriminatory firms, but in a model with discrete time and discrete firms, it is possible that no such entry will occur. Guaranteeing entry of at least some Type II discriminatory firms in such a model would require assuming a low rate of arrival of new firms $g_N = g_D$, a low value of entry costs F_0, and a low fixed cost F.

[22] Since the profits of a time t entrant decline monotonically in t, and since on the equilibrium path the lifetime variable

In the case where this last entrant is a Type I firm, (28) implies:

$$\overline{n}_I + \frac{\overline{n}_{II}}{\beta^{\sigma-1}} = \frac{1}{\sigma[F + rF_0]}$$

Note that, in either case $\overline{n}_I + \overline{n}_{II} < \overline{n}_N = \frac{1}{\sigma[F+rF_0]}$. Allowing for endogenous entry costs reduces the total number of firms in the long-run equilibrium as the later entrants face competition from low-cost early entrants. We apply this fact to condition (27):

$$\begin{aligned}\pi_D(\overline{n}_{II}, \overline{n}_I; 0) &> \frac{(\beta c_D)^{1-\sigma}}{\sigma[\overline{n}_I(\beta c_N)^{1-\sigma} + \overline{n}_{II}(\beta c_N)^{1-\sigma}]} \\ &= \frac{c_D^{1-\sigma}}{\sigma[(\overline{n}_I + \overline{n}_{II})c_N^{1-\sigma}]} \\ &> \frac{c_D^{1-\sigma}}{\sigma \overline{n}_N c_N^{1-\sigma}} = \pi_D(\overline{n}_N, 0)\end{aligned} \tag{29}$$

Therefore, as the marginal discriminatory firm is making higher per-period profits and is thus less likely to exit, we conclude that the survival of discriminatory firms in the long run is more likely under endogenous entry costs. ■

As proposition 6 does not depend on the value of α or β, the result is robust to any specification of the model. Despite the fact that non-discriminatory firms earn a higher profit than discriminatory firms in any time period, regardless of type, and so would seem to have more to gain from the linear increase in profits resulting from becoming a Type II firm, endogenous entry costs make discrimination more likely to survive in long-run equilibrium.

6.3 Capital Transfer and Discrimination

As mentioned in Hellerstein et al. (2002), the degree of capital transfer in an industry is another important factor in whether competition can eliminate discriminatory firms within that industry. This idea goes back to Becker (1957) and Alchian and Kessel (1962) which provides some discussion on how competition in the capital market could act as a substitute for competition in the product market even in the case where firms are monopolists. Specifically, Becker (1957) argues that, provided firm ownership is transferable, a monopolistic enterprise that is engaging in discriminatory behavior would be willing to sell the firm to non-discriminatory owners since they would receive higher net income than if they operated it themselves. Thus, in the presence of capital market competition (i.e.,

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profits of a Type II non-discriminatory entrant divided by the lifetime variable profits of a Type I non-discriminatory entrant is $\beta^{1-\sigma} > 1$, there exists a time period $\tilde{t}$ such that non-discriminatory entrants are Type II iff $t < \tilde{t}$. However, the market may reach long-run equilibrium before time period $\tilde{t}$, in which case all non-discriminatory firms will be Type II.

transferable assets) even the absence of product market competition does not imply that discriminatory behavior could persist. In the following section, we consider the case of transferable capital where, in addition to choosing whether or not to enter the market by producing a new variety, potential entrants also have the option of purchasing an existing firm from its owner.

Fortunately, it turns out that formalizing the concept of capital transferability is fairly straightforward in our model. For any potential entrant, assume the cost of acquiring an existing firm is $\xi + F_0'$, where ξ is the negotiated purchase price of the firm, and $F_0' < F_0$ are the (one-time) fixed costs of acquisition/entry. Note that these costs include both the frictional costs to technology/capital transfer (e.g., costs of learning about the market or purchased firm's systems, costs of any needed modifications, etc...) as well as the sunk costs to the acquisition process itself (e.g., contract costs, fees, etc...). In this case we can refer to the *degree of capital transferability* within an industry (denoted by η) as the portion of start-up costs that can be avoided by simply purchasing an existing firm:

$$\eta = (F_0 - F_0')/F_0$$

Note that if $\eta = 1$ capital is perfectly transferable and a potential entrant who purchases an existing firm incurs no start-up costs to entering the market while if $\eta = 0$ capital is non-transferable in the sense that the firm does not receive any benefits from purchasing an existing firm. This section develops a condition on η under which the equilibria discussed above persist and discriminatory firms remain active in the long run.

Thus, consider the case where, in lieu of investing F_0 to introduce a new firm/variety, potential entrants could invest F_0' and purchase an existing firm/variety for ξ. First, it is clear both that a non-discriminatory firm would never sell to a new entrant and that a discriminatory entrant would never purchase an existing firm, as either type of transaction would generate a joint surplus of at most $-F_0' < 0$. Next, for a discriminatory incumbent to be willing to sell to a non-discriminatory entrant, it must be that $\xi \geq \int_0^\infty e^{-rt}(\pi_D(t) - F)dt$, that is, the purchase price of such a firm must be at least the present discounted value of future profits. Finally, it must be that $\xi \leq \min\{F_0 - F_0', \int_0^\infty e^{-rt}(\pi_N(t) - F)dt - F_0'\}$ if a non-discriminatory firm is willing to purchase an incumbent discriminatory firm. The first inequality states that the potential entrant is better off purchasing an existing firm (and investing F_0') than starting their own firm (and investing F_0). The second inequality states that the purchase is profitable (i.e., the purchase price is less than the net income that would be generated by owning the firm).

The set $[\int_0^\infty e^{-rt}(\pi_D(t) - F)dt, \min\{F_0 - F_0', \int_0^\infty e^{-rt}(\pi_N(t) - F)dt - F_0'\}]$ is empty if F_0' is sufficiently large, meaning there is no price ξ that would leave both a seller of an incumbent firm and its purchaser better off. Specifically, if $F_0' > F_0 - \int_0^\infty e^{-rt}(\pi_D(t) - F)dt$ at time t, there does not exist a mutually profitable transaction between an entrant and an incumbent. Since incumbent profits converge to a long-run value of $\overline{\pi}_D - F$ given by (12) and (21), a sufficient condition for no trade to take place between entering and incumbent firms in the long-run equilibrium is:

$$\eta < \frac{1}{\phi^{\sigma-1}} - \frac{\phi^{\sigma-1} - 1}{\phi^{\sigma-1}} \frac{F}{rF_0} \tag{30}$$

Condition (30) says that, provided the degree of capital transferability is sufficiently low, then discriminatory firms will not be bought-out by potential non-discriminatory entrants in the long-run equilibrium. If capital is transferable, discriminatory firms survive in the long run if both (30) and (22) hold.

There are a couple of things to note about condition (30). First, it is direct to derive that condition (30) is never satisfied when $\eta = 1$. Thus, consistent with the arguments in Becker (1957), when capital is perfectly transferable discriminatory firms cannot survive in long-run equilibrium even when product market conditions are otherwise favorable (i.e., competition in the capital market can serve as a substitute for competition in the product market). Second, note that the degree of capital transferability necessary for the long-run elimination of discriminatory firms will vary across industries based on industry characteristics. However, it is direct to derive from condition (30) that the basic intuition behind the conditions where *product market competition* allows for long-run discrimination are similar to the conditions where *capital market competition* allows for long-run discrimination. Specifically, condition (30) is more likely to be satisfied (and thus the long-run survival of discriminatory firms is more likely) when (i) sunk start-up costs, F_0, are high, (ii) per-period fixed costs, F are low and (iii) product substitutability, σ is low. These conditions are identical to those derived in proposition 4. Thus, the market conditions under which discriminatory firms are likely to survive in the long-run equilibrium are consistent across both stories of product market and capital market competition.

7 Conclusion

This paper provides a formal framework in which to consider the standard Becker prediction that product market competition curtails the ability of firms to engage in discriminatory behavior. The benefits of such a formalization is that it allows us to clarify the market conditions conducive to the long-run survival of discriminatory behavior. Not surprisingly, market power — which has been the main point of emphasis of the previous literature — is central to our framework as well. Indeed, we show that some degree of market power (driven by product differentiation across firms in our model) is necessary for discriminatory firms to exist even in the short run. However, we also prove that the cost structure of an industry is of equal importance in explaining the survival of discriminating firms.

Specifically, we show that, even in industries characterized by low degrees of market power (i.e., low levels of product differentiation and thus low price-cost margins), the presence of high entry costs, low per-period entry costs and sequential entry can generate the long-run survival of discriminatory firms.

This approach also allows us to endogenize both the market structure of the industry as well as the degree of discrimination. Dating from the original work of Becker (1957) it has long been assumed that industries exhibiting high degrees of market concentration would also be more conducive to the survival of discriminatory behavior. Indeed, the link between measures of market concentration and discrimination remains one of the most tested in the literature on competition and discrimination. One of the more surprising results of our analysis was that the widely assumed positive correlation between market concentration and discrimination does not necessarily hold in theory. In fact, it is often precisely the elements of market structure that allow discriminatory firms to survive (i.e., high degrees of product differentiation and low fixed costs) which typically lead to less-concentrated industries (i.e., a large number of small firms). This ambiguous relationship between concentration and discrimination in theory may help explain the conflicting results in the empirical literature.

Indeed, this recognition that market demand conditions and industry cost structure is important for understanding the ability of discriminatory firms to survive has additional empirical applicability. Specifically, it suggests additional determinants of the degree of discrimination beyond conventional measures of market concentration. Indeed, if one looks at the recent literature on the effects of competition on firm/industry productivity, one sees that, instead of relying on market concentration ratios to proxy for product market competition, they typically use more exogenous shocks such as increases in foreign competition (see, Syverson (2011)). Such research on the link between global competition and discrimination has already started in the discrimination literature (see Black and Brainerd (2004) and Ederington et al. (2010)) and, as we discuss in Section 5 finds support in our theory. In addition the competition/productivity literature has occasionally used product substitutability (in addition to price-cost margins) as a proxy for market competition (e.g., see Aghion et al. (2000) and Syverson (2004b)), which fits our model as σ plays a large role in our dynamics. In the Dixit-Stiglitz framework product substitutability derives from consumers' perceptions about the characteristics of the good: the extent to which they perceive different varieties as substitutes in their consumption decisions (and they might be proxied for by measures of product differentiation). Similarly, spatial differentiation of firms may affect substitutability, and, in turn, market structure and discrimination. For example, some papers in the competition/productivity literature have exploited the high degree of geographic segmentation in concrete markets to derive how local market demand conditions (e.g., Syverson (2004a) and Collard-Wexler (2013)) can impact firm survival, suggesting there might also be geographic variation in discrimination generated by local demand conditions.

In addition, while the existing empirical literature has focused on the level of market power as the key determinant of the degree of discrimination within an industry, our dynamic model suggests that the conditions affecting the stability of industry structure are an equally valid predictor. Specifically, low barriers to entry (i.e., high arrival rate of potential entrants), low sunk costs of entry, high fixed costs, and a high degree of product substitutability result in an industry structure characterized by a high degree of industry turnover and mobility (i.e., large changes in the number of firms and output shares over time). In these industries, the ability of discriminatory firms to survive in the long run is seriously curtailed. In contrast, high barriers to entry and sunk costs, as well as low fixed costs and product substitutability, result in a more stable market structure in which discriminatory firms are more likely to survive. Thus, the main implication of our dynamic model is that the degree of market stability is an equally valid predictor as the level of market power in explaining the degree of discrimination within an industry. Economists have been investigating industry stability for a long-time (e.g., see Dunne et al. (1988)) and another potential empirical approach would be to look at the connection between measures of industry stability and discrimination.

Finally, it should be apparent that while our theoretical model explicitly considered the case of gender discrimination in hiring decisions, it can also be applied to the question of the long-run survival of any intrinsically-motivated firm that might deviate from pure profit-maximizing behavior. For example, our framework of firms choosing between equally productive workers in the presence of an exogenous wage gap would also be applicable to the situation of a firm making hiring decisions across workers with different reservation wages such as immigrants and native labor. It might also provide insights into the survival of ethically-motivated firms that might forego profit due to moral concerns. For example, there is a long-standing tradition of modeling non-profit firms as being (at least partly) motivated out of a sense of ethics or altruism (see, e.g., Chalkley and Malcomson (1998) and Jack (2005)). Our model can offer insights into the conditions under which altruistic firms would survive an environment in which they must compete with profit maximizing firms.

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