Employer Discrimination and Market Structure

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Abstract

We extend Gary Becker's theory, that competitive forces will drive discriminating employers from the market in the long run, to the case of monopolistically competitive industries characterized by sunk costs and sequential entry. We derive some predictions about the market characteristics that allow for the long-run existence of discriminating employers. We then test these predictions using a cross-sectional dataset on U.S. manufacturing industries.

1 Introduction

One of the central predictions of Becker's canonical model of discrimination is that employers with a taste for discrimination should not survive in the long run in a competitive market. The intuition behind this prediction is simply based on the fact that non-discriminating employers would out-perform discriminating employers because they are willing to hire the cheaper but equally productive workers. Thus, non-discriminating employers would expand while discriminating employers contracted until only non-discriminating employers would be left in the market.

However, Becker derived his predictions in a model that assumed perfect competition. In this paper we investigate the Becker prediction, that competitive forces will drive discriminating employers from the market in the long-run, in the context of a dynamic model of a monopolistically competitive industry. We verify that, under certain conditions, the Becker result holds in that competition (proxied for by the arrival of new potential entrants) will eventually drive all discriminating firms out of the market. However, we also show that under alternate conditions, an industry can exhibit the long-run survival of discriminating firms. This result is possible in industries which exhibit three characteristics. The first is the presence of imperfect product substitutability, which allows discriminating firms to make positive profits in equilibrum as it prevents the more efficient non-discriminating firms from stealing all the demand for their good by offering lower prices. The second is the presence of sunk costs of entry, which hinder the entry of new non-discriminating competitors. The third is the presence of sequential entry, which encourages discriminatory firms to enter the market, even in the knowledge that they will have a cost disadvantage, as it allows them profit opportunities before the market is filled.

In addition, our theoretical framework allows us to derive some novel predictions about the impact of different market characteristics on the degree of discrimination in the industry. As we show, one of the main predictors of the survival of discriminatory firms in an industry is the degree of product differentiation. Specifically, we show that, as the elasticity of substitution between products increases, the fraction of discriminatory firms active in the long run falls. Intuitively, this is due to the fact that an increase in product substitutability makes discriminatory firms more vulnerable to competitive pressures. We then test this prediction by ....

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 such firms 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 [1], 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 in our model that allows discriminatory firms to survive in the long-run equilibrium.

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:

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

where $y(z,t)$ represents consumption of brand z 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 $\sigma = 1/(1-\rho) > 1$:

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

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.

2.2 Firm Behavior - Discrimination

In this model, firms have four choices to make: whether to enter, their degree of discrimination, what price to charge, and whether (and when) to exit.

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

$$c = \int_0^1 w(t)dt \tag{4}$$

We assume that either a male employee can be hired to complete a task at cost w_m or a female employee can be hired at cost w_f where $w_m = \phi w_f$ where $\phi > 1$. Thus, we assume that male and female employees are equally productive in producing the differentiated product, but that there exists a wage differential in the economy).[1] Defining $z_i \in [0,1]$ as the fraction of females employed by firm i, the marginal cost of firm i is given by:

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

It should be clear that, given the existence of a wage differential, a cost-minimizing firm will choose to hire only women (i.e., set $z_i = 1$). However we assume firms maximize a utility function that encompasses both profits and a "taste for discrimination," which we capture by assuming that the firm owner/manager derives extra disutility from hiring female workers, defined by $\psi_i(z_i)$. Note that we assume the Arrow version of Becker's model, in which firms care only about the fraction of their workforce that is female (i.e., firms care about 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 the female share of its employees while the right hand side represents the marginal benefit (in lower costs of production). Firms will choose to employ men (i.e., $z_i < 1$) if and only if the marginal disutility of hiring women is sufficiently high (and outweighs the cost of the wage differential). Note that firms with the greatest "taste for discrimination" (i.e., with the highest values of $\psi_i'(z_i)$ for any z_i) will employ the lowest share of female workers (i.e., choose the lowest z_i). Thus, discriminatory firms will have higher marginal costs of production (i.e., higher c_i). For analytical simplicity, we consider two types of firms: discriminatory and non-discriminatory. Non-discriminatory firms are firms where $\psi_i(z_i) = 0$ (i.e., they have no taste for discrimination) and thus, given the wage differential, they 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 will hire only male workers (i.e., set $z_i = 0$). Given this set-up 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.

[1] This wage differential is simply taken as exogenous in the differentiated product sector. It can be generated either by discrimination or productivity differences in the numeraire product sector. For example, assuming each male employee can produce w_m units of the numeraire good and each female employee can produce w_f units of the numeraire good, production of the numeraire good in positive amounts would fix wages in the economy at w_m and w_f respectively.

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

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

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

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

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 are decreasing 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, has the potential to drive discriminating firms out of the market.

2.3 Entry

A key assumption in the paper is that there are not an unlimited number of potential entrants at the inception of the industry. Rather, the number of potential entrants is fixed in each period. Specifically, we assume 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 [2]). Upon arrival, firms must choose whether or not to enter the market. We assume firms can enter the differentiated goods sector by paying a sunk entry fee of F_o and also incur per-period fixed costs of F.

It should be clear that once in the market, a non-discriminatory firm will never exit. However, the arrival and entry of non-discriminatory firms can result in the exit of discriminatory firms, resulting in two distinct cases to consider: the "Becker Case" in which all discriminatory firms exit the market and the "non-Becker Case" 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 Becker prediction holds in that market forces drive discriminatory firms out of the market).

2.4 "Becker Case" - Exit of Discriminatory Firms

For the Becker case to hold, period profits for discriminatory firms must be negative in the long run, that is:

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

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), we then need the following for the Becker case to obtain:

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

Given that condition (15) holds the "Becker Case" holds and all discriminatory firms exit in the long run. In this case, industry evolution is first characterized by the arrival and entry of both discriminatory and non-discriminatory firms.[2] Since profits are monotonically decreasing with entry (and thus over time), we eventually achieve 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 results in continued entry of non-discriminatory firms, driving profits of discriminatory firms down lower until we eventually achieve a time period, labeled 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, at which the present discounted value of their profits is zero and the industry has achieved the long-run equilibrium number of firms, 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:

$$F = \pi_D(n_N = g_N t_3, n_D = 0)$$

$$\Rightarrow F = \frac{1}{\sigma[g_N t_3 \phi^{\sigma-1}]}$$

$$\Rightarrow t_3 = \frac{1}{\sigma[F g_N \phi^{\sigma-1}]} \tag{16}$$

Recall that the Becker prediction is that, "in the long-run" market forces will drive firms with a taste for discrimination out of the market. 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 calculate how many time periods such a process will take and thus derive some predictions about the determinants of the length of time discriminatory firms can survive in the market. This is done 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:*

i) per-period fixed costs, F,

ii) the arrival rate of non-discriminatory firms, g_N,

iii) the wage gap, ϕ.

iv) product substitutability, σ.

Proof Follows directly from comparative statics on t_3. ■

[2] 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 always do so profitably.

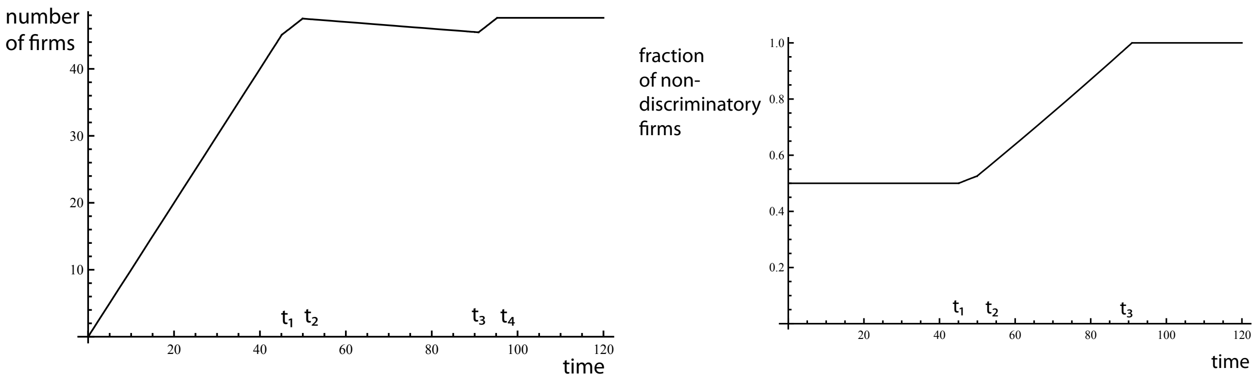

Figure 1: For $\phi = 1.1$, $\sigma = 2$, $g_N = g_D = .5$, $r = .01$, $F = .01$, $F_0 = .05$, the number of firms increases until t_2, when discriminatory firms begin to exit the market. The fraction of non-discriminatory firms increases until reaching 1 at t_3.

The economics behind the above proposition are fairly intuitive. Higher fixed costs, F, make it more difficult for discriminatory firms to earn positive profits (recall that their higher costs and thus prices force them to operate on a smaller scale than their non-discriminatory competitors). The faster arrival of competing non-discriminatory firms, g_N, obviously increases the exit rate of discriminating firms. Larger wage gaps, ϕ, places 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 stolen from the remaining discriminating firms and thus a faster rate of exit.

Finally, industry evolution in the "Becker Case" 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 will 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 will 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 are entering. From t_1 to t_2, only non-discriminatory types are entering. From t_2 to t_3, non-discriminatory types are still entering, while discriminatory types are exiting, at a rate faster than g_N. Between t_3 and t_4, non-discriminatory firms continue to enter, while all discriminatory firms have now left. After t_4, the market is stable, with 0 discriminatory firms and $\frac{1}{\sigma[F+rF_0]}$ non-discriminatory firms. Thus, Figure 1 is a graphical representation of the Becker prediction in which market forces drive discriminatory firms out of the market and result in a long-run equilibrium involving only non-discriminatory firms. However, is the above evolutionary pattern the only possibility? As we argue in the following section, another possibility is the long-run survival of discriminating firms.

3 "non-Becker Case"- Long Run Survival of Discriminatory Firms

In this section we consider the case in which discriminatory firms survive in the long-run. For the non-Becker case to obtain (discriminatory firms active in the long-run equilibrium) we need that discriminatory firms are making 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 the following lemma, if discriminatory firms are active in the long run, than those who enter the market at any time never exit.

Lemma 2. *If there exist discriminatory firms 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 four possibilities. One, $\hat{t}_1 > \hat{t}_N$. Two, $\hat{t}_1 \leq \hat{t}_N < \hat{t}_2$. Three, $\hat{t}_1 < \hat{t}_2 < \hat{t}_N$. Four, $\hat{t}_2 = \hat{t}_N$.

One is absurd, as once non-discriminatory firms stop entering, profits are constant, and so there would be no reason for discriminatory firms to exit. Two is impossible as non-discriminatory firms would only stop entering when $\pi_N = F + S$, yet as π_N increases as n_D decreases, it cannot be that $\hat{t}_N < \hat{t}_2$. Three 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 as non-discriminatory firms enter. Four is absurd since as a simple calculation shows that non-discriminatory profits are constant in $[\hat{t}_1, \hat{t}_2]$, and so it cannot be that non-discriminatory firms decide to exit at $\hat{t}_2$. ■

Since non-discriminatory firms never exit the market as well, industry evolution in the "non-Becker Case" 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 2, 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 iff:

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

Thus, the non-Becker and the Becker cases are uniquely determined by condition (22) (and, inversely, (15)). This allows us to derive the characteristics of markets in which discriminatory firms are likely to survive in the long-run:

Proposition 3. *The long-run survival of discriminatory firms is more likely in industries characterized by:*

i) high sunk start-up costs, F_o,

ii) low fixed costs, F.

iii) 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 greater ability to earn positive profits. In addition, higher sunk-costs of entry also 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 reduces entry by late-arriving non-discriminatory firms. Basically, early arriving discriminatory firms will be 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 there per-period profits are zero, thus completely driving the higher-cost discriminatory firms out of the market.

Finally, it is informative to look at how the long-run fraction of discriminatory firms varies in model parameters. While the system (19) and (20) does not admit a closed-form solution, we can numerically investigate the effect of parameter changes on the long-run fraction of discriminatory firms. Figure 2 plots the fraction of all firms active in the long run who are discriminatory. Inspection of Figure 2 reveals the characteristics of industries in which discriminatory firms are more likely to be active.

First, note from Figure 2a that the fraction 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 is decreasing in the wage gap. Once again, larger wage gaps place the discriminating firms at a greater competitive disadvantage.

Second, from Figure 2c, the fraction of discriminating firms is decreasing in the arrival rate of potential entrants. Note that this figure points to the importance of our assumption of limited, sequential entry. As you allow the number of potential entrants to go to infinity, the fraction of discriminating firms will diminish to zero (and the length of time they survive also diminishes 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 simply copies the product and strategy of an incumbent firm), than 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. In contrast, 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 being associated with lower rates of entry and thus a larger fraction of surviving discriminatory firms.

Third, from Figure 2d, the fraction of discriminating firms is non-monotonically related to the sunk-costs 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 fraction of discriminatory firms is actually decreasing in the sunk-costs of entry. This non-monotonicity is due to the fact that sunk costs must be sufficiently high to allow for the long-run survival of discriminating firms, however, as these fixed costs continue to increase, it will disproportionately choke off 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.

Finally, from Figure 2e, the fractions of discriminating firms is decreasing as product substitutability increases. This result is a function of the intuition discussed previously. When products substitutability is low, then 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 3) and more likely to represent a fraction of output (figure 2). Given these results, we should expect a greater degree of discriminating in low-substitutability industries. It is this empirical prediction that we test in the following section.

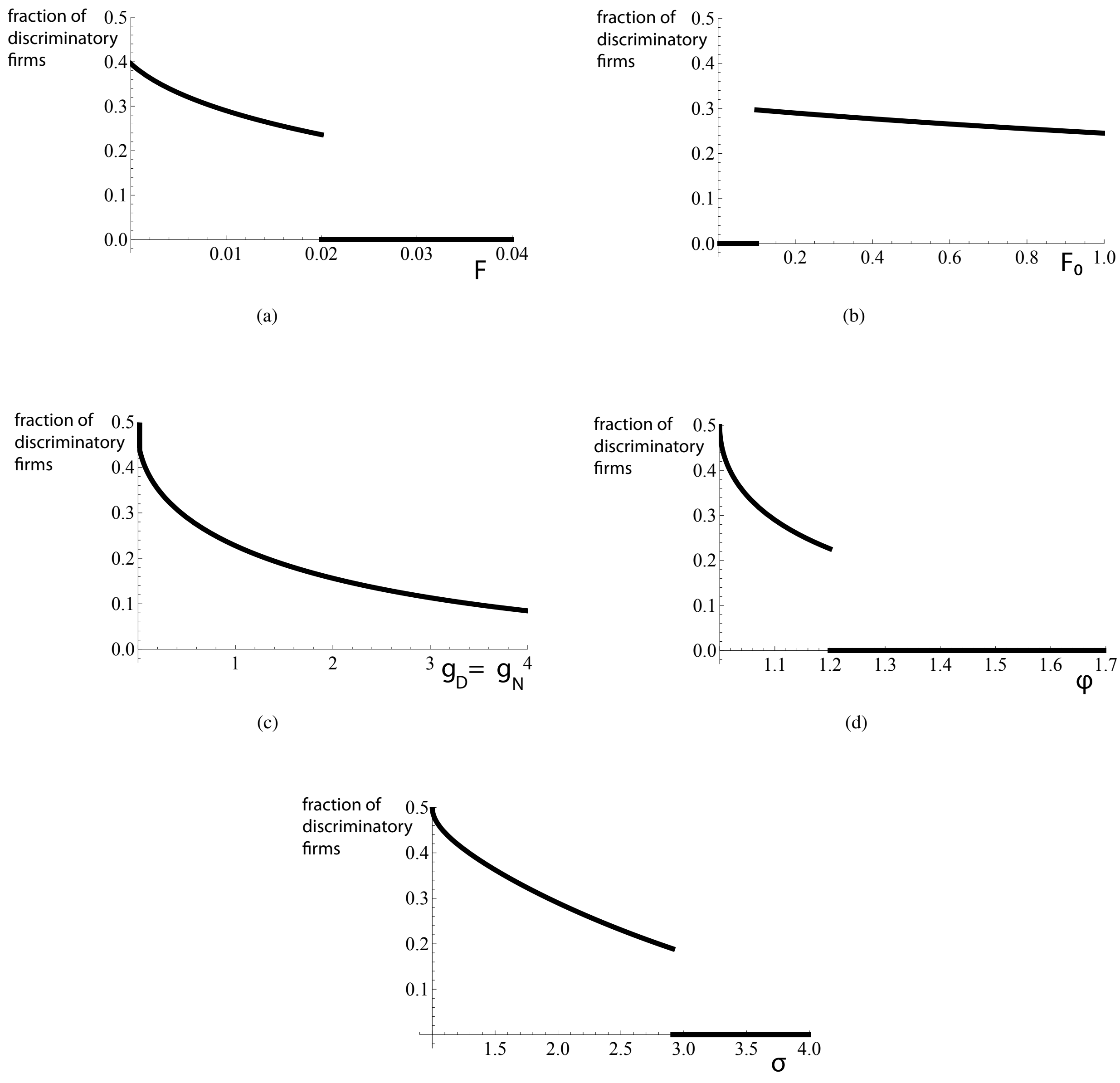

Figure 2: For $\phi = 1.1$, $\sigma = 2$, $g_N = g_D = .5$, $r = .01$, $F = .01$, and $F_0 = .2$, the fraction of discriminatory firms active in the long run is decreasing in F, g_N, g_D, ϕ, and σ, and non-monotonic in F_0. If F, ϕ, or σ are sufficiently large or if F_0 is sufficiently small, the Backer case obtains.

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