How Does Labor Market Discrimination Affect Capital Investment? The Effects of Fan Discrimination on Stadium Investment

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Abstract

We investigate the possibility that labor market discrimination affects economic outcomes in the complementary capital market. Previous research contains ample theoretical justification, and empirical evidence, that discrimination affects wages and employment in labor markets. However, the effects of discrimination against minority labor on transactions in markets for other inputs used in production is not known. We develop a model of the optimal capital stock put in place by firms in the presence of customer discrimination and test this model using data on sports facility construction over the period 1908-2003. The empirical evidence suggests that teams in cities with more racial segregation spend less on these facilities, confirming the predictions of the model about the effect of customer discrimination on capital investment.

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1 Introduction

Since the pioneering work of Becker (1971), economists have examined the causes and consequences of discrimination in labor markets from a theoretical and empirical perspective. Curiously, little attention has been paid to the possibility that the effects of discrimination in labor markets may also affect the use and prices of other inputs in production. For example, if labor and capital are complementary or substitute inputs in production, discrimination against the labor force may increase or reduce the optimal amount of capital the firm will acquire. At first blush, this omission seems somewhat odd, given that economic theory clearly highlights the inter-related nature of firm's decisions about labor and capital in the production process. However, the effects of discrimination are clearly discernable in labor markets, where large gaps in the earnings of workers of different races with similar levels of education and experience are observable and data are abundant. Concern about the equity and efficiency implications of labor market discrimination fueled interest in this area. In contrast, capital markets function on a different time scale than labor markets, capital is more persistent than labor inputs, and most data from capital markets are aggregated over both firms and time making it difficult to control for most sources of discrimination in empirical research. Given these differences, the lack of attention paid to discrimination in capital markets is understandable.

Becker's (1971) model of discrimination posits that discrimination begins with individual's tastes or preferences. This model identified three possible sources of discrimination: tastes of employees, employers, or customers. According to this model, employees prefer to work with people with similar characteristics, employers prefer to hire such workers, and customers prefer to purchase goods and services produced and sold by such people. Note that the model does not predict that workers, employers, and customers will only associate with people of the same race, just that they have tastes for these characteristics. These tastes for discrimination have effects on wages, prices, costs, and revenues in product and input markets, and lead to observable economic phenomena like earnings gaps and occupational segregation.

In this paper, we investigate the possibility that the effects of discrimination extend beyond labor markets into capital markets. We present theoretical and empirical evidence that a firm's decisions about the optimum stock of capital will be influenced by customer discrimination. First, we develop a model of firm behavior that accounts for the firm's customers' preferences regarding the race of the workers that produce the firm's products. This model generates predictions about the effect of customer discrimination on the amount of capital put in place by firms. Second, we test the predictions of this model using data on new sports stadium and arena construction by professional football, basketball, baseball and hockey franchises in the United States over the past 100 years.

The existence and effects of discrimination in sports labor markets have received extensive attention from economists. Kahn (1991) surveyed this extensive literature and discussed dozens of empirical studies of employer, employee and customer discrimination, as well as a handful of studies of gender discrimination, published over the past forty years. In the fifteen years since Kahn's survey, the literature on discrimination in sports labor markets has continued to grow. Recent research on discrimination in sports includes papers by Szymanski (2000), who found evidence of discrimination in English league soccer over the period 1978-1993, and Kanazawa and Funk (2001) who found evidence of discrimination in Nielson ratings for locally televised professional basketball games.

However, we know of no study that has examined capital markets, in the sports industry or any other industry, for evidence of discrimination. The capital market in the sports industry appears to be a fruitful arena for studying discrimination. There has been a boom in the construction of sports facilities over the past twenty years and we have access to a considerable amount of data on the racial composition of both individual firms and the market that these firms operate in. As a bonus, most firms in this industry operate as monopolists in their markets, reducing the possibility that confounding effects related to competitive forces obscure the consequences of discrimination.

In the following section, we develop a model of capital investment in a market where the firm's customers have Becker-style tastes for discrimination and explore the implications of these tastes for the firm's capital investment decisions. Subsequent sections develop an empirical version of this model, describe our data, and discuss the results of our empirical work.

2 A theory of optimal stadium size when fans are prejudiced

We first develop a model of a sports team's choice of optimal stadium size. The model has three important components:

1. a sports fan market demand function that includes fan preferences for team racial composition;

2. a team revenue function where stadium capacity and labor are complementary in the generation of ticket revenues; and

3. partial subsidization of the team's stadium costs.

Consider the fan market served by a stadium. Suppose that fan demand for sports entertainment depends upon–in addition to price, team success and other traditional demand shifters–the racial compositions of the team and fan population and the racial preferences of fans. We divide the fan market into two segments - white fans and non-white fans. Suppose that white sports fans prefer, all other things equal, a team that has a larger proportion of white players, whereas non-white sports fans prefer, all other things equal, a less white team.[1] If the entire fan market was white, then market demand for stadium admissions would be described by the following constant elasticity demand function,

$$Q = \left[\frac{\varepsilon \left(\frac{L_W}{L} \right)^{\frac{1}{\phi}}}{P} \right]^{\frac{1}{\eta}}, \tag{1}$$

where Q is the number of stadium admissions demanded, P is the price of admission to the stadium, L_W is the number of white players on the team, L is team size (assumed to be fixed), ϕ is a parameter reflecting the intensity of white fan preferences for watching white players perform ($\phi > 0$; when white fan preferences get stronger, ϕ gets larger), η is the inverse of the price elasticity of demand ($0 < \eta < 1$), and ε is a shift variable reflecting other determinants of fan demand, e.g. team success (win-loss percentage or championships won, for example), fan incomes, the size of the fan market, prices of alternative forms of entertainment, non-racial fan tastes, the costs of traveling to the stadium, etc. In contrast, if the entire fan market was non-white, then market demand for stadium admissions would be

[1] Another approach would be to model white fan distastes for watching non-white players perform and non-white fan distastes for watching white players perform. We take an alternative approach, however, and assume that fans of one skin color have a preference for watching players of their own skin color, all other things equal.

$$Q = \left[\frac{\varepsilon \left(1 - \frac{L_W}{L}\right)^{\frac{1}{\delta}}}{P} \right]^{\frac{1}{\eta}}, \tag{2}$$

where δ is a parameter reflecting the intensity of non-white fan preferences for watching non-white players perform ($\delta > 0$; when non-white fan preferences get stronger, δ gets larger).[2] However, the fan market is split between a fraction μ that is white and $(1 - \mu)$ that is non-white. Total market demand will thus be a weighted average of white and non-white fan demand:

$$Q = \mu \left[\frac{\varepsilon \left(\frac{L_W}{L}\right)^{\frac{1}{\phi}}}{P} \right]^{\frac{1}{\eta}} + (1-\mu) \left[\frac{\varepsilon \left(1 - \frac{L_W}{L}\right)^{\frac{1}{\delta}}}{P} \right]^{\frac{1}{\eta}}. \tag{3}$$

Equation (3) has a number of important implications. First, there will be conflicting effects on the demand for stadium admissions when the team makes an adjustment in its racial composition. Specifically, when team racial composition is adjusted in order to indulge the racial preferences of one fan group, this necessarily results in weaker demand from the other fan group. Suppose, for example, that the team increases the share of white players ($\frac{L_W}{L}$ rises). This will stimulate ticket demand by white fans (the first term on the right-hand side of equation (3) rises), but it will also reduce demand by non-white fans (the second term on the right-hand side of equation (3) falls). There will thus be a cost to the team of indulging the racial tastes of one segment of the population.[3]

The tradeoff between white fan revenues and non-white fan revenues that results from altering team racial composition is illustrated below. Let us differentiate expression (3) with respect to the share of the team comprised of white players:

$$\frac{\partial Q}{\partial \left(\frac{L_W}{L}\right)} = \frac{\mu}{\eta} \left[\frac{\varepsilon \left(\frac{L_W}{L}\right)^{\frac{1}{\phi}}}{P} \right]^{\frac{1}{\eta}-1} \left[\frac{\frac{\varepsilon}{\phi} \left(\frac{L_W}{L}\right)^{\frac{1}{\phi}-1}}{P} \right] - \frac{1-\mu}{\eta} \left[\frac{\varepsilon \left(1 - \frac{L_W}{L}\right)^{\frac{1}{\delta}}}{P} \right]^{\frac{1}{\eta}-1} \left[\frac{\frac{\varepsilon}{\delta} \left(1 - \frac{L_W}{L}\right)^{\frac{1}{\delta}-1}}{P} \right]. \tag{4}$$

The sign of equation (4) depends the relative magnitude of the parameters. In particular

$$\frac{\partial Q}{\partial \left(\frac{L_W}{L}\right)} \gtrless 0 \text{ if } \frac{\mu}{(1-\mu)} \frac{\left(\frac{L_W}{L}\right)}{\left(1 - \frac{L_W}{L}\right)} \gtrless \frac{\phi}{\delta}.$$

The sign of the marginal effect of team racial composition on fan demand is ambiguous. The first term on the right-hand side of equation (4) measures the gain in white fan demand that results from

[2]For expositional simplicity, we assume the same price elasticity of demand for non-white fans, as well as the same vector of other demand shifters (ε). The model's predictions would not change if we assumed otherwise.

[3]We recognize that there could also be a cost to fans of having their racial tastes indulged. If, for example, white fans are willing to pay more to see a whiter team play and there are racial differences in player productivity, that may require a team that is not as productive in winning games. If those fans also value team success, they will lose utility from watching a less successful team. We do not include this trade-off between fan value derived from team racial composition and value derived from team performance in our model, although that would be a worthwhile extension.

the increased pleasure those fans experience from seeing a whiter team, whereas the second term measures the loss in non-white fan demand that results from those fans having to watch a team with a racial composition less to their liking. Overall fan demand will rise (fall) if the first term exceeds (is less than) the second term. Stadium admissions will net rise when the team gets whiter, provided that the team is sufficiently white to begin with and the white fan base is sufficiently large. In contrast, a whiter team will result in lower demand if the team is relatively non-white to begin with and the non-white fan base is sufficiently large. The implication of equation (4) is thus that in markets where fans are primarily white and in which sports teams are relatively white, whiter teams will augment fan demand. Under such conditions, white fan demand will be very responsive to a change in team racial composition, whereas non-white fan demand will not. In contrast, if a team increases the white player share in a market which is primarily non-white and when the team is primarily non-white to begin with, fan demand will on balance fall.

As the parameter restrictions on the signing of expression (4) indicate, the net effect of team racial composition on fan demand depends precisely on whether the ratio of the share of the team that is white weighted by the share of the fan market that is white $\mu\frac{L_W}{L}$ to the share of the team that is non-white weighted by the share of the fan market that is non-white $(1-\frac{L_W}{L})(1-\mu)$ is above or below a threshold equaling the ratio of white fan tastes for white players (ϕ) to non-white fan tastes for non-white players (μ). If white fans have very strong tastes for watching white players perform, but non-white fans have relatively mild tastes for watching non-white players, that threshold will be high.

There will also be conflicting effects on fan demand if the racial composition of the fan market changes. Differentiating expression (3) with respect to the white fan market share (μ), we find that the marginal effect of the white fan share on stadium admissions can be positive or negative:

$$\frac{\partial Q}{\partial \mu} = \left[\frac{\varepsilon\left(\frac{L_W}{L}\right)^{\frac{1}{\phi}}}{P}\right]^{\frac{1}{\eta}} - \left[\frac{\varepsilon\left(1-\frac{L_W}{L}\right)^{\frac{1}{\delta}}}{P}\right]^{\frac{1}{\eta}} \gtrless 0 \text{ if } \left(\frac{L_W}{L}\right)^{\frac{1}{\phi}} \gtrless \left(\frac{1-L_W}{L}\right)^{\frac{1}{\delta}} \tag{5}$$

According to (5), a whiter fan market will result in greater stadium admissions provided that the share of white players on the team is sufficiently high and/or white fan tastes for watching white players are sufficiently strong relative to non-white fan tastes for watching non-white players. The reason is that when the fan market gets whiter, there is an increase in demand attributable to more white fans and a decrease in demand attributable to fewer non-white fans. If the racial composition of the team is sufficiently desirable and white fans value that racial composition strongly, an increase in the white fan share will induce an increase in demand more than sufficient to offset the loss in demand from fewer non-white fans.[4]

Note also that the fan market and team racial compositions will interact; the size of the marginal effect of a change in white fan market share on demand will be influenced by team racial composition:

$$\frac{\partial^2 Q}{\partial \mu \partial\left(\frac{L_W}{L}\right)} = \frac{1}{\eta}\left[\frac{\varepsilon\left(\frac{L_W}{L}\right)^{\frac{1}{\phi}}}{P}\right]^{\frac{1}{\eta}-1} \left[\frac{\frac{\varepsilon}{\phi}\left(\frac{L_W}{L}\right)^{\frac{1}{\phi}-1}}{P}\right] + \frac{1}{\eta}\left[\frac{\varepsilon\left(1-\frac{L_W}{L}\right)^{\frac{1}{\delta}}}{P}\right]^{\frac{1}{\eta}-1} \left[\frac{\frac{\varepsilon}{\delta}\left(1-\frac{L_W}{L}\right)^{\frac{1}{\delta}-1}}{P}\right] > 0 \tag{6}$$

[4]This assumes that the total number of sports patrons (one of the variables comprising the vector ε) is fixed.

According to (6), if an increase in the share of the fan market that is white boosts stadium admissions, then the increase will be larger the whiter the team. On the other hand, if stadium admissions fall, the decrease will be larger the more non-white the team.

The team employs two inputs - labor (players) and capital (the stadium) - which are assumed to be complements in production. We use a Cobb-Douglas production function to describe this input complementarity:

$$Q = \Psi K^{\alpha} L^{\beta} \tag{7}$$

where K is units of capital (measured, for example, by number of seats in the stadium), L is number of players, Ψ reflects the efficiency of production and α and β are the share parameters.[5] Since the number of players on a sports team is usually fixed, we will assume L to be fixed, hence $\alpha + \beta < 1$.

The capital markets are assumed to be perfectly competitive and require that capital suppliers be paid a price of r per unit of capital. For practical purposes, r could, for example, be the (constant) marginal cost of adding another seat to the stadium or the cost of financing another dollar of construction. Since a team's stadium costs are often at least partially subsidized, we assume that the team is partially subsidized, thus pays less than r for each unit of capital. Specifically, we assume that the marginal cost to the team of acquiring an additional unit of capital is $(1-\theta)r$, where θ is the fraction of capital costs that are subsidized. Finally, define M as all non-capital costs, where M is fixed.

The team's profits π are

$$\pi = P\Psi K^{\alpha} L^{\beta} - (1-\theta)rK - M \tag{8}$$

Substituting the demand function, equation (3) into the above expression, we obtain

$$\pi = \varepsilon \left[\mu \left(\frac{L_W}{L} \right)^{\frac{1}{\phi\eta}} + (1-\mu) \left(1 - \frac{L_W}{L} \right)^{\frac{1}{\phi\eta}} \right]^{\eta} \Psi^{1-\eta} K^{\alpha(1-\eta)} L^{\beta(1-\eta)} - (1-\theta)rK - M \tag{9}$$

Once the fan demand function is incorporated into the revenue component of the profit function, resulting in the first term on the right-hand side of equation (9), the profit function reveals three novel features. First, team racial composition influences profits; all other things equal, a whiter team is capable of raising or lowering profits. Second, a change in the racial composition of the fan market will influence profits. Third, due to the multiplicative nature of the revenue component of profits, team racial composition, the racial composition of the fan market and other determinants of stadium size will all interact. These features will have important implications for optimal stadium size, as we will see below.

In the analysis that follows, we treat the team's optimization problem as a univariate one; the goal of the team is to solve for the optimal size of stadium to build (K), given, along with the other determinants of stadium size, a predetermined team racial composition. A more complete, albeit realistic, depiction of the team's problem would be to model the joint choice of stadium size and team racial composition ($\frac{L_W}{L}$). However, because of the assumed functional form of the fan's demand function, extending the optimization problem to also allow for the choice of team racial

[5]Since the share parameters also reflect relative factor productivity, team success is incorporated into β. Teams that win more frequently, for example, would have higher values of β.

composition adds much more complication with no additional predictive content.[6] Therefore, for expositional simplicity we chose to treat team racial composition as exogenous.

In solving for the stadium size that maximizes profits, first order conditions require that the team adjust stadium size such that the marginal benefit from the last unit of capital acquired equals the subsidy-adjusted marginal cost:

$$\frac{\partial \pi}{\partial K} = 0 \quad \Rightarrow$$
$$\varepsilon\alpha(1-\eta)\left[\mu\left(\frac{L_W}{L}\right)^{\frac{1}{\phi\eta}} + (1-\mu)\left(1-\frac{L_W}{L}\right)^{\frac{1}{\delta\eta}}\right]^{\eta}\Psi^{(1-\eta)}L^{\beta(1-\eta)}K^{(\alpha(1-\eta)-1)} = (1-\theta)r \tag{10}$$

Furthermore, second order conditions for a maximum dictate that in order to have an interior solution, there must be diminishing marginal benefits to increasing stadium size, i.e.

$$\frac{\partial^2 \pi}{\partial K^2} =$$
$$(\alpha(1-\eta)-1)(\varepsilon\alpha(1-\eta))\left[\mu\left(\frac{L_W}{L}\right)^{\frac{1}{\phi\eta}} + (1-\mu)\left(1-\frac{L_W}{L}\right)^{\frac{1}{\delta\eta}}\right]^{\eta}\Psi^{(1-\eta)}L^{\beta(1-\eta)}K^{(\alpha(1-\eta)-2)} < 0. \tag{11}$$

Since $(\alpha(1-\eta)-1)(\varepsilon\alpha(1-\eta)) < 0$, the sign of equation (11) is negative, satisfying the second order condition.

To solve for optimal stadium size, we solve equation (10) for K

$$K^* = \left[\frac{(1-\theta)r}{\varepsilon\alpha(1-\eta)\left[\mu\left(\frac{L_W}{L}\right)^{\frac{1}{\phi\eta}} + (1-\mu)\left(1-\frac{L_W}{L}\right)^{\frac{1}{\delta\eta}}\right]^{\eta}\Psi^{(1-\eta)}L^{\beta(1-\eta)}}\right]^{\frac{1}{(\alpha(1-\eta)-1)}} \tag{12}$$

According to expression (12), optimal stadium size depends upon the price elasticity of demand for stadium admissions, the strength of fan racial preferences, team racial composition, other exogenous determinants of fan demand (ε), efficiencies in production (Ψ), team size (L), the relative productivities of labor and capital (β and α, respectively), the stadium subsidy rate (θ) and the market price of capital. Furthermore, because of the multiplicative nature of expression (12), optimal stadium size will be influenced by interaction effects between all the determinants of the optimal capital stock. Note that $(\alpha(1-\eta)-1) < 0$.

Equation (12) yields some self-evident predictions, e.g. stadium size rises with the subsidy rate ($\frac{\partial K^*}{\partial \theta} > 0$) and team size ($\frac{\partial K^*}{\partial L} > 0$). A number of novel predictions also arise from equation (12):

1. *The racial composition of the fan market can affect capital investment by sports teams. The marginal effect of the fan market on optimal capital investment can be positive or negative, depending upon team racial composition and relative fan preferences:*

[6] We found that when team racial composition is also a choice variable, it is impossible to obtain closed form solutions for K and ($\frac{L_W}{L}$). We tried other specifications for fan demand where the demand function is one term, e.g. making fan demand a geometric weighted average of white and non-white fan demands, but in all cases it was impossible to obtain closed form solutions for at least team racial composition. We prefer to model fan demand as an arithmetic weighted average of white and non-white demands, as has been done in equation (3) above, because that is the most intuitive depiction of demand and because the separate demand functions for white and non-white fans contain all the traditional properties of demand functions.

$$\frac{\partial K}{\partial \mu} = -\left(\frac{1}{\alpha(1-\eta)-1}\right)\left[\frac{(1-\theta)r}{\varepsilon\alpha(1-\eta)\left[\mu\left(\frac{L_W}{L}\right)^{\frac{1}{\phi\eta}}+(1-\mu)\left(1-\frac{L_W}{L}\right)^{\frac{1}{\delta\eta}}\right]^{\eta}\Psi^{(1-\eta)}L^{\beta(1-\eta)}}\right]^{\frac{1}{(\alpha(1-\eta)-1)}-1} \times$$

$$\left[\frac{(1-\theta)r\alpha(1-\eta)\eta\varepsilon\left[\mu\left(\frac{L_W}{L}\right)+(1-\mu)\left(1-\frac{L_W}{L}\right)^{\frac{1}{\delta\eta}}\right]^{(\eta-1)}\Psi^{(1-\eta)}L^{\beta(1-\eta)}}{\left[\varepsilon\alpha(1-\eta)\left[\mu\left(\frac{L_W}{L}\right)^{\frac{1}{\phi\eta}}+(1-\mu)\left(1-\frac{L_W}{L}\right)^{\frac{1}{\delta\eta}}\right]^{\eta}\Psi^{(1-\eta)}L^{\beta(1-\eta)}\right]^{2}}\right]\left[\left(\frac{L_W}{L}\right)^{\frac{1}{\phi\eta}}-\left(1-\frac{L_W}{L}\right)^{\frac{1}{\delta\eta}}\right] \quad (13)$$

$$\gtrless 0 \;\; if \;\; \left(\frac{L_W}{L}\right)^{\frac{1}{\phi}} \gtrless \left(1-\frac{L_W}{L}\right)^{\frac{1}{\delta}}$$

According to equation (13), stadium size rises (falls) when the white share of the fan market rises if the team is sufficiently white (non-white) and the racial preferences of white fans are strong (weak) relative to the racial preferences of non-white fans. The restrictions imposed on the signing of equation (13) are identical to those imposed on the signing of equation (3).

Why does the racial make-up of the fan population matter in the determination of stadium capacity? The reason is that one source of stadium revenue is fan willingness to pay to watch a team with a preferred racial composition. Suppose, for example, that the team is 80% white, white and non-white fan tastes are equally strong and μ rises from 0.75 to 0.85. Since it is assumed that the size of the total fan population remains the same, there are now more white fans and fewer non-white fans. Since the team is relatively attractive to white fans with respect to its racial composition, there will be a relatively large increase in white fan demand. For the non-white segment of the market, willingness to pay with respect to team racial composition is quite low because the team is relatively unattractive to that group. Hence, a drop in the number of non-white fans will not lead to a very large reduction in the demand for stadium admissions and there will be a net increase in total demand for stadium admissions. The returns to stadium construction will thus rise and this will induce the construction of a larger stadium.[7] The net returns to stadium construction arising from a whiter fan market will be even stronger if white fan tastes are stronger than non-white fan tastes.[8] Note that if fan tastes for team racial composition are non-existent, then a *ceteris paribus* change in the racial composition of the fan market will have no effect on the returns to stadium construction and stadium capacity would be unchanged. Therefore, the hypothesized effects of the racial composition of the fan pool depend as much on the racial predilections of fans as on the team's racial composition;

2. *The racial composition of the team can affect capital investment. When the team gets whiter, stadium size can rise or fall, depending upon the team's prior racial composition and how strong white fan preferences are relative to non-white fan preferences:*

[7] In the extreme case where the team is completely white, there will be no reduction in non-white fan demand.

[8] Consider the case where μ rises, but the team is relatively non-white and non-white fan preferences are strong. White fan valuation of the team's racial composition will be very low and non-white valuation will be very high. There will thus be only a very small increase in white fan demand when μ rises, but a very large decrease in demand coming from non-white fans.

$$\frac{\partial K}{\partial\left(\frac{L_W}{L}\right)} = -\left(\frac{1}{\alpha(1-\eta)-1}\right)\left[\frac{(1-\theta)r}{\varepsilon\alpha(1-\eta)\left[\mu\left(\frac{L_W}{L}\right)^{\frac{1}{\phi\eta}}+(1-\mu)\left(1-\frac{L_W}{L}\right)^{\frac{1}{\delta\eta}}\right]^{\eta}\Psi^{(1-\eta)}L^{\beta(1-\eta)}}\right]^{\frac{1}{(\alpha(1-\eta)-1)}-1}\times$$

$$\left[\frac{(1-\theta)r\alpha(1-\eta)\eta\varepsilon\left[\mu\left(\frac{L_W}{L}\right)^{\frac{1}{\phi\eta}}+(1-\mu)\left(1-\frac{L_W}{L}\right)^{\frac{1}{\delta\eta}}\right]^{(\eta-1)}\Psi^{(1-\eta)}L^{\beta(1-\eta)}}{\left[\varepsilon\alpha(1-\eta)\left[\mu\left(\frac{L_W}{L}\right)^{\frac{1}{\phi\eta}}+(1-\mu)\left(1-\frac{L_W}{L}\right)^{\frac{1}{\delta\eta}}\right]^{\eta}\Psi^{(1-\eta)}L^{\beta(1-\eta)}\right]^{2}}\right]\times$$

$$\left[\left(\frac{\mu}{\phi\eta}\right)\left(\frac{L_W}{L}\right)^{\frac{1}{\phi\eta}-1} - \left(\frac{1-\mu}{\delta\eta}\right)\left(1-\frac{L_W}{L}\right)^{\frac{1}{\delta\eta}-1}\right] \gtrless 0$$

$$if\ \frac{\left(\frac{L_W}{L}\right)\mu}{\left(1-\frac{L_W}{L}\right)(1-\mu)} \gtrless \frac{\phi}{\delta} \tag{14}$$

As with equation (13), the behavior of the marginal effect of a change in the share of the team comprising white players on stadium size depends entirely on the underlying fan demand function, with the restrictions for the signing of (14) identical to those for the signing of expression (4). According to expression (14), if the team increases the share of white players, this will induce an increase (decrease) in stadium capacity if the team is relatively white (non-white) to begin with and/or the fan market is relatively white (non-white). Furthermore, the threshold values of the team's white player share and the white share of the fan market for the signing of expression (14) depend on how strong white fan preferences are relative to non-white fan preferences.

If the team increases the share of players that is white, this will induce conflicting effects on the demand for stadium admissions. On the one hand, white fan demand will rise because for that segment of the market, the team is now more attractive with respect to its racial composition and white fans will value more watching the team perform. On the other hand, non-white fan demand will fall because the team is now less attractive, racially speaking, and those fans will value less watching the team perform. If the white share of the team is high to begin with and the fan market is primarily white, then the boost in white fan demand will be substantial relative to the drop in non-white fan demand. The net return to stadium construction will be positive, inducing larger stadium capacity. On the other hand, if the white share of the team is low to begin with and the fan market is primarily non-white, the boost in white fan demand will be small relative to the drop in non-white fan demand, resulting ultimately in a smaller stadium.

Finally, the right hand side of equation (12) suggests that there will be interaction effects between the various determinants of K^*. The marginal effect of the racial composition of the fan market on stadium capacity will depend upon:

1. the racial composition of the team $\left(\frac{\partial^2 Q}{\partial\mu\partial L_W/L}\right)$,
2. the cost of capital $\left(\frac{\partial^2 Q}{\partial\mu\partial r}\right)$,
3. the subsidy rate $\left(\frac{\partial^2 Q}{\partial\mu\partial\theta}\right)$,

4. factor productivity $\left(\frac{\partial^2 Q}{\partial \mu \partial \alpha}\right), \left(\frac{\partial^2 Q}{\partial \mu \partial \beta}\right)$,

5. the price elasticity of demand for stadium admissions $\left(\frac{\partial^2 Q}{\partial \mu \partial \eta}\right)$,

6. team size $\left(\frac{\partial^2 Q}{\partial \mu \partial L}\right)$,

7. fan tastes $\left(\frac{\partial^2 Q}{\partial \mu \partial \phi}\right), \left(\frac{\partial^2 Q}{\partial \mu \partial \delta}\right)$, and

8. other determinants of fan demand $\left(\frac{\partial^2 Q}{\partial \mu \partial \varepsilon}\right)$.

We found, however, that these interactions could not be signed without parameter restrictions. Nevertheless, the model suggests that interaction terms could be included when estimating the relationship between stadium size and its determinants.

3 Empirical Analysis

Equation (12) above is an expression for the optimum stock of capital that will be put in place by a firm. This expression is a version of what Chirinko (1993) called the "Benchmark Model" of capital investment. To derive an empirically viable model of demand for capital investment from this expression, we would add adjustment costs to the capital demand function in order to bring dynamics into the model. However, we are not interested in exploring the dynamic process of investment in sports facilities by professional sports teams in this paper; we are interested instead in analyzing the determinants of the optimum stock of capital that each team puts in place when they build a new sports facility. Instead of building dynamics into the model, we assume that capital adjustment costs are zero, and firms build facilities of the optimum size each time a new facility is built. Our basic empirical model is a linear version of equation (12) that relates the amount of capital put in place by a sports team to relevant prices, quantities, and customer demand shifters. The basic empirical model is

$$K_{it} = \beta_0 + \beta_1 r_t + \beta_2 RC_{it} + \beta_3 RT_{it} + \gamma Z_{it} + \theta D_{it} + e_{it} \qquad (15)$$

where $K_i t$ is the quantity of capital put in place by a sports team in city i in year t, r_t is a measure of the cost of capital in year t, RC_{it} is a variable that captures the racial characteristics of the population in city i in year t, RT_{it} is a variable that captures the racial characteristics of the sports team playing in the stadium in city i in year t, Z_{it} is a vector of variables that shift the demand for the products produced by the sports team, and D_{it} is a vector of variables that capture other team and stadium specific factors in city i in year t. The βs,γ, and θ are unknown parameters to be estimated and e_{it} is a random variable capturing all other factors that affect the amount of capital put in place by the sports team in city i in year t. This error is assumed to be a mean zero and constant variance random variable. Many empirical capital investment studies that use aggregate data assume that e_{it} is serially correlated. However, we estimate the parameters of equation (15) using micro data - data for specific teams - in a pooled sample of cross sections. Our pooled sample does not contain observations for every year in the sample period, and the sports teams in any city in the sample build a new stadium or arena infrequently. Because of these features of the data, we assume that e_{it} is serially uncorrelated.

In this context, a number of variables could be used for the amount of capital put in place by sports teams building new facilities. The model derived above defines K as the quantity of capital used by the firm. Under this definition, the capacity of the sports facility would be an appropriate variable to use as a proxy for K_{it}. However, the cost of a seat in a basketball arena in Denver may not be the same as the cost of a seat in a football stadium in Miami, or a seat in a hockey arena in Buffalo. Alternatively, the average construction cost per seat could be used as a proxy for K_{it}. Average cost per seat reflects factors like land acquisition costs, regional differences in wages paid to construction workers, and variation in real materials costs that affect stadium construction projects. We use average construction cost per seat in our empirical estimation of the parameters of equation (15). The primary parameter of interest in equation (15) is β_2. This parameter captures the effect of variation in the racial composition of city i in year t on the amount of capital put in place by a sports team. The sign and significance of β_2 is related to the hypothesized effect of changes in parameter μ (the white fan population share) on capital in the theoretical model. We hypothesize specifically that, given the prediction of our theoretical model (equation (13)), $\beta_2 < 0$, i.e. an increase in the share of the fan population that is white results in less capital put in place by the sports team in city i in year t. The estimated sign and significance of this parameter is the primary test for the presence of discrimination in capital markets in this paper.

3.1 Data Description

The data set used in this paper was constructed from a variety of sources. We began with the list of stadium and arena construction projects, including total construction costs, compiled by Keating (1999). This list of over 100 stadium construction and renovation projects over the period 1898-1997 was compiled by Keating from primary sources, including newspaper reports. We expanded Keating's data for the period 1998-2004 using the stadium and arena construction data in Long (2005) and augmented it with stadium capacity data from the Ballparks.com web site (www.ballparks.com). In general, the estimated construction cost reported by Keating (1999) and Long (2005) are similar. However, Long's estimates are more comprehensive and where these estimates differ we use the total cost estimates from Long (2005). Combining the data from these two sources yielded a sample of 187 individual facility construction and renovation projects for professional football, basketball, baseball and hockey teams in the United States over the period 1897-2004. 151 of these were new facility construction projects and 36 were renovations of existing facilities. Of these 151, 122 took place after the NFL, NBA and MLB were racially integrated in the late 1940s to early 1950s. Before integration, there were no minority athletes in professional sports, and the possibility of discrimination was greatly diminished. We focus on these 122 new sport facility construction projects.

Table 1: Summary Statistics, New Facility Construction and Teams

Sport	Number of Projects	Millions of \$2004	Capacity	Cost per seat	% of Team non-white
NFL	31	249	68,074	3,633	35
MLB	34	164	45,254	5,062	26
NBA	41	177	18,710	9,206	58
NHL	16	152	17,864	8,448	4

Table 1 summarizes the stadium construction and renovation data in the sample, and the racial composition of teams in the sample. 34% of the 122 new facility construction projects in the sample were baseball stadiums, 31% were football stadiums, 41% were basketball arenas and 16% were hockey arenas. This taxonomy treats multi-purpose facilities - stadiums home to both football and baseball teams and arenas home to both basketball and hockey teams - as the home to a single sports team. There are 15 facilities in the sample that hosted both football and baseball teams and 19 facilities that hosted both basketball and hockey teams in the sample. A one-way analysis of variance indicates that the average cost per seat in basketball and hockey arenas is higher than the average cost per seat in baseball and football stadiums.

We augmented the stadium construction and capacity data with economic and demographic data for the cities that were hosts to these facilities from a variety of sources. Per capita personal income, population, and the racial composition of the population in each city were taken from the Decennial census for the period 1900-1939, from various issues of the County and City Data Book supplement to the Statistical Abstract of the United States for the period 1940-1968, and from the Bureau of Economic Analysis historical State and Local Personal Income statistics web site (http://www.bea.gov/bea/regional/statelocal.htm) for the period 1969-2004.

A measure of the real interest rate is needed in order to estimate the model. We constructed an estimate of the *ex post* real interest rate by subtracting the actual inflation rate from the Consumer Price Index over the previous year by the nominal interest rate on AAA rated corporate bonds. The other possible interest rate variable available over the sample period is the interest rate on municipal bonds. The results reported below were not sensitive to the choice of a nominal interest rate.

Simple measures of the racial composition of he population in each city may not reflect underlying attitudes about race. A city with a majority white population does not necessarily contain a large population of whites with a preference for watching sports teams composed of white players. In order to broaden the measures of fan's racial preferences, we augmented the data set with variables reflecting the spatial segregation of blacks and whites in US cities developed by Cutler, Glaeser and Vigdor (1999). Cutler, Glaeser and Vigdor (1999) point out that the existence of "ghettos" in US cities can reflect racial discrimination and develop several city-specific measures of spatial segregation using census data. We use two of these measures of racial segregation, an index of dissimilarity that captures the extent to which blacks disproportionately reside in in some areas of a city relative to whites, and an index of isolation that reflects the exposure of blacks to whites in cities. For each new sports facility construction project in the sample, the dissimilarity index variable and the isolation index variable are the index values for the census immediately proceeding the opening of the facility.

The geographic unit of measurement in the sample is a metropolitan area. Our sample extends back beyond the period over which the Census Bureau defined Metropolitan Statistical Areas, which were only delineated after 1950. This makes the definition of a metropolitan area, in the context of published population and income data, difficult. Over the period 1969-2003, the city that is home to each stadium is defined as the current Standard Metropolitan Statistical Area that contains the stadium or arena. In the period 1950-1968, we use the Metropolitan Statistical Area for the appropriate period. Prior to 1950, we use the population and income data for the city that was home to the facility, based on the list of cities appearing in the *Statistical Abstract of the United States* for that year.

Capital investment projects are large undertakings and are typically financed by borrowing. Borrowing costs depend on the real interest rate, and estimates of the real interest rate require nominal interest rate data from financial markets and price data. Also, converting nominal capital spending variables to real terms requires price indexes. We augmented the data set with financial variables from the NBER Macro History database (http://www.nber.org/databases/macrohistory/contents/) and price indexes from the Bureau of Labor Statistics (http://www.bls.gov/bls/inflation.htm).

We also collected team specific data for the teams that played in the new facilities in the sample. These data include the winning percentage for the team over the five years prior to the facility opening and the fraction of the players who were non-white in the year the facility opened. The winning percentage variable was set to zero for expansion teams. The team racial composition variable was calculated by examining team photographs and player cards for the appropriate years. Based on these photographs, the fraction of each team that appeared to be non-white was calculated. Kahn's (1991) survey of the empirical literature on discrimination in sports indicates that this procedure is commonly used to identify the racial composition of sports teams.

Table 2: Summary Statistics, Other Covariates

Variable	Mean	Standard Deviation
Real Per Capita Income	30,331	7,000
Real Interest Rate	1.91	2.10
City Population	2,987,969	302,260
Winning Percent, last 5 years	0.511	0.108
Domed Stadium	0.08	0.275
Facility in CBD	0.24	0.427
Fraction of City Population White	0.75	0.202
Dissimilarity Index	0.70	0.137
Isolation Index	0.48	0.198

Table 2 shows summary statistics for the other explanatory variables used in the empirical analysis of capital investment. Note that mean and standard deviation of the winning percent variable if for teams that played games in the previous five years. For expansion teams, the winning percent variable over the past five years was set to zero. According to Cutler, Glaeser and Vigdor (1999), a city has a ghetto if the index of dissimilarity has a value over .60 and the index of isolation has a value of over 0.03. Based on this measure, the average city in our sample contains a ghetto.

3.2 Empirical Approach, Results and Discussion

We estimated the parameters of equation (15) with data for the 122 observations of new sports stadium and arena construction projects described above. The model contains a cost of capital term r_t. A measure of the real interest rate is needed in order to estimate the model. We constructed an estimate of the *ex post* real interest rate by subtracting the actual inflation rate over the previous year by the nominal interest rate on AAA rated corporate bonds. The other possible interest rate variable available over the sample period is the interest rate on municipal bonds. The results are not sensitive to choice of a nominal interest rate.

The vector of demand shifters in equation (15), D_{it}, contains the population of the city and a measure of the past success of the team playing in in the facility, the average winning percentage over the past 5 or 10 seasons. The vector of variables that capture facility specific factors that affect construction costs include indicator variables for domed stadiums and for facilities located in the central business district of the city, where land costs may be higher. We also included the capacity of the facility to capture and potential scale economies in construction costs.

The model developed above predicts that the racial composition of the team and fan's tastes for discrimination can both affect capital investment. We collected data on the racial composition of the team that played in each new facility in the sample. One econometric problem with a variable that reflects the racial composition of each team is that this variable could be correlated with the equation error term, e_{it}, in equation (15). To control for this problem, we estimated equation (15) using an Instrumental Variables (IV) estimator that treats the racial composition of the team as endogenous. The instruments used were the fraction of the city's population that was black and indicator variables for NBA and NFL teams. Both these sports employ more black players.

Table 3 contains IV parameter estimates and P-values of the parameters in equation (15) when average construction cost per seat is used as the dependent variable. The standard errors underlying the reported P-values were corrected for heteroscedasticity using the White-Huber "sandwich" correction.

Table 3: IV Parameter Estimates of Equation (15)

Dependent Variable is Average Construction Cost per Seat

Variable	Parameter	P-value	Parameter	P-value	Parameter	P-value
Team % non-white	3508	0.112	3406	0.055	2880	0.094
City Population % white	1510	0.442	—	—	—	—
Racial Isolation Index	—	—	-5404	0.000	—	—
Racial Dissimilarity Index	—	—	—	—	-7606	0.022
Real Income per capita	104	0.011	75.2	0.072	90.6	0.018
Real interest rate	349	0.046	180	0.306	164	0.337
Population (0000)	4.27	0.029	4.59	0.021	3.91	0.062
Winning %, last 5 years	2807	0.018	3119	0.006	3289	0.004
Facility Capacity (000)	-92	0.000	-85	0.000	-91	0.000
Domed Stadium	1845	0.020	1863	0.015	2004	0.005
Facility in CBD	2564	0.018	2567	0.008	2356	0.020
R^2/N	0.48	122	0.51	119	0.51	119

The estimated parameters on the demand and cost shifters are generally significant and correctly signed. Cities with higher real per capita income build more expensive facilities. Cities with larger populations build more expensive facilities. Cities with more successful teams build more expensive facilities. Domed stadiums are more expensive to build, and facilities built in the central business district of cities cost more. These estimated signs are consistent with standard neoclassical capital investment theory and the model developed above.

The parameter on the facility capacity variable is negative and significantly different from zero. The sign of this parameter indicates that the average cost per seat in sports facilities declines as the size of the facility increases. This indicates that some economies of scale exist in sports facility construction.

The parameter on the real interest rate is imprecisely estimated. This is probably due to the relatively poor quality of the nominal interest rate variables available over this long sample period, and the ex post real interest rate used in the model. Economic theory predicts that the expected inflation rate should be subtracted from the nominal interest rate in order to estimate the real interest rate. The actual inflation rate is equal to the expected inflation rate only under perfect foresight, a condition that probably does not hold over long periods of time. Despite this imprecise estimate, the model predicts that a measure of real interest rates belongs in the empirical model and omitting this variable might lead to bias in other parameter estimates.

The primary parameters of interest are those on the variables reflecting the racial composition of teams and cities. The prediction about the effect of fan prejudice on capital investment that emerges from the model is conditional on the fraction of non-white players on the team roster, so we estimate empirical models containing variables capturing both the racial composition of the teams and the racial composition of the city. Recall that we use Instrumental Variables to correct for correlation between this variable and the equation error term. The parameter estimate on the variable reflecting the racial composition of the team is not significantly different from zero in any of the three models shown on Table 3. Variation in team racial composition does not explain any of the observed capital investment by sports teams in the sample.

We require a proxy for the parameter μ in our theoretical model, which captures the effect of fan's tastes for discrimination on the optimal level of capital. We use three different variables to proxy for fan's tastes for discrimination: the fraction of the local population that is white, an index of dissimilarity that captures the extent to which blacks disproportionately reside in in some areas of a city relative to whites, and an index of isolation that reflects the exposure of blacks to whites in cities. The latter two variables were created by Cutler, Glaeser and Vigdor (1999). The fraction of the local population that is white has often been used in empirical studies of customer discrimination in labor markets (see Kahn (1991) for a discussion of measures of fan prejudice).

From Table 3, variation in the fraction of the local population that is white does not explain any of the variation in capital investment in the sample, but the two measures of spatial racial segregation are both negative and significant. The more spatial dissimilarity and isolation in a city, the lower the spending on new sports facility construction in the city, other things equal.

We interpret this as evidence that customer racial discrimination affects capital investment, and that the primary mechanism is customer discrimination. Cutler, Glaeser and Vigdor (1999) point out that the existence of racial segregation in cities can be the "result of collective actions taken by whites to enforce separation from backs" (page 476), and that even in the absence of formal barriers to racial segregation that existed in the early twentieth century, persistent underlying racial preferences can make segregation persistent. In the context of out results, tastes for racial segregation in housing in a city may be related to tastes for customer discrimination in the city, holding the racial composition of the team constant. Our results are consistent with this, and support the predictions in the model developed earlier in the paper.

The results shown on Table 3 are generally robust to alternative specifications. The estimated parameters, and the significance of these parameters are qualitatively similar if the real cost per seat variable is replaced with total real construction costs. Controlling for the size of the public subsidy provided for the sports facility construction project, either by expressing the dependent variable in terms of private spending or including the public subsidy as an explanatory variable had no effect on the results. The estimated parameter on an alternative measure of the real interest rate, based on municipal bond rates was also not statistically significant.

4 Conclusions

In this paper, we develop a capital investment model for sports facilities that includes possibly discriminatory customers. The model is novel in that the effect of customer discrimination on capital investment has not been investigated in previous research. This omission is interesting, given the well-established complementarity of capital and labor in production and the extensive empirical evidence that discrimination affects labor markets. The empirical analysis generally supports the predictions that emerge from the model.

The paper contains evidence that the effect of customer discrimination in labor markets extends into capital markets. Becker's (1971) model of discrimination extended to firm's decisions about capital investment predicts that customer's tastes for products produced by workers of the same race will affect firm's capital investment decisions. Evidence from the estimation of an empirical version of the optimality conditions that emerge from the model indicate that new stadiums and arenas built in cities with greater racial segregation tend to be smaller, and have lower total construction costs. This result is analogous to previously reported results in the literature that customer discrimination leads to lower wages in capital markets.

The evidence about the extent of discrimination in this paper has important implications for public policy, as well as for economists' understanding of the scope and consequences of discrimination. First, our results show that the scope of discrimination is broader than was previously suspected. Discrimination, in particular customer discrimination, affects both the wages of employees and the capital put in place by firms. If the results in this paper generalize to other settings, then minority owned and operated firms may not have as large a capital stock as they could in the absence of discrimination. Undercapitalization can affect both the earnings and productivity of workers and the economic returns to owners. Federal and state governments have devoted considerable resources to detecting and mitigating the effect of discrimination in labor markets. If the effects of customer discrimination extend to capital investment, then existing anti-discriminatory policies should be expanded to include the possibility that the capital structure of firms is also affected. Clearly, these results suggest that additional empirical research into the effects of discrimination on capital investment in other settings is warranted.

Finally. to date, no research has addressed the optimum size of sports facilities. Our results reveal some interesting information about the determinants of the optimal capital stock for sports teams. Our results indicate that the optimum capital investment in a sports facility increases with income per capita in the local market, with the population of the local market, and with the long-term success of the team playing in the facility. These results indicate that capital investment made by sports teams has similar characteristics to capital investment made by other firms.

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