Customer Discrimination, Capital Investment, and Sports Stadiums

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Abstract

We investigate the possibility that discrimination affects economic outcomes in capital markets. Previous research contains ample theoretical justification, and empirical evidence, that discrimination affects wages and employment in labor markets. 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 larger white populations build smaller facilities and spend less on these facilities, confirming the predictions of our model about the effect of customer discrimination on capital investment.

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

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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.

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 production function where stadium capacity, labor and team racial composition are all complementary in the generation of ticket revenues; and
3. partial subsidization of the team's stadium costs.

Suppose that fan demand for sports entertainment depends upon, in addition to price and the traditional demand shifters, the racial compositions of the team and fan population, as well as the racial tastes of fans. Specifically, suppose that white sports fans prefer a team that has a larger proportion of white players, but non-white sports fans prefer a team that has a smaller proportion of white players, all other things equal. We use the following constant elasticity demand function to capture these characteristics of the sports fan market,

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

where P is the price of admission to the stadium, L_W is the number of white players on the team, L is team size, Q is number of stadium admissions, μ is the fraction of the fan population that is white, ϕ is a parameter reflecting the intensity of white fan preferences for watching white players perform ($\phi > 0$), δ is a parameter reflecting the intensity of non-white fan preferences for watching non-white players perform ($\delta > 0$), η is the inverse of the price elasticity of demand ($0 < \eta < 1$) and ε is a shift variable reflecting the influence of other determinants of fan demand, e.g. 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.

Built into the fan demand function above are several important features. First, there are conflicting effects of fan racial preferences on the demand for stadium admissions. The challenge facing the team is that when it adjusts team racial composition in order to indulge the racial preferences of one fan group, this results in weaker demand from the other fan group. For example, if the team increases the white player share of the team, this will stimulate that portion of demand attributable to white fans (the $\mu\,(L_W/L)^{\frac{1}{\phi}}$ term rises), but reduce that portion of demand attributable to non-white fans (the $(1-\mu)\,(L_W/L)^{\frac{1}{\delta}}$ falls.)

To further illustrate this important feature of the fan demand function, solve the function for quantity demanded:

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

Consider now the marginal effect of a change in the white share of the fan population on fan demand, which is measured by the partial derivative of admissions with respect to the share of white fans in the population:

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

In equation (3), the first term in brackets on the right-hand side is always positive, but the second term in brackets will be negative, all other things equal, if the white fan share (μ) initially exceeds 0.5, positive if μ is initially less than 0.5 and zero if the white fan share equals 0.5. For example, suppose the white fan share is initially greater than 0.5 and this share rises. On the one hand, there will now be stronger demand coming from white fans (the $\mu(\cdot)^{\frac{1}{\phi}}$ term rises). On the other hand, since there are fewer non-white fans there will be less willingness by them to pay for watching a given proportion of non-white players perform. The gain in demand attributable to white fans will be less than the loss in demand attributable to non-white fans, because

$$\varepsilon\left[\left(\frac{L_W}{L}\right)^{\frac{1}{\phi}}(1-\mu)\left(\frac{L_W}{L}\right)^{\frac{1}{\delta}}\right] < \mu\left[\left(\frac{L_W}{L}\right)^{\frac{1}{\phi}}\left(1-\frac{L_W}{L}\right)^{\frac{1}{\delta}}\right]$$

hence a larger white fan share will lead to lower stadium admissions. In contrast, the marginal effect of a larger white fan share on stadium admissions will be positive if μ is initially less than 0.5. This is because when the fan population is predominantly non-white and the white fan share rises, the gain in demand attributable to white fans will exceed the loss in demand attributable to non-white fans

$$\varepsilon\left[\left(\frac{L_W}{L}\right)^{\frac{1}{\phi}}(1-\mu)\left(\frac{L_W}{L}\right)^{\frac{1}{\delta}}\right] > \mu\left[\left(\frac{L_W}{L}\right)^{\frac{1}{\phi}}\left(1-\frac{L_W}{L}\right)^{\frac{1}{\delta}}\right]$$

and there will be a net increase in stadium admissions.[1]

A second important feature of the demand function is that there is also an ambiguous relationship between fan demand for stadium admissions and the racial composition of the team. Differentiating admissions with respect to team racial composition,

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

reveals that the marginal effect of team racial composition on admissions can be positive, negative or zero. While the first term in brackets on the right-hand side of equation (4) is always positive, the second term in brackets can be positive, negative or zero. The sign of the second term, hence of expression (4), will depend precisely on how white the team initially is:

$$\begin{aligned}\frac{\partial Q}{\partial \frac{L_W}{L}} > 0 \quad \text{if} \quad \frac{\frac{L_W}{L}}{1-\frac{L_W}{L}} < \frac{(1-\mu)\delta}{\phi\mu}\\ \frac{\partial Q}{\partial \frac{L_W}{L}} < 0 \quad \text{if} \quad \frac{\frac{L_W}{L}}{1-\frac{L_W}{L}} > \frac{(1-\mu)\delta}{\phi\mu}\end{aligned} \quad (5)$$

If the team is initially predominantly white, then an increase in the white share of the team will lead to lower fan demand. The reason is: (i) a whiter team caters to the tastes of white fans and demand attributable to that share of the fan pool will rise (this positive effect on fan demand is reflected in the

[1] As a numerical example, suppose that the white player share is 0.5 and that the white and non-white fan taste parameters (ϕ and δ, respectively) are both unity. If the white fan share rises from 80% to 85%, then the expression

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

in the fan demand function falls from 0.04 to 0.031875, implying that demand for stadium admissions will fall. In contrast, if the white fan share rises from 0.4 to 0.45, the same expression rises from 0.06 to 0.061875, implying that stadium admissions will rise.

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

term); but (ii) a whiter team will displease non-white fans, so the demand for admissions attributable to the non-white fan pool will fall (this negative effect on fan demand is reflected in the

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

term in equation (4)). When the team is primarily white to begin with, the latter effect dominates the former effect and fan demand will net fall. On the other hand, when the team is initially predominantly non-white, the gain in white fan demand due to a whiter team will more than offset the loss in non-white fan demand and total fan demand net will fall.

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 the complementary relationship between these inputs:

$$Q = \psi K^{\alpha} L^{\beta} \tag{6}$$

where K is units of capital (measured, for example, by number of stadium seats), L is units of labor, ψ reflects the efficiency of production and α and β are share parameters, where α and β are assumed to be less than unity. The number of players on a sports team is usually fixed, so we will assume L to be fixed.

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. Since a team's stadium costs are often at least partly subsidized, we assume that the team is partly subsidized and effectively 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

$$\pi = P\psi K^{\alpha} L^{\beta} - (1-\theta)rK - M \tag{7}$$

Substituting equation (1) into equation (7) and solving yields and expression for profit

$$\pi = \varepsilon\left[\mu\left(\frac{L_W}{L}\right)^{\frac{1}{\phi}}\cdot(1-\mu)\left(\frac{L_W}{L}\right)^{\frac{1}{\delta}}\right]\psi^{1-\eta}K^{\alpha(1-\eta)}L\beta(1-\eta)-(1-\theta)rK-M. \tag{8}$$

Once the fan demand function is incorporated into the profit function, the profit function takes on three novel features. First, team racial composition influences profits; a whiter team can raise or lower revenues and profits, all other things equal, depending upon how white the team initially is. Second, a change in the racial composition of the fan pool will influence team revenues and profits, e.g. a whiter fan pool will lower revenues and profits if the white fan share is initially large. Third, due to the multiplicative nature of the revenue component of the profit function, team racial composition, the racial composition of the fan population and stadium size all interact.

The team's objective is to choose a 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:

$$\frac{\partial Q}{\partial K} = 0 \;\Rightarrow\; \alpha(1-\eta)\varepsilon\mu\left(\frac{L_W}{L}\right)^{\frac{1}{\phi}}(1-\mu)\left(1-\frac{L_W}{L}\right)^{\frac{1}{\delta}}\psi^{1-\eta}K^{\alpha(1-\eta)-1}L^{\beta(1-\eta)} = (1-\theta)r \tag{9}$$

Second order conditions dictate that in order to have an interior solution, there must be diminishing marginal benefits to stadium size, i.e.

$$\frac{\partial^2 Q}{\partial K^2} = \alpha(1-\eta)(\alpha(1-ets)-1)\varepsilon\mu\left(\frac{L_W}{L}\right)^{\frac{1}{\phi}}(1-\mu)\left(1-\frac{L_W}{L}\right)^{\frac{1}{\delta}}\psi^{1-\eta}K^{\alpha(1-\eta)-2}L^{\beta(1-\eta)} < 0 \tag{10}$$

Second order conditions are satisfied because the expression $\alpha(1-\eta)(\alpha(1-ets)-1)\varepsilon$ will always be negative.

An expression for optimal stadium size can be obtained by solving equation (9) for K

$$K = \left[\frac{(1-\theta)r}{\alpha(1-\eta)\varepsilon\mu\left(\frac{L_W}{L}\right)^{\frac{1}{\phi}}(1-\mu)\left(1-\frac{L_W}{L}\right)^{\frac{1}{\delta}}\psi^{1-\eta}L^{\beta(1-\eta)}}\right]^{\frac{1}{\alpha(1-\eta)-1}} \tag{11}$$

According to expression (11), optimal stadium size depends upon the price elasticity of demand for stadium admissions ($1/\eta$), the strength of fan racial preferences (ϕ and δ), team racial composition (L_W/L), other exogenous determinants of fan demand (ε), efficiencies in production (ψ), team size (L), the relative productivity of labor and capital (α and β, respectively), the stadium subsidy rate (θ), and the market price of capital (r). Furthermore, because of the multiplicative nature of expression (11), optimal stadium size will be influenced by interaction effects between all the determinants of the optimal capital stock. Note that the exponent term (outside of the brackets) is always negative.

Expression (11) yields some self-evident predictions, e.g. stadium size rises with the subsidy rate ($\partial K/\partial\theta > 0$), team size ($\partial K/\partial L > 0$) and other determinants of fan demand ($\partial K/\partial\varepsilon > 0$). There are also a number of novel predictions, specifically predictions regarding the effects on stadium size of changes in the racial composition of the fan population and the racial composition of the team. We discuss each of these predictions in detail below.

(i) *Stadium size falls (rises) when the white share of the fan population rises (falls), provided that the population is predominantly white*:

$$\frac{\partial K}{\partial \mu} = -\left(\frac{1}{\alpha(1-\eta)-1}\right)\left[\frac{(1-\theta)r}{\alpha(1-\eta)\varepsilon\mu\; {\frac{L_W}{L}}^{\frac{1}{\phi}}(1-\mu)\; 1-{\frac{L_W}{L}}^{\frac{1}{\delta}}\psi^{1-\eta}L^{\beta(1-\eta)}}\right]^{\frac{1}{\alpha(1-\eta)-1}} \times$$
$$\left[\frac{(1-\theta)r\alpha(1-\eta)\varepsilon\psi^{1-\eta}L^{\beta(1-\eta)}\left[{\frac{L_W}{L}}^{\frac{1}{\phi}}(1-\mu)\; 1-{\frac{L_W}{L}}^{\frac{1}{\delta}}-\mu\;{\frac{L_W}{L}}^{\frac{1}{\phi}}\; 1-{\frac{L_W}{L}}^{\frac{1}{\delta}}\right]}{\left[\alpha(1-\eta)\varepsilon\;{\frac{L_W}{L}}^{\frac{1}{\phi}}\psi^{1-\eta}L^{\beta(1-\eta)}\right]^2}\right] < 0 \;\; if \;\; \mu > 0.5 \tag{12}$$

Note that while the second term in equation (12) is always positive, the third term can be positive, negative or zero. If the white fan share is initially greater than 0.5, then the third term will be negative, causing expression (12) to be negative. The third term will be negative for the same reason that equation (3) is negative; when the white fan share is initially greater than 0.5 and then rises, the resulting increase in demand for admissions attributable to white fans will be more than offset by the decrease in admissions demand attributable to non-white fans. Because fan demand will net fall, this reduces the returns to stadium construction and leads to a smaller optimal scale of stadium. In contrast, if the white fan share is initially less than 0.5 and that share rises, the resulting increase in demand for admissions attributable to white fans will exceed the decrease in demand attributable to non-white fans. Because fan demand will net rise, the returns to stadium construction are augmented and the team will build a larger stadium. Because white fans dominate most, if not nearly all, large sports markets in the USA, we predict a negative *ceteris paribus* relationship between stadium size and the white fan share for the average American sports market.

(ii) *Stadiums will be larger when teams become whiter, assuming that teams are predominantly non-white to begin with*

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

$$\left[\frac{(1-\theta)r\alpha(1-\eta)\varepsilon\psi^{1-\eta}L^{\beta(1-\eta)}\left[\frac{\varepsilon\mu}{\phi}\ {\frac{L_W}{L}}^{\frac{1}{\phi}}(1-\mu)\ {1-\frac{L_W}{L}}^{\frac{1}{\delta}}-\frac{\varepsilon\mu}{\delta}\ {\frac{L_W}{L}}^{\frac{1}{\phi}}\ {1-\frac{L_W}{L}}^{\frac{1}{\delta}}\right]}{\left[\alpha(1-\eta)\varepsilon\ {\frac{L_W}{L}}^{\frac{1}{\phi}}\psi^{1-\eta}L^{\beta(1-\eta)}\right]^2}\right] < 0 \qquad (13)$$

$$if\ \frac{\frac{L_W}{L}}{1-\frac{L_W}{L}} < \frac{(1-\mu)\delta}{\phi\mu}$$

The signing of equation (13) requires precisely the same parameter restrictions as the signing of equation (4). All other things equal, if the team increases the fraction of players that are white, this raises white fan demand, but lowers non-white fan demand. If the team is initially predominantly white, non-white fan demand will fall more than white fan demand will rise, reducing the returns to stadium construction and inducing the team to choose a smaller stadium. On the other hand, if the team is primarily non-white to begin with and the team increases the white player share, the gain in white fan demand will be larger than the loss in non-white fan demand and the team will find it profitable to build a larger stadium. The implication here is that in those leagues where teams are primarily white, efforts by teams to cater to white fans will lead to less profitable stadiums, whereas in those leagues where teams are primarily non-white, indulging white fan tastes will augment stadium profitability.[2]

3 Empirical Analysis

Equation (11) in the theory section 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 "Bench-

[2]The model also predicts that stadiums will be larger in those markets where fan demand is more price elastic ($\partial K/\partial\eta < 0$). Recall that the price elasticity of demand rises if η falls. The lower value of η has the effect of raising quantity demanded for admissions at each price, thereby stimulating revenues and boosting returns to the stadium input. There is a counterintuitive practical implication here: stadiums will be larger, all other things equal, in markets where there are more close substitute forms of entertainment. Proof of this proposition is available from the authors upon request.

mark 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 studying 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 stadiums of the optimum size in each instance. Our basic empirical model is a linear version of equation (11) 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

$$K_{it} = \beta_0 + \beta_1 r_t + \beta_2 RC_{it} + \beta_3 RT_{it} + \gamma Z_{it} + \theta D_{it} + e_{it} \tag{14}$$

where K_it 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 (14) 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, a seat in a basketball arena in Denver may not be the same as a seat in a football stadium in Miami, or a seat in a hockey arena in Buffalo. Alternatively, the total construction costs could be used as a proxy for K_{it}. Total construction costs reflect 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 both definitions of capital in our empirical estimation of the parameters of equation (14). The primary parameter of interest in equation (14) 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 (12)), $\beta_2 < 0$, 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 construction projects, including total construction costs, compiled by Keating (1999). This impressive 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 updated Keating's list for the period 1998-2004 and augmented it with stadium capacity data from the Ballparks.com web site (www.ballparks.com). After updating the Keating list, we identified 177 individual stadium construction and renovation projects for professional football, basketball, baseball and hockey teams in the United States over the period 1887-2004. 143 of these were new stadium construction projects and 34 were renovations of existing stadiums.

Table 1: Summary Statistics, Stadium Construction and Renovation

Sport	Number of Projects	Millions of $2004	Capacity	Cost per seat
		New Facility Construction		
NFL	33	212	65,126	3,139
MLB	48	172	40,890	3,776
NBA	43	180	19,996	9,039
NHL	18	143	17,824	7,971
		Facility Renovation		
NFL	14	109	72,126	1,614
MLB	12	88	45,431	1,825
NBA	7	70	22,476	3,728
NHL	1	15	17,537	872

Table 1 summarizes the stadium construction and renovation data in the sample. 33% of the 143 new stadium construction projects in the sample were baseball stadiums, 30% were football stadiums, 24% were basketball arenas and 12% 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 sport. There are 18 facilities 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 suggests that the average real construction cost is not significantly different for the four sports, but the average cost per seat in basketball and hockey arenas is higher than the average cost per seat in baseball and football stadiums.

17.5% of the new stadium and arena projects were associated with one or more referendums on the funding of these projects. This percentage is based on data collected from the existing literature on stadium referendums, including referendums reported by Fort (1997) and Mondello and Anderson (2004). These studies only go back to the 1970s and there could have been additional referendums earlier in our sample period. 23% of the construction projects were undertaken by private firms and 77% were undertaken by public entities, including quasi-governmental agencies.

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.

The geographic unit of measurement in the sample is a city. 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 "city," 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).

3.2 Results and Discussion

We estimated the parameters of equation (14) with data for the 143 observations of new sports stadium and arena construction projects described above using the OLS estimator. We did not use observations for the 34 stadium renovation projects as these projects may be related to replacement investment of depreciated capital and thus differ in important ways from new facility construction projects. As discussed above, a number of definitions of capital are consistent with the model. Table 2 shows the results when stadium capacity is used as the dependent variable.

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.

We use the fraction of the local population that is white as an empirical measure of the parameter μ in our theoretical model. Note that this measure has often been used in empirical studies of customer discrimination in labor markets (see Kahn (1991) for a discussion of measures of fan prejudice).

The first column on Table 2 shows OLS estimates for the full 1909-2003 sample period. The model explains 64% of the observed variation in new stadium size and many of the parameters are significant and correctly signed. Higher levels of real per capita income, and larger populations, are associated with larger capacities of a newly built stadiums or arenas. Real per capita income and local population both increase demand for tickets to games, leading to larger facilities. Privately owned facilities tend to be smaller than publicly owned facilities. This result is consistent with the argument that ownership of a sports facility affects the team and facility made by O'Roark (2001). It is also consistent with the predictions of the model, in that privately owned facilities receive lower public subsidies. The vector of indicator variables for different sports suggest that basketball and hockey arenas are significantly smaller than baseball and football stadiums. The omitted category is a stadium that is either football only or baseball only and is publicly owned.

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

Table 2: OLS Estimates of Equation (14)

Dependent Variable is Facility Capacity

Variable	Full Sample	Pre 1960	Post 1960
Real Income per capita	330.45	-120.68	85.75
	0.011	0.765	0.675
Population (0000)	14.99	-9.14	14.89
	0.047	0.776	0.038
Real interest rate	981	883	336
	0.068	0.485	0.618
% white	-13350	4605	-14540
	0.036	0.829	0.021
Referendum	41.81	—	163
	0.99	—	0.956
Privately Owned	-10137	-21311	-886
	0.001	0.037	0.802
Basketball	-30633	-16231	-34310
	0.000	0.328	0.000
Hockey	-34517	-17077	-38056
	0.000	0.288	0.000
Basketball/Hockey	-33066	-12571	-39949
	0.000	0.413	0
Baseball/Football	2388	8436	-1046
	0.535	0.427	0.789
R^2	0.64	0.49	0.74
N	138	27	111

P-values shown below parameter estimates

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 parameter of interest is on the variable capturing the fraction of the city's population that is white. For this full sample, this parameter is negative and significant at the 3% level. This estimate implies that the whiter the local population, the smaller the stadium, other things equal. We interpret this as evidence confirming: (i) the existence of customer discrimination in the capital markets and; (ii) the negative marginal effect of the white racial fan share on stadium size predicted by our theoretical model.

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. We currently lack data on the racial composition of teams over the entire sample period. Even if we had such data, it is unclear how much the racial composition of visiting teams might also affect the discrimination mechanism, so the predicted effect of this variable on capital investment is unclear. In the early part of the sample, professional sports leagues were not integrated, and all of the players were white. Major League Baseball became integrated in 1947 when Jackie Robinson signed with the Brooklyn Dodgers of the National League. The National Basketball Association became integrated in the

1950-1951 season. The National Football League became integrated when the Cleveland Browns of the All-American Football Conference - a short-lived but integrated professional football league - were absorbed into the NFL.

Goff, McCormack, and Tollison (2002) studied racial integration in sports leagues from the perspective of innovation. They found that once the color barrier was broken on one team, competing teams quickly followed suit. This suggests two periods during which the racial composition of professional sports teams was relatively constant - the period before North American Sports Leagues were integrated, and the period after integration when the racial composition of sports leagues reached steady-state equilibrium. Estimating equation (14) separately for these two periods provides a rudimentary control for the racial composition of teams.

The second two columns of Table 2 show the results from estimating equation (14) for these two periods. Very few of the parameters are significant in the pre-integration period, including the variable capturing the racial composition of cities. But in the post-integration period, the variable capturing the racial composition of cities is negative and significant. To the extent that the racial composition of teams is constant after 1960, the results shown in column three indicate that the whiter the population in a city, the smaller the capacity of a new sports facility.

3.3 Robustness Checks

We performed two robustness checks on the results reported on Table 2. First, we were able to collect data on the racial composition of 28 sports teams in the year before a new facility opened. Including this variable in the empirical model over the full sample had no effect on the sign and significance of the % white variable. The small number of observations weakens the test, but this does suggest that the evidence of customer discrimination is robust to conditioning on the racial composition of teams.

Second, we re-estimated the model using an alternative interest rate variable. The NBER Macro History database contains data on the three and six month Treasury Bill rate back to 1959. T-Bills may be a more comparable debt instrument over a long period than municipal and AAA grade corporate bonds. Using a real interest rate variable calculated from the six month T-Bill rate resulted in a negative but statistically insignificant parameter on this variable and had no effect on the sign or significance of the other variables in the empirical model.

3.4 An Alternative Dependent Variable

We also estimated the parameters of equation (14) using the total construction cost of the facility as the dependent variable using the OLS estimator. Table 3 shows the result of these regressions for the three alternative sample periods reported on Table 2.

The results are similar to those obtained when capacity is the dependent variable. The empirical model explains less of the observed variation in total construction costs, but the parameters on real income per capita and population are positive and significant in the full sample and the post-integration period. Most importantly, the parameter on the variable capturing the percent of the population that is white is negative and significant, implying that the whiter the population of a city, the lower the total construction costs of new sports facilities, other things equal. Again, we interpret the sign of this parameter as confirming the key prediction of our theoretical model.

Note that Becker's (1971) model of discrimination predicts that customer discrimination, unlike other types of discrimination, can persist in the long run because of the lack of competitive market forces to correct the effects of this type of discrimination in labor markets. This prediction also holds for capital markets. In fact, the long-lived property of capital suggests that the effects of

Table 3: OLS Estimates of Equation (14)

Dependent Variable is Total Facility Cost

Variable	Full Sample	Pre 1960	Post 1960
Real Income per capita	4.401	-0.187	3.71
	0.000	0.745	0.061
Population (0000)	0 .170	0.074	0 .158
	0.005	0.121	0.022
Real interest rate	5.119	0.095	3.158
	0.229	0.958	0.625
% white	-156.7	-2.7	-120.6
	0.002	0.93	0.046
Referendum	127	—	113.6
	0	—	0
Privately Owned	-29.59	-20.71	1.06
	0.23	0.145	0.975
Basketball	-21.08	27.26	-41.52
	0.431	0.251	0.015
Hockey	-58.17	0 .560	-27.19
	0.054	0.98	0.446
Basketball/Hockey	6.31	58.18	-27.19
	0.84	0.016	0.446
Baseball/Football	-21.29	9.94	-22.71
	0.487	0.51	0.545
R^2	0.45	0.45	0.35
N	137	26	111

P-values shown below parameter estimates

customer discrimination would be more likely to be observed in capital markets than in labor markets.

4 Conclusions

We conclude that customer discrimination against labor inputs appears to spill over 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 whiter populations are smaller, and have lower total construction costs.

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. Optimum stadium size increased with income per capita in the local market and with the population of the local market. Private ownership of the facility reduces optimal stadium size, because publicly owned facilities receive significant public subsidies.

Finally, facilities built following a referendum on public funding, regardless of the outcome, tend to be larger, and more expensive than stadiums built without a referendum on public funding, other things equal. Based on the research of Mondello and Anderson (2004) and Fort (1997), not all these referendums pass, so this result suggests that further analysis of the political economy of stadium financing referendums might uncover some interesting behavior.

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