NOVELTY EFFECTS OF NEW FACILITIES ON ATTENDANCE AT PROFESSIONAL SPORTING EVENTS

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Abstract

We investigate the possibility that new facilities affect attendance - the "novelty effect" - in professional baseball, basketball, and football from 1969-2001 by estimating the parameters of a reduced form attendance model. Our results indicate a strong, persistent novelty effect in baseball and basketball and little or no novelty effect in football. Our estimates of size and duration of the novelty effect imply that, in a new facility, at a minimum, a baseball team would sell an additional 2,561,702 tickets over the first eight seasons, a basketball team 446,936 over the first nine seasons, and a football team 163,436 over the first five seasons. This increase in attendance also suggests a corresponding increase in revenues that could be tapped to help defray the large public subsidies that state and local governments frequently provide to new stadium and arena construction projects.

JEL Codes: L83, R39, D12

I. Introduction

Both conventional wisdom and casual empiricism suggest that new sports facilities boost attendance at sporting events. Economists, when analyzing the economic impact of professional sports teams and facilities on local economies, also typically assume that these effects are concentrated in the years immediately following the opening. Some evidence of a relatively large "novelty effect" on attendance exists. Quirk and Fort (1997) report an average increase in attendance of about 62% during the first five years a baseball team plays in a new stadium. But based on attendance at several new baseball stadiums, where attendance is down significantly, the era of large novelty effects on attendance may be ending. Whether this decline can be attributed to macroeconomic events outside the control of sports teams or to the glut of new stadiums opened in the last decade is an open question. In order to address these issues, several fundamental questions must be answered

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about the “novelty effect” of new facilities on attendance, including how this effect varies over time and between sports. In this paper, we investigate the size and dynamic behavior of the effect of a new sports facility on annual average live game attendance in professional football, basketball, and baseball.

This research examines attendance in a number of professional sports leagues. Quirk and Fort (1997) documented large increases in average attendance following the opening of new baseball stadiums. They claim that similar increases may not exist in professional basketball and football because the large number of sold out regular season games leaves little leeway for dramatic increases in attendance after a new facility opens in these sports, although Quirk and Fort point out that the profits of franchises in these other sports may be enhanced by opening a new facility, largely through higher prices for tickets. Sold out games occur infrequently in regular season baseball games. Noll (1974) reported that the effects of the age of a baseball stadium show “a steady, linear decline in the attendance generated by a new stadium” and that this “proved much more significant than alternatives, such as dummy variables for 'very new' and 'middle-aged' stadiums.” Noll's regressions explaining attendance at basketball, football and hockey games do not include terms capturing the novelty effect. We analyze attendance at professional football, basketball and baseball games to assess the validity of these predictions.

The effect of a new stadium or arena on attendance at professional sporting events also has important public policy implications. Nearly all new professional sports facilities built in the US in the past forty years received large public subsidies. The public supports construction of stadiums through the issue of bonds with a maturity of many years. State and local governments subsidize sports facility construction and pay off the bonds that finance this construction, so information about the size and duration of the novelty effect can help decision makers to formulate appropriate policies. For example, using the increased public revenues from these stadiums to cover the principal and interest on government bonds issued to finance stadium construction until their maturity would be in the public interest. To know if this is possible, one needs an estimate of how long the boost to attendance and, therefore, revenues, from the new facilities lasts and how large the boost might be.

The length of the novelty effect also plays an important role in studies of the economic impact of professional sports teams and facilities on local economies. Empirical research in this area makes a distinction between new sports facilities - those open between five and eleven seasons - and existing facilities. For example, Baade and Sanderson (1997), citing Noll, suggest that the novelty effect of new sports facilities disappears 7 to 11 years after opening in their study of the effects of sports facilities on employment. Coates and Humphreys (1999, 2001, 2003) use a dummy variable indicating the first ten years a sports facility is open regardless of the sport or sports the facility houses, implicitly assuming that the novelty effect is of equal duration and size regardless of the sport for which a facility is constructed or the amount of time that has passed since the facility opened. Any economic impact generated by new sports facility construction may be masked by misspecification in the estimating equations used in these studies. This research assesses the validity of this assumption.

Most studies of the determinants of attendance at professional sporting events typically assume equal size and duration of the novelty effect. Bruggink and Eaton (1996) modeled the effect of stadium age on baseball attendance using the age of the stadium in years and found negative and statistically significant effects of stadium age for American League franchises, but positive and significant effects of age in the National League. They suggest the difference may be related to vastly different stadium ages between the two leagues. Three American League facilities were under four years old but the youngest National League stadium was 6 years old, followed by the next youngest at 22 years old. Coffin (1996) modeled the novelty effect in baseball stadiums as declining over the first four seasons and found evidence of a positive effect on attendance. Kahane and Shmanske (1997) modelled the novelty effect as constant over three years and found positive and significant effects of new stadiums on annual attendance in professional baseball during the period 1990-1992. Harrison and Coates (2002) estimate demand functions for major league baseball attendance that allow the natural logarithm of the age of the stadium to affect attendance. None of these studies examined the size and dynamic behavior of the novelty effect on attendance for all three major professional sports or in all types of facilities. We attempt to fill this void in the literature.

It appears, at least in baseball, that the novelty effect of a new stadium now has a much shorter duration than in the past. For example, in Pittsburgh, where PNC Park opened in 2001, attendance was down about 26.8% in the 2002 season from the 2001 level, almost back to its level from the last season in Three Rivers Stadium in 2000, and after 51 home dates in the 2003 season continued to decline another 9% from the 2002 season. In Detroit, where Comerica Park opened in April 2000, attendance was down 21.7% in 2002 relative to 2001, which was lower than the 2000 level, and even below the level for 1999, the last in Tiger Stadium.After 49 home dates in the 2003 season attendance continued to decline by another 9% from the 2002 season. In Milwaukee, where Miller Park opened in April 2001, generating a boost to Brewers' attendance of 1.23 million over the 2000 season, attendance was down by 30% in 2002 relative to 2001, and after 54 home dates in 2003 continued to decline by 22% from the 2002 season. Admittedly, the national economy has been in, or sluggishly emerging from, a recession for the past few years, and the threat of a work stoppage hung over much of the 2002 season. However, attendance was only down 6.2% across all of Major League Baseball in 2002 and several teams experienced attendance growth.[1] The *Sports Business Journal* highlighted these effects in an article by Frederick C. Klein (2002), suggesting that there has been a decline in the novelty effects of stadiums and that the decline has been worse for stadiums and arenas that are not placed "in a lively neighborhood, where people are happy to gather even on non-game days."

The remainder of the paper is organized as follows. In the next section, we describe a reduced form empirical model of live game attendance at sporting events that captures the novelty effect of new facilities. Rather than force the data into a path of our choosing, estimation of the parameters of this model allows the data to tell us the time-path of the novelty effect. Succeeding sections describe the data used in the analysis, report and discuss the results, and draw some conclusions from these results.

II. An Attendance Model

In this section we describe a reduced form empirical model of live game attendance at sporting events. Before specifying this reduced form model, we consider the economic theory underlying the model. We intend to explain average attendance at professional sporting events. Attendance is the result of the interaction of the demand for attending games in person and the supply of seats in sports facilities.

To illustrate this point, consider the following simple supply and demand model for attendance where Q_d is quantity of tickets demanded, Q_s is quantity of tickets supplied, and P is the ticket price. The demand function is

[1] Figures reported in the text for the 2003 season come from http://www.canoe.ca/Baseball/attendance.html, accessed on July 25, 2003. Figures for the 2002 season and declines from the 2001 season were taken from The *Sports Business Journal*, "By The Numbers", Vol. 5, Issue 36.

$$Q_d = \alpha + \beta P + \gamma_1 D_1 + \gamma_2 D_2 + \gamma_3 D_3 \tag{1}$$

where the D_js are demand shifters - dummy variables indicating the stadium is in its jth year of operation - that capture the novelty effect in this model. In this way, we assume that the novelty effect works through consumers' preferences or tastes for attendance at sporting events. β is the effect of price on the quantity demanded and α an intercept parameter. For computational convenience, we assume that the novelty effect lasts three seasons in this example. The supply function is

$$Q_s = \lambda P \tag{2}$$

where λ is the effective of price on quantity supplied. The supply function is assumed to have unit price elasticity everywhere, without loss of generality. The equilibrium condition in this market is $Q_d = Q_s$, and a reduced form equation for attendance can be found using this condition. Invert the supply function and substitute the result into the demand equation. Using the equilibrium condition, an expression for equilibrium attendance

$$\begin{aligned} Q &= \frac{\alpha\lambda}{(\lambda-\beta)} + \frac{\gamma_1\lambda}{(\lambda-\beta)} D_1 + \frac{\gamma_2\lambda}{(\lambda-\beta)} D_2 + \frac{\gamma_3\lambda}{(\lambda-\beta)} D_3 \\ Q &= a + c_1 D_1 + c_2 D_2 + c_3 D_3 \end{aligned}$$

can be derived after a bit of manipulation. In the second line, c_1, c_2 and c_3 are reduced form parameters that reflect both the novelty effects and the relative price elasticities from the supply and demand functions. These reduced form parameters are the product of the novelty effect parameters γ_i and $\frac{\lambda}{\lambda-\beta} = \frac{\epsilon_s}{\epsilon_s+\epsilon_d}$, where the ϵ_j are the price elasticities of the demand and supply functions. The latter term falls in the range 0 to 1, implying that c_i is a lower bound on γ_i, the structural novelty effect of interest. This equation for attendance forms the basis for our empirical investigation of the novelty effect. We estimate an expanded version of the reduced form equation

$$Q = \sum_{k=1}^{K} c_k D_k + \theta W + \epsilon \tag{3}$$

that includes W, a vector of control variables that shift either the demand or supply function. K is the number of seasons over which the novelty effect persists and ϵ an unobservable error term.

For our purposes, the γs are the parameters of interest, as they capture the novelty effect on demand for tickets to sporting events. Coffin (1996) and Harrison and Coates (2002) both investigate the novelty effect on attendance by explicitly estimating a demand function, like equation (1), for baseball games over a short period for which baseball ticket price data exist. Although ticket price data are sporadically available for baseball over our longer sample period, ticket price data are not available for professional football or professional basketball by team over much of the period. We lack the price data required to estimate a demand function containing novelty effect terms but can learn something about the novelty effect using the relationship between the reduced form parameters and the structural parameters of the demand and supply functions. In particular, the ratio of any two of the reduced form parameters on D_k equals the ratio of the structural parameters in the demand function

$$\begin{aligned} \frac{c_2}{c_1} &= \frac{\gamma_2}{\gamma_1} \\ \frac{c_3}{c_1} &= \frac{\gamma_3}{\gamma_1}. \end{aligned}$$

If $\frac{c2}{c1} > 1$ then the novelty effect of a new facility rises in the second season relative to the first season. If the sign is reversed, the novelty declines from the first to the second season. Our expectation is that the c_is are each positive, though they approach zero over time.

The specific linear reduced form model of attendance at sporting events we estimate

$$ATT_{it} = aX_{it} + bZ_{it} + \sum_{k=1}^{K} c_k D_{kit} + e_{it} \tag{4}$$

relates ATT_{it}, average attendance at games in city i in year t to X_{it}, a vector of demographic and economic control variables for the city and year, Z_{it}, a vector of franchise and stadium characteristics including the age of the facility in years, and D_{kit}, a dummy variable that takes on a value of one if the stadium in city i and year t is in its kth year of operation. Vectors a and b, and the c_ks, are all reduced form parameters, functions of the underlying structural parameters of the demand and supply functions as described in the model above. e_{it} is an unobservable equation error term that captures the effects of all other factors on average attendance at sporting events. We assume that the error term takes the form

$$e_{it} = v_i + m_t + u_{it}. \tag{5}$$

where $u_{it} \sim (0, \sigma_u^2)$. This assumption means that there is some city or franchise specific component that is constant over time, a year specific component that is constant across franchises and cities in each year, and a well behaved random component that varies by franchise or city and year. The city and year specific components of the error term can be estimated as a series of dummy variables in a two-way fixed effects model.

In this context, the vectors of explanatory variables X_{it} and Z_{it} contain variables that shift the demand and supply curves for attendance at professional sporting events in cities; some of these variables may shift both. Although we focus on estimating the novelty effect of new facilities on attendance, we still must control for variation in other factors that affect attendance.

Successful teams are likely to have higher attendance than unsuccessful teams. In our analysis, we use the won-loss percentage in the current year in one specification, the won-loss percentage in the previous year in another, and playoff participation from the previous year in both to control for team success. Our hypothesis is that a greater won-loss percentage raises attendance, as does participation in the previous season's playoffs.

Additional sports related variables that might explain attendance include stadium capacity, the total number of professional sports franchises in a city, and the number of games in a season. Stadium capacity is assumed to have an impact on attendance. Obviously, at one extreme attendance is limited by the number of seats in the venue. However, number of seats is only a binding consideration if the stadium is sold out. Consequently, the marginal impact of capacity must vary with capacity. It may even turn negative as a large stadium with room for more fans may also mean greater distance from the field and less visibility of the action.

The number of sports franchises in a city reflects the scope of alternative sporting events available to residents of the city, as well as visitors. Many of the cities in our sample have a franchise in more than one of the three sports, and Chicago, New York, and Los Angeles have multiple franchises in a single sport. The availability of these alternative major league sport entertainment opportunities may affect the attendance at the different franchises and, more importantly for our purposes, the novelty effect, from opening new facilities. For example, suppose a franchise opens a new football stadium during the heat of a pennant race involving that city's baseball team. One can imagine that might reduce the interest in attending football, reducing the novelty impact of the stadium. To capture the presence of these alternative sports we include a variable that counts the number of franchises in either baseball, football or basketball in the city. The relationship between this variable and attendance cannot be signed with certainty *a priori* because alternative sporting events may be either substitutes or complements, but our intuition is that more sports franchises in a city will tend to lower the average attendance for a specific franchise.

The number of games in a season may also affect average attendance. Professional baseball teams play 81 regular season home games, football changed from 14 to 16 regular season home games beginning with the 1978 season, and basketball teams play 41 home games. The football season runs from September through January, or five months, while the baseball season runs from April until October, more than 6 months, and the basketball regular season runs from late October through mid-April. The lengths of the seasons, the relative scarcity of home football games, the fact that nearly all football games are played on Sunday afternoons while baseball and basketball games are played throughout the week and generally in the evening, suggests that intensity of demand for attendance at the three types of sporting events may differ. These vast differences in schedules and the generally much larger attendance at NFL games suggests that equations for novelty effects of new facilities must be estimated for each sport. We also use average attendance as our dependent variable rather than total attendance to control for the effects of differences in schedules.

Demographic and economic controls in our reduced form equation are per capita income, population and city and year-specific dummy variables. We hypothesize that greater income in the community will raise attendance and that having a larger fan base to draw from, a larger population, will have the same effect. City specific dummy variables control for any local factors not already accounted for, such as climate, ease of obtaining tickets, and parking and other monetary and non-monetary costs of attendance at sporting events in the city.

III. Data Description

The data used in this analysis form a panel of annual average attendance at Major League Baseball (MLB), National Football League (NFL) and National Basketball Association (NBA) games in each U.S. city that hosted a franchise in one of those sports, along with additional franchise-specific and city-specific data, over the period 1969 to 2001. The panel includes data for franchises that existed in cities throughout the sample period as well as expansion franchises and teams that relocated during the sample period, but excludes franchises in Canadian cities due to a lack of city-specific economic and demographic data.

Studies of attendance at sporting events typically use annual attendance for an entire sports league (see Schmidt and Berri (2002) for a recent example), annual attendance for individual teams (see Humphreys (2002) and Eckard (2001) for recent examples), or attendance at individual games (see Garcia and Rodriguez (2002) and Price and Sen (2003) for recent examples). We use annual average attendance for teams in professional sports leagues as the unit of observation. Total annual league attendance would obscure the effects of a single new facility. Game specific attendance data are not available over a long period of time in the three professional sports we examine and we lack economic and demographic control variables at this frequency. Our unit of observation, average annual attendance for an individual franchise, should capture the effects of individual sports facilities and corresponds in frequency and geographical area with economic and demographic data available for Standard Statistical Metropolitan Statistical Area (SMSA) data available as part of the Regional Economic Information System data published by the Department of Commerce.

Table 1 shows sample statistics for the key variables in the empirical model for the three professional sports. As expected based on facility size, football franchises have the largest average attendance, followed by baseball and then basketball. Baseball franchises tend to be located in larger cities - football is pulled down significantly by the Green Bay Packers because Green Bay is much smaller than any other city hosting a professional sports franchise - and baseball stadiums and franchises are older than those in football and basketball. Also as expected, many more basketball teams reach the postseason than in football, and relatively few baseball franchises reach the postseason.

Our sample period has been an active one in the construction of stadiums and arenas, and in the creation of new franchises. For example, during the 1990s alone the four major professional sports, baseball, football, basketball, and hockey, experienced growth of 19 expansion franchises and construction of 55 new stadiums or arenas. Major League Baseball has seen four new franchises and 14 new stadiums since 1990; the NFL expanded by adding franchises, in Charlotte, Jacksonville and Cleveland, and saw four franchises relocate from one city to another (Browns from Cleveland to Baltimore where they became the Ravens, Oilers from Houston to Nashville where they became the (Tennessee) Titans, Rams from Los Angeles to St. Louis, and Raiders from Los Angeles to Oakland) and 15 new stadiums. Baltimore lured the existing franchise away from Cleveland in 1995, with play beginning in Baltimore in 1996. Cleveland launched a successful campaign to recover a team and to keep the colors and name of the departed franchise. From the last two lines of Table 1, between 2.7% and 6.6% of the franchise seasons in the sample were the first season in a new facility and between 27% and 58% of the franchise seasons in the sample were within ten seasons of the opening of a new facility. There were more new facilities opened during the sample period in basketball than in the other two sports.

The empirical analysis controls for variation in factors like team loyalty in assessing the novelty effects of the new stadium. Teams that have existed in a particular city for longer periods of time will develop both a broader and a deeper following among local fans. This greater attachment, or the "fan loyalty effect," may result in greater attendance at games, other things equal. Our approach to measuring this loyalty to the team is to include as a regressor the age of the franchise. For many franchises this is quite simple. For example, the Boston Red Sox and the New York Yankees have played since the early years of the 20th century in the same city. Their ages date from that time. Franchises like the Baltimore Orioles, the San Francisco Giants and the Los Angeles Dodgers existed in other cities prior to becoming the teams that are familiar now. The Giants and the Dodgers both moved from New York in 1958, keeping their names and colors. The Orioles moved from St. Louis, where they were the Browns, in 1954. The ages of these franchises for the purposes of our analysis date from their inaugural seasons in their current home cities. That is the approach we take in each case. However, there are some complications.

In the NFL, the problem is that there are two unprecedented events that complicate franchise dating. First, the Raiders franchise left Oakland in 1982 for Los Angeles and then left Los Angeles in 1994 to return to Oakland. Through these moves they retained the team nickname, logo, and colors. The franchise returned to the same stadium in Oakland that it had left 12 years before. Our approach is to treat the Raiders as three distinct franchises, one born in 1961 that died in 1982, one born in 1982 that died in 1994, and a third that was born in 1994. Whether such an approach captures the build-up of fan loyalty over time that we proxy for with franchise age is questionable. The case of the Cleveland Browns highlights this uncertainty.

In 1995, the then Cleveland Browns relocated to Baltimore. Residents of Cleveland had historically supported this franchise with high attendance despite a creaky old stadium and many seasons of lackluster play. The fans in Cleveland were rightfully upset, and elicited great sympathy from around the country, for the way their city had been abandoned. Interestingly, no similar outpouring of sympathy for Baltimore arose when its team, the Colts, moved to Indianapolis in 1984, for Oakland when the Raiders moved to Los Angeles in 1982, or for St. Louis when the Cardinals left for Arizona. A few months after the move, the NFL promised the city a new franchise and the owner of

Table 1: Sample Statistics

Variable	MLB N	MLB Mean	MLB S.D.	NFL N	NFL Mean	NFL S.D.	NBA N	NBA Mean	NBA S.D.
Average Attendance Per Game	809	22,780	9,464	927	57,394	11885	771	13,456	4366
Real Per Capita Personal Income	809	15,888	3027	927	15,428	3073	771	15,560	2819
Population (000)	809	3,731	2,477	927	3,144	2,323	771	3,360	2,481
Winning Percentage	809	.500	.069	927	0.500	0.197	771	0.500	0 .151
Stadium Age	809	29	23	927	24	17	771	16	14
Team Age	809	47	34	927	31	19	771	25	14
Playoff Appearance Last Year	780	0.18	0.39	891	0.29	0.45	736	0.58	.49
First 10 years in Stadium	809	0.272	.445	927	0.376	.484	771	0.578	.494
First Year in Stadium	809	0.027	.163	927	0.046	.210	771	.066	.249

the Browns, Art Model, relinquished the team name and colors to the city. Consequently, while no team played in Cleveland from 1996 until 1999, three seasons, there is some very real sense in which the franchise is the same. Indeed, if one looks at the Cleveland Browns history on the NFL.com website, the records and accomplishments of the pre-move Browns are chronicled with those of the new incarnation of the Browns, albeit with a three year gap. (By contrast, the accomplishments of the Baltimore Colts are displayed on the Indianapolis Colts web page despite the fact that none of the Hall of Fame Colts ever played or coached in Indianapolis and that the team was in Baltimore when it won each of its 3 NFL championships.) The Browns and Raiders situations complicate the franchise age issue. Nonetheless, as a first approximation we simply measure age from the arrival of a franchise into a city.

Finally, the model described above includes both year and franchise specific effects. The year specific effects may capture national economic circumstances, a compelling pennant race or the effects of a player chasing some record. For example, one might think that attendance in baseball was higher than usual throughout the National League in 1998 when Mark McGwire and Sammy Sosa were chasing, and breaking, the single season home run record. The year specific effects will capture some of these and myriad other year to year variations which are common across professional sports and cities. The franchise specific effects will capture aspects of the local community that are consistent across time yet not captured by other factors. Possible effects captured by the franchise specific effects are the climate or region, the nature of the city (industrial versus commercial, e.g.), or the "sports culture" of the community.

In terms of capturing the novelty effect, we use two distinct variables in the analysis. First, we include the age of the stadium in a given year. Second, we have dummy variables that indicate the first through tenth year in a new stadium or a variable that indicates that the current year is one of the first ten. This latter variable is akin to the approach taken by Coates and Humphreys (1999, 2001, 2003). We have included the age of the stadium to account for detrimental effects on attendance associated with run down or decrepit facilities with poor amenities. Clearly, older stadiums were designed with less consideration given to fan comfort and environment than the newer ball parks of the last decade. The condition of the older stadiums is often one of the issues raised by owners who hint at moving their franchise if a new stadium is not built. At the same time, we are interested in those effects on attendance associated with the novelty of the stadium. These effects would appear above and beyond those of the age of the facility. Consequently, we include the variables picking out each of the first ten years a stadium is open. Descriptive statistics for the variables, except the dummies for year of operation, are provided in Table 1.

IV. Estimation Results

Table 2 shows the results of estimating equation (4) with the OLS estimator under the assumption that current real per capita income in each city and the current winning percentage of each franchise are uncorrelated with the equation error term. Recall that the attendance model is a reduced form equation and the parameters of this model reflect both demand shifts and supply shifts, complicating the interpretation of the coefficients.

The duration of the novelty effect will be reflected in patterns in the c_ks and in the size of K. Because the appropriate number of D_k terms to include may vary by sport, we estimate the reduced form attendance model separately for each sport. In keeping with the standard practice in the literature, we chose 10 seasons as the base case in our empirical analysis.

The results for the columns headed with (1) use a dummy variable that is equal to 1 in each of the first ten seasons played in a new stadium or arena as a proxy for the novelty effect and the results in the columns headed with (2) use ten separate dummy variables to capture the novelty effect. The parameter estimates on the city and franchise specific variables are not sensitive to the choice of a proxy variable for the novelty effect. There is a good deal of variation in the parameter estimates across the three professional sports.

The parameter estimates on the city and franchise specific variables are, in general, statistically significant and correctly signed. Variation in per capita income is positively associated with variation in average attendance in MLB and the NFL, although the significance of the parameters in the NFL is weak. Variation in per capita income is not statistically related to variation in average attendance in the NBA. There is no evidence of market size effects for MLB and NFL franchises; variation in the population of the city hosting MLB and NFL franchises does not explain variation in average attendance. Curiously, there is evidence of a negative market size effect in the NBA, where franchises in larger cities tend to average fewer fans per game than franchises in smaller cities.

Success on the field or court is associated with higher attendance; the parameters on the current winning percentage variables are uniformly positive and statistically significant. The size of this parameter is somewhat difficult to interpret because the values taken on by the explanatory variable are fractions between zero and one. At the means of the variables, the elasticity of average attendance with respect to changes in winning percentage implied by these point estimates are 1.06 in MLB, 0.14 in the NFL, and 0.29 in the NBA. These elasticities are consistent with the idea that the walk-up gate, which should be related to on-field success, is more important in baseball than in basketball or football. The parameters on the lagged playoff appearance variables are positive and statistically significant in the NFL and MLB but not in the NBA, perhaps due to the smaller number of teams that make the postseason in MLB and the NFL relative to the NBA, where most teams make the postseason.

We use both facility age and the number of years a franchise has played in a city as explanatory variables. Theory provides no guidance on the appropriate functional form for these variables, so we investigated alternative specifications: a linear specification, a linear-quadratic specification, and a semi-log specification. We report only the linear and linear-quadratic specification results because the semi-log results are essentially the same as the linear-quadratic ones, though with somewhat larger novelty effects. These results are available upon request. We found differences between attendance in MLB and the NFL and NBA in terms of nonlinearities in the stadium age and team trend variables. F-tests suggest that the effects of stadium age and franchise tenure in the NFL and NBA are linear, but these effects are nonlinear in MLB. These F-tests suggest that squared terms on stadium age and the team trend variable belong in the attendance model for MLB only.

The signs on the stadium age variables are consistent with the idea that teams in older facilities draw fewer fans than teams in newer facilities, a claim made frequently by franchises in search of public funding for a new stadium, at least up to a point. Each additional year a team plays in an existing stadium reduces average attendance by 71-91 per game in a baseball stadium, by 134-145 per game in a football stadium and by 78-82 per game in a basketball arena. This range comes from evaluating the derivative of the relationship with respect to stadium age at the average stadium age in the sample. At the average age of facilities in each sport this suggests that the total effect of stadium age is to reduce attendance by about 35 per game in MLB, 3,500 per game in the NFL, and 1,300 in the NBA. But the novelty effects discussed below suggest that the impact of a new stadium on attendance will be larger than just from replacing an average aged facility.

Interestingly, the stadium age effect in MLB increases with age, rising from -150 at opening, not including the novelty effects discussed below, reaching zero at about 74 years, and becoming positive thereafter. In other words, at about 74 years, a baseball stadium changes from an "aging eyesore" in need of replacement into an "historic treasure" to the community. The status given to old baseball parks like Fenway Park in Boston, Wrigley Field in Chicago, and Yankee Stadium in New York motivate the size and sign of these variables.

The parameters on the team trend variable are a mixed bag, perhaps because this variable is a poor proxy for fan loyalty and does not adequately capture the effects of fan loyalty on attendance. The point estimates on this variable are not statistically different from zero in the NFL. It is positive and significant in MLB, suggesting that the fan loyalty effect on attendance is positive. But the parameters are negative and significant in the NBA, suggesting that the longer an NBA franchise stays in a city, the lower its average attendance. This negative fan loyalty effect may explain why NBA franchises move much more often than NFL or MLB franchises, but the underlying preferences and consumer behavior of fans are unclear. The negative squared term on the team trend variable in MLB suggests that the positive effect of fan loyalty on average attendance is increasing at a decreasing rate in that sport and becomes negative at an age of 40 years. This effect is not intuitive so we also estimated the model using the log of team trend rather than the linear-quadratic specification. The results on the variables of interest, the novelty effects, were somewhat larger and followed the same pattern as described below. The log team trend variable was positive and statistically significant. These results are available upon request.

We also control for the relationship between the number of other professional sports teams in a city and average attendance at games in each sport. The variable "`# Other Franchises` " is the number of other professional teams in each city. This variable reflects the scope of alternative sporting events attendees have to choose from in each city in the sample in each year. The point estimates on this variable are statistically different from zero at the 5% level only in MLB, although the P-values indicate significance at the 10% level in the NBA. The signs of these variables suggest that other sports are substitutes for professional baseball and, to a lesser extent, professional basketball in cities. Each additional competing professional sports franchise reduces average attendance at MLB games by about 1,800. The parameter on a variable containing the capacity of each sports facility was not statistically different from zero in any of the models, so we dropped this variable from the model.

The final set of explanatory variables capture the novelty effects of new facilities. Model (1) uses a dummy variable for the first ten seasons in a new facility, a specification consistent with the general practice in the literature. The parameter on this variable is positive and significant in all three professional sports, suggesting that new sports facilities increase attendance holding constant on-field success, market size, and other factors. The novelty effect is largest in MLB, an increase in average attendance of about 11% per year in each season over the 10 season period, somewhat smaller in the NFL, an 8% increase, and smallest in the NBA, about a 4% increase. However,

Table 2: Attendance Model - Wins and Income Exogenous

Dependent Variable: Average Attendance

	MLB		NFL		NBA	
Variable	(1)	(2)	(1)	(2)	(1)	(2)
Per Capita Income	1.001	0.978	0.722	0.676	-0.096	-0.115
	0.000	0.000	0.062	0.080	0.392	0.309
Population	-0.0003	-0.0005	0.001	0.001	-0.0001	-0.0001
	0.710	0.527	0.356	0.316	0.540	0.416
Current Winning %	47819	48068	17478	17861	9120	9128
	0.000	0.000	0.000	0.000	0.000	0.000
Stadium Age	-150	-106	-145	-134	-82	-78
	0.001	0.031	0.000	0.000	0.000	0.000
Stadium Age^2	1.01	0.604				
	0.055	0.274				
Team Trend	120	118	337	313	-88	-90
	0.003	0.004	0.130	0.158	0.000	0.000
Team Trend^2	-1.48	-1.39				
	0.000	0.000				
# Other Franchises	-1864	-1774	193	282	-386	-387
	0.000	0.000	0.831	0.757	0.087	0.087
Playoffs$_{-1}$	4341	4398	1742	1791	297	306
	0.000	0.000	0.014	0.012	0.093	0.086
First 10 Years	2400		2484		1080	
	0.001		0.003		0.000	
First Year		5543		2916		1180
		0.001		0.087		0.013
Second Year		4940		4613		1262
		0.000		0.005		0.001
Third Year		2841		3805		1404
		0.028		0.029		0.000
Fourth Year		3455		1646		1510
		0.004		0.337		0.000
Fifth Year		2801		5329		1378
		0.021		0.001		0.000
Sixth Year		2298		1650		1090
		0.051		0.322		0.005
Seventh Year		2660		4299		854
		0.022		0.010		0.028
Eighth Year		2455		1570		833
		0.032		0.349		0.034
Ninth Year		1813		2033		1069
		0.104		0.229		0.008
Tenth Year		2046		-880		749
		0.062		0.594		0.066
Observations	780	780	891	891	736	736
R^2	0.80	0.80	0.53	0.54	0.80	0.80

P-values Shown Below Parameters

this specification forces an equal novelty impact on attendance in each season during the ten year period and may not capture the dynamics of the novelty effect.

The second specification uses a separate dummy variable for each season in the first ten after a new facility opens. Based on these results, the ten year dummy variable does not capture the dynamics of the novelty effect of a new facility on attendance. In MLB, the first eight year dummy variables are positive and significant at the 5% level and a declining pattern can be seen in these parameters. The novelty effect in baseball is persistent and declines gradually. The novelty effect is also persistent in the NBA, where a positive and significant effect - based on a 5% level of significance - on attendance can be seen in each of the first nine seasons played in a new arena. No clear pattern emerges in the NFL, where a scattering of parameters are positive and significant, including seasons two, three, five and seven. The novelty effect may be absent in the NFL because of differences in the number of home games per season - 8 in the NFL compared to 81 in MLB and 41 in the NBA - and because football stadiums are larger and on average filled closer to capacity than baseball and basketball facilities.

Overall, the attendance models explain less of the observed variation in attendance at NFL games than NBA and MLB games. The reduced form attendance model explains 80% of the observed variation in attendance at MLB and NBA games, compared to just over half the observed variation in attendance at NFL games. This may be due to the lack of a detectable novelty effect associated with new NFL stadiums.

Again, the contemporaneous per capita income and winning percentage variables in these six models may be correlated with the unobservable equation error terms. If such correlation exists, then the OLS estimator is biased and inconsistent, and the point estimates and standard errors on some or all of the explanatory variables incorrect. In order to gain insight into the extent to which this problem is present, we estimated equation (4) replacing the contemporary values of per capita income and winning percentage with a one year lag of these variables. These values are predetermined at the time the unobservable equation error term is realized. By definition these values are uncorrelated with the equation error terms at time t. An alternative correction would be to use the Instrumental Variables estimator. However, we do not have good instruments for these variables in our current data, leaving lagged values as the best available alternative. Table 3 contains the results of this estimation.

The results on Table 3 are similar to those on Table 2, with several important differences. The parameter on the winning percentage variable is markedly smaller for MLB when the lagged value is used - the elasticity of average attendance with respect to changes in winning percentage at the mean in MLB is about 0.70, compared to an elasticity of about 1 in the previous specification - suggesting that some bias might be present in the results on Table 2. Similarly, the parameters on the per capita income variable are both larger in MLB. The statistical significance of the team trend variable changes in both MLB and the NFL. In the NFL, the team trend variable is positive and significant at the 6% and 7% level, providing weak evidence of a positive fan loyalty effect in the NFL. There is also stronger evidence of a persistent novelty effect in the NFL of Table 3, as the dummy variables on seasons two, three, five and seven are positive and statistically significant at the 5% level.

The sizes of the significant novelty effect parameters shown on Table 3 differ considerably across sports. The results indicate that the novelty effect declines over time in MLB. For example, relative to average attendance, the first year a stadium is open attendance is about 24% larger than otherwise but in the seventh season the boost over the average attendance is just over 10%. In the NBA, the increase in attendance implied by the significant parameters is about 10% over average for the first nine seasons. In the NFL, the increase is never more than 1% above annual average attendance. In terms of number of additional tickets sold, and remembering that the estimates are

Table 3: Attendance Model - Wins and Income Endogenous

Dependent Variable: Average Attendance

	MLB		NFL		NBA	
Variable	(1)	(2)	(1)	(2)	(1)	(2)
Per Capita Income	1.248	1.210	0.722	0.695	-0.121	-0.131
	0.000	0.000	0.087	0.099	0.316	0.282
Population	0.0003	0.00006	0.001	0.001	-0.0002	-0.0002
	0.675	0.939	0.596	0.544	0.368	0.279
Current Winning %	32694	33850	16053	16532	7848	7863
	0.000	0.000	0.000	0.000	0.000	0.00
Stadium Age	-182	-116	-148	-139	-80	-765
	0.001	0.041	0.000	0.000	0.000	0.000
Stadium Age^2	1.35	0.762				
	0.026	0.232				
Team Trend	120	114	443	422	-90	-92
	0.010	0.015	0.056	0.068	0.000	0.000
Team Trend^2	-1.634	-1.508				
	0.000	0.000				
# Other Franchises	-2027	-1833	-715	39	-0.607	12
	0.000	0.001	0.443	0.967	0.998	0.952
Playoffs$_{-1}$	2845	2822	-48	-765	-286	-289
	0.000	0.000	0.959	0.412	0.231	0.228
First 10 Years	2445		2526		1042	
	0.003		0.003		0.000	
First Year		6668		3037		1263
		0.000		0.085		0.012
Second Year		5076		4093		1253
		0.001		0.017		0.002
Third Year		4384		3487		1162
		0.003		0.053		0.004
Fourth Year		3388		2131		1424
		0.015		0.229		0.001
Fifth Year		3660		4589		1451
		0.009		0.007		0.000
Sixth Year		2784		1808		849
		0.040		0.293		0.038
Seventh Year		2591		5223		767
		0.053		0.002		0.062
Eighth Year		3075		650		690
		0.020		0.707		0.098
Ninth Year		1260		3004		877
		0.327		0.086		0.040
Tenth Year		1704		-900		1166
		0.177		0.598		0.007
Observations	780	780	891	891	736	736
R^2	0.73	0.74	0.50	0.51	0.78	0.77

P-values Shown Below Parameters

lower bounds, the results on Table 3 imply that a baseball team with a new stadium would sell an additional 2,561,702 tickets in the first eight seasons in the new ballpark, a basketball team would sell 446,936 over the first nine seasons in a new arena, and a football team would sell an additional 163,436 over the first five seasons in a new stadium.

In sum, we interpret the results on Table 3 as indicating the possibility of endogeneity problems, in the form of correlation between contemporaneous values of per capita income and winning percentage and the equation error term, affecting the results shown on Table 2. After correcting for possible endogeneity by lagging the winning percentage and real per capita income variables, we find strong evidence of a novelty effect of new sports facilities on average attendance in MLB and the NBA and somewhat weaker evidence in the NFL. In the following investigation of the dynamics of the novelty effect of new facilities on attendance, we use the empirical model with lagged values of these variables.

A. The Dynamics of the Novelty Effect

The results in the previous section suggest that the presence of a new facility provides a persistent and significant boost to average attendance in the NFL, NBA and MLB. The persistence and size of this novelty effect appears to vary across sports. Because of the potentially complex dynamics of this effect, and because this relatively crude dummy variable approach used in the previous section may not capture rich dynamic behavior, we further explore the relationship between new facilities and attendance using the patterns of point estimates on the c_k parameters in equation (4) for each professional sport. These parameters reflect the dynamics of the novelty effect of new facilities on average attendance.

We first perform F-tests on subsets of these parameters. We perform two types of F-tests. The first procedure iteratively increases K by one and tests the significance of each additional variable. This approach looks for evidence of a marginal novelty effect in each additional season a franchise plays in a new facility; holding constant the novelty effect in prior seasons, does the novelty effect persist for an additional season. This is a relatively strict definition of a novelty effect, as it holds constant any previous impact on attendance.

The results of these F-tests are shown on the top panel of Table 4. Note that we report F-statistics and the P-value for these F-statistics on the table. An alternative would be to report t-statistics on each additional variable in this iterative procedure. In this setting, an F-test and a t-test are computationally equivalent - the P-values are identical - but we report the F-statistics because they were more convenient to calculate and report. The marginal novelty effects persist in seasons one through three, and reappear in seasons five and eight, in MLB. Like the results on Table 3, this suggests relatively persistent novelty effects of new stadiums in baseball. As discussed above, these parameters decline in size over time, suggesting that the marginal novelty effect diminishes with the passage of time in new baseball stadiums. There is relatively little evidence of important marginal novelty effects in both the NFL and the NBA. In the NFL, a marginal novelty effect appears only in seasons five and seven following the opening of a new stadium, and in the NBA a marginal novelty effect appears in only seasons five and ten, based on a 5% level of statistical significance. Under this stricter definition of novelty effects, only MLB appears to experience the effect.

A less stringent definition of novelty effects can be tested for in the same setting by examining the statistical significance of sets of parameters. The individual coefficients may not be well identified because the variables indicating the number of years since opening are highly correlated. Consequently, individual statistical significance may not be found while the variables are jointly significant. A test for novelty effects that addresses this weaker form of effect iteratively increments

Table 4: Novelty Effects: F-Tests on c_k Parameters

	MLB		NFL		NBA	
Null Hypothesis	F-statistic	P-value	F-statistic	P-value	F-statistic	P-value
$c_1 = 0$	7.51	0.006	0.56	0.453	0.45	0.502
$c_2 = 0$	5.20	0.023	1.94	0.164	0.77	0.379
$c_3 = 0$	5.08	0.025	1.03	0.309	0.66	0.417
$c_4 = 0$	2.88	0.090	0.09	0.768	3.45	0.064
$c_5 = 0$	4.78	0.029	4.68	0.031	5.49	0.019
$c_6 = 0$	2.76	0.097	0.24	0.622	0.81	0.368
$c_7 = 0$	3.15	0.076	8.71	0.003	0.80	0.372
$c_8 = 0$	5.97	0.015	0.05	0.820	0.67	0.413
$c_9 = 0$	0.77	0.381	3.24	0.072	2.26	0.133
$c_{10} = 0$	1.42	0.233	0.28	0.598	7.20	0.007
$c_1 = c_2 = 0$	6.38	0.002	1.25	0.287	0.61	0.542
$c_1 = \ldots = c_3 = 0$	5.97	0.001	1.18	0.317	0.63	0.597
$c_1 = \ldots = c_4 = 0$	5.21	0.000	0.91	0.460	1.34	0.255
$c_1 = \ldots = c_5 = 0$	5.15	0.000	1.66	0.141	2.17	0.055
$c_1 = \ldots = c_6 = 0$	4.76	0.000	1.43	0.202	1.95	0.071
$c_1 = \ldots = c_7 = 0$	4.54	0.000	2.48	0.016	1.78	0.088
$c_1 = \ldots = c_8 = 0$	4.75	0.000	2.17	0.028	1.64	0.109
$c_1 = \ldots = c_9 = 0$	4.30	0.000	2.30	0.015	1.71	0.082
$c_1 = \ldots = c_{10} = 0$	4.02	0.000	2.09	0.023	2.28	0.013

the parameter K in equation (4) and tests for the joint significance of the parameters on all the year dummy variables using an F-test.

The bottom panel of Table 4 shows the results of tests for an average novelty effect of new facilities on attendance. Again, evidence of an average novelty effect appears in MLB, where the null of a zero parameter on all of the added variables is rejected for each specification. This would be expected given the strong marginal novelty effects in MLB. In the NFL, evidence of an average novelty effect does not appear until season seven, again suggesting that the novelty effect is quite weak in football. There is no evidence of important average novelty effects in the NBA until season 10.

Recall that all of the parameters estimated from equation (4) are reduced form parameters in an attendance model. We described above a feature that allows us to calculate a measure of the novelty effect that corrects for the scaling of the structural parameters by the factor $\frac{\epsilon_s}{\epsilon_s+\epsilon_d}$, where the ϵ_j are the price elasticities of supply and demand by using ratios of the reduced form parameters c_k. Since each c_k parameter is scales the structural novelty effect parameters γ_i in the same direction, then the ratio of any two parameters will "wash out" the scaling. The statistical significance of a non-linear relationship between two or more parameters in a linear regression model can be tested for using a Wald test and the test statistic has an F distribution asymptotically. See Greene (2000), pages 438-439, provides details on this procedure. Table 5 shows the values of the parameter ratios, the F-statistic for the null hypothesis that the parameter ratio is equal to zero, and the P-value on the test statistic for the ten seasons following the opening of a new facility in each professional sport.

The results for MLB are consistent with the results from previous tests. The novelty effect in MLB persists for eight seasons and declines steadily over the period. In the sixth season and beyond, the novelty effect is less than half the size it was in the first season in a new ballpark.

Table 5: Novelty Effects: Parameter Ratios

	MLB			NFL			NBA		
Ratio	Value	Wald	P-Value	Value	Wald	P-Value	Value	Wald	P-Value
$\frac{c_2}{c_1}$	0.761	10.00	0.002	1.35	2.43	0.119	1.00	4.95	0.026
$\frac{c_3}{c_1}$	0.658	8.07	0.005	1.15	2.09	0.149	0.93	4.83	0.028
$\frac{c_4}{c_1}$	0.508	6.17	0.013	0.70	1.18	0.278	1.14	5.39	0.021
$\frac{c_5}{c_1}$	0.549	6.74	0.010	1.51	2.53	0.112	1.17	5.50	0.019
$\frac{c_6}{c_1}$	0.417	4.40	0.036	0.60	0.95	0.330	0.67	3.24	0.072
$\frac{c_7}{c_1}$	0.389	3.89	0.049	1.72	2.54	0.111	0.60	2.74	0.098
$\frac{c_8}{c_1}$	0.461	5.07	0.025	0.21	0.14	0.706	0.53	2.18	0.140
$\frac{c_9}{c_1}$	0.189	1.02	0.314	0.99	1.70	0.193	0.69	2.88	0.090
$\frac{c_{10}}{c_1}$	0.256	1.86	0.173	-0.30	0.24	0.626	0.93	3.84	0.051

There is no evidence of important novelty effects in football in the parameter ratios.

In the NBA the evidence from the parameter ratios shows strong evidence of a novelty effect of new arenas on attendance at professional basketball games through the first five seasons in a new facility, with the effect strengthening in seasons four and five. This evidence differs from the F-tests, which showed only weak evidence of novelty effects in the NBA and can be accounted for by the added structure the ratios imply for the model. There is no evidence of a novelty effect on average attendance in the NFL based on the Wald test statistics on the parameter ratios.

V. Policy Implications

A large majority of new sports facilities in the U.S. are paid for entirely or mostly by public funds. In the past 10 years only Pac Bell Park, the new home of the San Francisco Giants, and the MCI Center, the new home of the Washington Wizards, were paid for using private funds. Despite the repeated claims to the contrary by proponents of public subsidies for professional sports facilities, there is no evidence that professional sports teams or franchises have a positive economic impact on the surrounding communities, and some evidence suggests that they have a detrimental effect.

Our results show that average attendance at professional sporting events, especially MLB, increases as a direct result of the construction of a new stadium or arena in a city. Because ticket sales are an important source of revenues for professional sports franchises, most of the incremental economic benefits generated by new sports facilities appear to be captured by the franchises. This has important public policy implications.

The increased attendance provides an easily identifiable target for user fees to offset the public subsidization for the construction of new sports facilities. In the cases of baseball and basketball, such user fees could be collected over the period of increased attendance due to the novelty effect. To the extent that the novelty effect reflects visitors from outside the city who are attracted by the new facility, these user fees represent new sources of revenue to the local government, and may be substantially "exported" to other jurisdictions.

New stadium and arena construction projects are often financed through the sale of bonds. These bonds typically have a maturity period of twenty or more years. Our results suggest that the novelty impact of new facilities on average attendance occurs over a much shorter period of time, as little as four to ten seasons. Financing a new facility over two or three decades that increases attendance for only five to ten years makes little sense in economic terms unless revenues from the years of boosted attendance exceed in present value terms the financing costs, and those revenues are banked to cover those future costs. Given the relatively short duration of the novelty effect on attendance, alternative financing methods should be explored in the future.

VI. Conclusions

Building a new stadium or arena increases average attendance at professional sporting events held in these new facilities. The evidence in this paper suggests that this effect is strongest, and most persistent, in Major League Baseball, somewhat smaller and less persistent in the National Basketball Association, and relatively weak and short lived in the National Football League. The novelty effect of a new facility appears to persist as long as seven or eight seasons in MLB and the NBA. In MLB, the novelty effect diminishes slowly and steadily over time but in the NBA it remains steady before disappearing abruptly. A small but significant increase in attendance in the NFL can be detected over the first ten seasons, but the dynamics of the novelty effect in the NFL do not appear to be strong.

The importance of the novelty effect, and the complex dynamic behavior of this effect, found in our research differs considerably from the way that the effect of new sports facilities were treated in prior research. Up until now, researchers assumed that the effects of a new sports facility were distributed equally over a period of between three and eleven years following the opening of the new facility and that the effect was equal in all seasons in all sports. Our results indicate a richer, more complicated dynamic environment. The novelty effect of new facilities differs in size and persistence across the three sports. In general it does not last as long as was assumed in previous research.

Our results have important implications for public policy and future research. Novelty effects on attendance imply that future public subsidies for new sports facility construction could be partially offset by user fees levied on attendees. This would be a significant change in the public financing of sports facility construction. The short duration of the novelty effect calls into question the practice of financing new sports facility construction with bonds that are paid off over long periods of time. Future public subsidies should be financed over shorter periods of time to match the estimated duration of the novelty effect or surpluses from early years held to meet future obligations.

Our results raise several interesting issues to be addressed in future research. Why does the novelty effect vary across sports? Does the typical baseball fan differ in important ways from the typical football fan or basketball fan? What role do local and national broadcasts of sporting events play in the effect of a new facility on attendance? Finally, we find mixed evidence about the effect of fan loyalty, as measured by the number of years a franchise has been in a particular city, on average attendance. This measure of fan loyalty is crude, and leaves considerable room for the development of better measures of fan loyalty. The striking differences in the estimated effect of fan loyalty across sports also raises interesting questions about the nature of sports fans and the consumption benefits they derive from the presence of a local team to root for, as well as the nature of consumer preferences.

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