NOVELTY EFFECTS OF NEW FACILITIES ON ATTENDANCE AT PROFESSIONAL SPORTING EVENTS

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We investigate the effect of new facilities on attendance in professional baseball, basketball, and football from 1969 to 2001. We find a strong, persistent effect in baseball and basketball, and little effect in football. Size and duration estimates imply that baseball teams sell 2,500,794 additional tickets over the first eight seasons, basketball teams 293,878 over the first nine seasons, and football teams 137,792 over the first five seasons, implying an increase in revenues that could defray public subsidies that state and local governments provide for new sports construction projects. Rough calculations suggest that stadium subsidies are an inefficient method of subsidizing professional sports franchises. (*JEL* R39, D12, L83)

I. INTRODUCTION

Both conventional wisdom and casual empiricism suggest that new sports facilities boost attendance at sporting events. Part of this increased attendance is attributed to the desire by both fans and nonfans to see and experience the new stadium. We refer to these attendance gains as the "novelty effect."[1] Economists, when analyzing the economic impact of professional sports teams and facilities on local economies, typically assume that these effects are concentrated in the years immediately following the opening. Indeed, 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 about the novelty effect of new facilities on attendance, including how this effect varies over time and between sports. In this article we investigate the size and dynamic behavior of the effect of a new sports facility on average annual live game attendance in professional football, basketball, and baseball.[2]

The novelty effect has received little systematic attention in the literature. Many studies of attendance and the economic impact of sporting events mention the possibility that new facilities affect attendance, and some include ad hoc time dummy variables to control for these effects, but little systematic research on the length and magnitude of the novelty effect exists. We address this gap in the literature by formulating and estimating an attendance model that allows for the novelty effect to systematically vary in both duration and magnitude in each year following the opening of a new professional sports stadium or arena in the National Football League (NFL), the

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1. This phenomena has also been called the "honeymoon effect."

2. The lack of city-specific annual economic data from Canada prevents us from examining professional hockey, which has a large number of franchises in Canada.

ABBREVIATIONS

MLB: Major League Baseball
NBA: National Basketball Association
NFL: National Football League
OLS: Ordinary Least Squares
S.D.: Standard Deviation
SMSA: Standard Metropolitan Statistical Statistical Area

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National Basketball Association (NBA), and Major League Baseball (MLB).

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," suggesting the novelty effect wears off gradually. His results showed that the linear decline "proved much more significant than alternatives, such as dummy variables for 'very new' and 'middle-aged' stadiums," further supporting the idea that the novelty effect gradually disappears. Noll's regressions explaining attendance at basketball, football, and hockey games do not include terms capturing the novelty effect. Noll's empirical approach to this issue differs from ours, and his research reaches a different conclusion about the duration of the novelty effect.

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 United States in the past 40 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, if the new facility generates increased attendance and higher revenues for the team, it may be in the public interest for the local government to recoup some of the subsidy through a tax on these revenues or an explicit revenue-sharing plan. Under most current stadium and arena agreements, ticket, concession, and parking revenues accrue to the team. If the public had a better idea of how much money the stadium subsidy generates for the franchise, alternative agreements might be negotiated that provide more direct benefits to the local government. To know if this is possible, however, one needs an estimate of both the size and the duration of the boost to attendance, and therefore revenues from the new facilities.

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 5 and 11 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 10 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. If the novelty effect differs from year to year and between sports, then these stadium impact studies may report biased estimates of the economic impacts of new sports facility construction. In other words, any economic impact generated by a new sports facility may be masked by misspecification in the estimating equations used in these studies. This research assesses the validity of this assumption that novelty effects last from 7 to 11 years in baseball, football, and basketball.

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 less than 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) modeled 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. Coates and Harrison (forthcoming) 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. Again, we address this void by estimating novelty effects for baseball, football, and basketball facilities, allowing the effect to systematically differ in duration and magnitude after a new facility opens.

The remainder of the article 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. We choose a very flexible functional form, allowing stadium age to enter the equation nonlinearly and including dummy variables indicating each of the first 10 years after the facility opens. Estimation of the parameters of this model allows the data to tell us the best 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 derive a reduced-form empirical model of live game attendance at sporting events. Before specifying this reduced-form model, we consider the economic theory underlying a reduced-form attendance 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 the quantity of tickets demanded, Q_s is the quantity of tickets supplied, and P is the ticket price. The demand function is

$$(1)\qquad Q_d = \alpha + \beta P + \gamma_1 D_1 + \gamma_2 D_2 + \gamma_3 D_3,$$

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

$$(2)\qquad Q_s = \lambda P,$$

where λ is the effect 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,

$$(3)\qquad Q = \frac{\alpha\lambda}{(\lambda-\beta)} + \frac{\gamma_1\lambda}{(\lambda-\beta)}D_1 + \frac{\gamma_2\lambda}{(\lambda-\beta)}D_2 + \frac{\gamma_3\lambda}{(\lambda-\beta)}D_3$$

$$Q = a + c_1 D_1 + c_2 D_2 + c_3 D_3,$$

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 zero to one, 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

$$(4)\qquad Q = \sum_{k=1}^{K} c_k D_k + \theta W + \epsilon$$

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 γ's are the parameters of interest, as they capture the novelty effect on demand for tickets to sporting events. Coffin (1996) and Coates and Harrison (forthcoming) 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. Therefore we lack the price data required to estimate a demand function containing novelty effect terms over the full run of years from 1969 to the present. However, we 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

$$(5) \qquad \frac{c_2}{c_1} = \frac{\gamma_2}{\gamma_1} \qquad \frac{c_3}{c_1} = \frac{\gamma_3}{\gamma_1}.$$

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_i's are each positive, though they approach zero over time.

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

$$(6) \qquad ATT_{it} = aX_{it} + bZ_{it} + \sum_{k=1}^{K} c_k D_{kit} + e_{it},$$

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_k's, 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

$$(7) \qquad e_{it} = v_i + m_t + u_{it},$$

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, the 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 sports entertainment opportunities may affect 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 the city's baseball team. One can imagine that might reduce the interest in attending football games, 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 7 to 8 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 afternoon, 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 nonmonetary 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 MLB, NFL, and 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 geographic area with economic and demographic data available for Standard Metropolitan

TABLE 1
Sample Statistics

	MLB			NFL			NBA		
Variable	**N**	**mean**	**S.D.**	**N**	**mean**	**S.D.**	**N**	**mean**	**S.D.**
Average attendance per game	809	22,780	9,464	927	56,959	10692	764	13,440	4367
Real per capita personal income	809	15,888	3027	927	15,428	3073	764	15,554	2819
Population (000)	809	3,731	2,477	927	3,144	2,323	764	3,372	2,481
Winning percentage	809	.500	.069	927	0.500	0.197	764	0.500	0.150
Stadium age	809	28	23	927	24	17	764	16	14
Team age	809	47	345	927	31	19	764	25	14
Playoff appearance last year	780	0.18	0.39	891	0.29	0.45	729	0.58	.49
First 10 years in stadium	809	0.286	.453	927	0.376	.484	764	0.578	.494
First year in stadium	809	0.035	.183	927	0.046	.210	764	.067	.249

Statistical 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. MLB 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 10 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 variations 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 being equal. Our approach to measuring this loyalty to the team is to include as a regressor the age of the franchise.[3] 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

3. Depken (2000, 2001) takes an interesting approach to measuring fan loyalty based on the one-sided residual from a stochastic frontier estimation procedure. Coates and Harrison (forthcoming) and Winfree et al. (2004) include lagged attendance as a regressor, though only the latter explicitly link the variable to fan loyalty.

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 buildup 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 the Browns, Art Model, relinquished the team name and colors to the city. Consequently, while no team played in Cleveland from 1996 to 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. (In contrast, the accomplishments of the Baltimore Colts are displayed on the Indianapolis Colts website despite the fact that none of the Hall of Fame Colts ever played or coached in Indianapolis and the team was in Baltimore when it won each of its three 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 in a city.[4]

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, for example), 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 1st through 10th year in a new stadium or a variable that indicates that the current year is one of the first 10. 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 ballparks of the last decade. The condition of 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

4. We do not control for the quality of franchises that move in the empirical analysis. The novelty effect may be larger for a well-run franchise than for a poorly run franchise. However, objectively distinguishing well-run franchises from poorly run franchises is a difficult process.

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 10 years a stadium is open. Descriptive statistics for the variables, except the dummies for year of operation, are provided in Table 1.

IV. RESULTS

Table 2 shows the results of estimating Equation (6) with the ordinary least squares (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_k's 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 one in each of the first 10 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 10 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, but not in the NBA. There is no evidence of market size effects on attendance; variations in the population of the city hosting MLB, NBA, and NFL franchises does not explain variations in average attendance.

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 1.03 in MLB, 0.15 in the NFL, and 0.34 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 semilog specification. We report only the linear and linear-quadratic specification results because the semilog 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 81–108 per game in a baseball stadium, by 143–156 per game in a football stadium, and by 80–84

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	0.759	0.690	0.802	0.777	−0.093	−0.111
	0.000	0.000	0.005	0.007	0.407	0.324
Population	−0.0005	−0.0001	0.0003	0.0004	−0.0001	−0.0002
	0.941	0.857	0.725	0.651	0.552	0.426
Current winning %	47151	47703	17392	17909	9111	9123
	0.000	0.000	0.000	0.000	0.000	0.000
Stadium age	−184	−132	−156	−143	−84	−80
	0.001	0.010	0.000	0.000	0.000	0.000
Stadium age^2	1.356	0.918				
	0.010	0.100				
Team trend	126	114	475	454	−88	−90
	0.003	0.004	0.004	0.006	0.000	0.000
Team trend^2	−1.49	−1.35				
	0.000	0.000				
No. of other franchises	−1793	−1744	292	287	−385	−385
	0.000	0.000	0.664	0.671	0.088	0.087
Playoffs$_{-1}$	4339	4460	2316	2381	296	304
	0.000	0.000	0.000	0.000	0.094	0.088
First 10 years	2413		2379		1058	
	0.001		0.003		0.000	
First year		5887		3288		1140
		0.001		0.009		0.016
Second year		4406		4934		1231
		0.000		0.000		0.002
Third year		2349		3955		1376
		0.050		0.002		0.000
Fourth year		3297		2203		1481
		0.005		0.082		0.000
Fifth year		2740		4200		1340
		0.021		0.001		0.000
Sixth year		2078		2312		1075
		0.074		0.060		0.005
Seventh year		2653		2059		830
		0.019		0.096		0.032
Eighth year		2913		1990		814
		0.010		0.108		0.038
Ninth year		1837		669		1057
		0.094		0.592		0.008
Tenth year		2095		474		738
		0.050		0.698		0.070
Observations	780	780	891	891	729	729
R^2	0.81	0.79	0.68	0.69	0.80	0.80

P-values shown below parameters.

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 4,000 per game in MLB, 3,700 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 age facility.

Interestingly, the stadium age effect in MLB increases with age, rising from −180 at opening, not including the novelty effects discussed below, reaching zero at about 68 years, and becoming positive thereafter. In other words, at about 68 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. It is positive and significant in MLB and the NFL, 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 9% 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 10 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, this specification forces an equal novelty impact on attendance in each season during the 10-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 10 after a new facility opens. Based on these results, the 10-year dummy variable from specification (1) does not capture the dynamics of the novelty effect of a new facility on attendance. In MLB, seven of the first eight individual-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. The novelty effect is shortest in the NFL, where only four of the first five individual-year dummy variables are positive and significant. The novelty effect may be shorter 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 about 80% of the observed variation in attendance at MLB and NBA games, compared to just less than 70% of 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 are incorrect. In order to gain insight into the extent to which this problem is present, we estimated Equation (6), 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 in Table 3 are similar to those in Table 2, with two 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 in Table 2. Similarly, the parameters on the per capita income variable are both larger in MLB.

The sizes of the significant novelty effect parameters shown in 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 28% larger than otherwise, but in the eighth season the boost over the average attendance is just over 15%. In the NBA, the increase in attendance implied by the significant parameters is about 10% over average for the first six seasons. In the NFL, the increase is about 6% above annual average attendance in the first three seasons. In terms of the number of additional tickets sold, and remembering that the estimates are lower bounds, the results in Table 3 imply that a baseball team with a new stadium would sell an additional 2,500,794 tickets in the first eight seasons in the new ballpark, a basketball team would sell 293,888 over the first six seasons in a new arena, and a football team would sell an additional 137,792 over the first five seasons in a new stadium.

In sum, we interpret the results in 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 in 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, NFL, and NBA. 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. *Equilibrium in the Live Game Attendance Market*

The model of the market for tickets to sports events developed above is an equilibrium model—at the equilibrium price, demand for tickets is equal to supply. Anecdotal evidence suggests that some sports facilities (in the NFL due to television blackout regulations and places like Cleveland and Baltimore in MLB) may be "sold out" for the season in that fans cannot buy tickets to individual games. In this case, unlike the model that forms the basis for the empirical work, there would be excess demand for tickets to games held in these facilities.

In these cases, the distribution of the average attendance variable would be right-truncated, and many team-year observations would be piled up at an average attendance equal to 100% of stadium capacity. The existence of persistent excess demand stands at

TABLE 3
Attendance Model—Wins and Income Endogenous

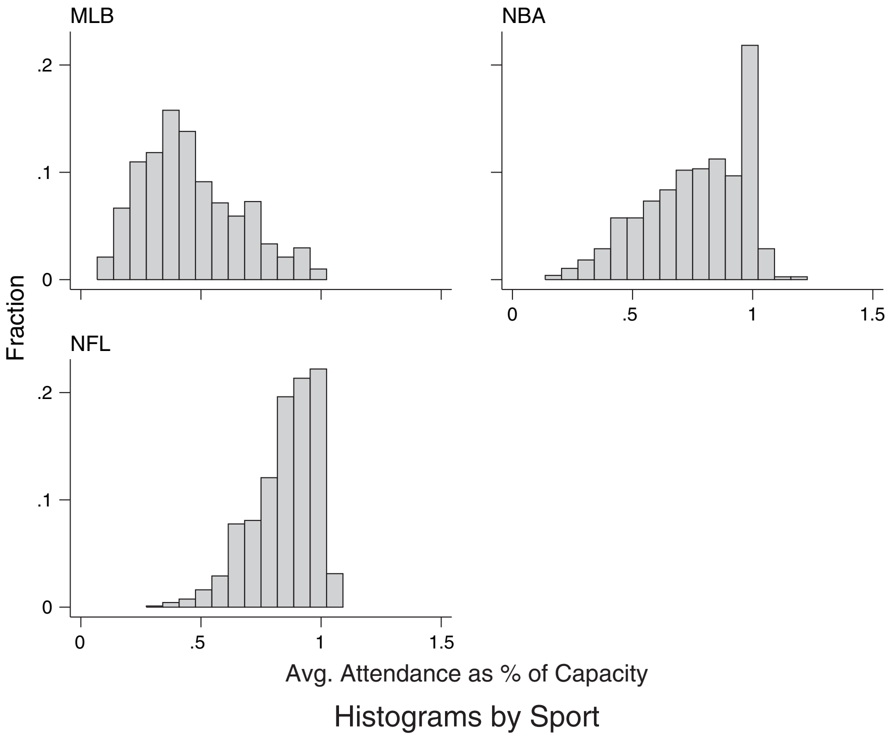
	Dependent Variable: Average Attendance					
	MLB		NFL		NBA	
Variable	**(1)**	**(2)**	**(1)**	**(2)**	**(1)**	**(2)**
Per capita income$_{-1}$	0.984	0.914	0.710	0.701	−0.115	−0.123
	0.000	0.000	0.028	0.031	0.343	0.310
Population	0.0006	0.0004	−0.0001	−0.0001	−0.0002	−0.0002
	0.470	0.598	0.894	0.949	0.382	0.292
Lagged winning %	32402	33769	14452	14849	7871	7885
	0.000	0.000	0.000	0.000	0.000	0.00
Stadium age	−219	−150	−156	−147	−82	−79
	0.001	0.007	0.000	0.000	0.000	0.000
Stadium age^2	1.76	1.156				
	0.026	0.065				
Team trend	126	113	583	568	−91	−92
	0.005	0.014	0.001	0.002	0.000	0.000
Team trend^2	−1.647	−1.477				
	0.000	0.000				
No. of other franchises	−1936	−1756	37	34	286	288
	0.000	0.002	0.959	0.963	0.230	0.228
Playoffs$_{-1}$	2824	2824	298	297	−5.68	6.00
	0.000	0.000	0.677	0.678	0.977	0.976
First 10 years	2500		2384		1009	
	0.002		0.000		0.000	
First year		6336		3323		1245
		0.000		0.014		0.013
Second year		4724		4304		1211
		0.001		0.001		0.003
Third year		4265		3533		1126
		0.000		0.010		0.005
Fourth year		3092		2635		1385
		0.023		0.053		0.001
Fifth year		3444		3429		1375
		0.012		0.009		0.001
Sixth year		2837		2394		826
		0.035		0.070		0.042
Seventh year		2573		2977		735
		0.050		0.005		0.072
Eighth year		3603		1128		664
		0.005		0.395		0.109
Ninth year		1307		1584		858
		0.298		0.238		0.043
Tenth year		1731		437		1149
		0.160		0.739		0.009
Observations	780	780	891	891	729	729
R^2	0.76	0.75	0.64	0.64	0.77	0.77

P-values shown below parameters.

odds with the basic assumptions of our theoretical analysis and the truncation caused by this excess demand could lead to econometric problems.

To explore the idea that the market for live game attendance at professional sports events is characterized by excess demand, we first examine the relationship between the

FIGURE 1
Distribution of *ACAP*



dependent variable in our empirical model—average annual attendance per game—and the capacity of the stadium where these games are played in the NFL, MLB, and the NBA.

Define the variable $ACAP_{it}$ (average capacity) as

$$ACAP_{it} = \frac{ATT_{it}}{CAP_{it}},$$

where ATT_{it} is average attendance per game in stadium i in season t and CAP_{it} is the reported maximum capacity of stadium i in season t. If attendance at games is limited by the reported capacity of a sports facility, then $ACAP_{it}$ is bounded above by 1.00.

Figure 1 shows the distribution of $ACAP_{it}$ for the NFL, NBA, and MLB over the sample period analyzed in this article. For MLB, the distribution of $ACAP_{it}$ lies well below the theoretical maximum of 1.0. The mean of $ACAP_{it}$ for professional baseball is 0.456, only 1% of the sample lies above 0.95, and $ACAP_{it}$ is equal to 1.0 in only nine team-seasons in the sample. There does not appear to be a significant amount of excess demand for tickets to MLB games. There may be excess demand for individual games, but to the extent that games against different opponents and at different times of the season are substitutes, the market for MLB tickets appears to be in equilibrium for the sample period.

The distribution of $ACAP_{it}$ for the NBA differs from MLB. The average in the NBA is 0.76 and the distribution skews more toward 1.0. Interestingly, $ACAP_{it}$ is greater than one for a sizable number of observations, and in some cases the variable is as large as 1.2. In the NBA, 26.5% of the observations are greater than 0.95. $ACAP_{it}$ exceeds one in 13 observations in the sample. A closer examination of the underlying data reveals that almost all of the values of $ACAP_{it}$ greater than 1.0 in the NBA come from the Chicago Bulls (nine team-years in the late 1980s and early 1990s) during the Michael Jordan era.[5] The

5. The other four are the Pistons in 1987—a season when they played in the Silverdome—the Dallas Mavericks in 2001, and the San Antonio Spurs in 1994 and 2000.

reported average attendance and stadium capacities for these franchises were verified by a number of different sources. It appears that the actual capacity of four NBA arenas—the Spurs played in both the HemisFair Arena and the Alamo Dome and the Bulls played in both Chicago Stadium and the United Center during this period—was larger than the reported maximum capacity of these facilities. The teams may sell "standing room" tickets to some games, or perhaps the capacity of luxury boxes can be expanded during periods of peak demand in these facilities.

The distribution of $ACAP_{it}$ for the NFL resembles that for the NBA and differs from MLB. The average value of $ACAP_{it}$ for the NFL is 0.85 and, like the NBA, 26.5% of the observations are larger than 0.95 in the NFL. The left tail of the distribution for the NFL is smaller, and there are 63 observations where $ACAP_{it}$ is greater than one. Again, a closer examination of the underlying data shows that a few franchises account for many of these observations. The Buffalo Bills report 11 seasons scattered throughout the 1970s, 1980s, and 1990s with an average attendance greater than the reported maximum capacity of Rich Stadium, and the Philadelphia Eagles report 10 seasons scattered throughout the same three decades with average attendance greater than the reported capacity of Veterans Stadium. Fifteen other franchises report one or two seasons in the 30-year sample period where average annual attendance exceeded the reported capacity of their stadiums by 1% to 5%.

Furthermore, the "72 hour" television blackout rule that has been in place in the NFL since the early 1970s provides fans and local television stations with an incentive to buy up unwanted tickets to football games. Under NFL rules, any game that is not sold out 72 hours prior to the scheduled kickoff cannot be televised on local stations. Putsis and Sen (2000) point out that this provides local television stations, businesses, and fans with an incentive to buy unwanted tickets. This incentive can drive the observed value of $ACAP_{it}$ to one in cities with NFL teams, even when there is an excess supply of tickets.

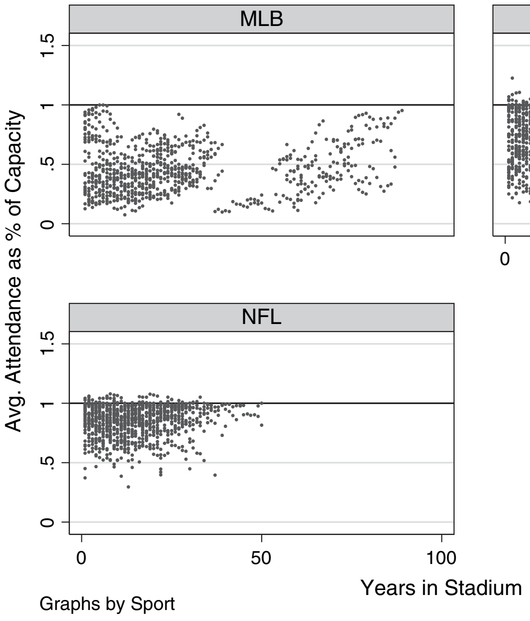
Figure 1 suggests that the market for tickets to MLB, NBA, and NFL games is not characterized by persistent excess demand; rather these markets appear to be in equilibrium much of the time, and almost all the time in the case of MLB. While average attendance in the NFL and NBA tends more toward the capacity of the facilities, average attendance in 75% of the team-seasons in the sample is less than 95% of the reported capacity of the stadiums and arenas, suggesting that there was relatively little excess demand for tickets in these team-seasons. Also, the nontrivial number of seasons when average attendance exceeded the reported capacity suggests that the reported capacity of facilities in these sports may not be an absolute maximum figure. Teams may have some ability to increase the number of tickets available from one season to the next. Although there may be some seasons with excess demand in these leagues, excess demand does not appear to be persistent or pervasive.

Still, it may be possible that a large fraction of those seasons where average attendance per game exceeds the reported capacity of the facility occurs in the first years that a new stadium or arena is open. In this case, our estimates of the novelty effect of new sports facilities might be biased downward, because of excess demand for tickets to games in new venues. Figure 2 shows the distribution of $ACAP$ by stadium age in the NFL, NBA, and MLB. This figure is a scatter plot with the age of the stadium or arena on the horizontal axis and $ACAP$ on the vertical axis. The solid horizontal line shows the points where $ACAP_{it} = 1$ for every stadium age. If the seasons with excess demand occur during the period when the novelty effect is strongest, then we would expect to see the points near or above $ACAP = 1$ toward the left edge of the graphs.

All three graphs show no pattern of high average attendance seasons concentrated in relatively new facilities. In both the NFL and NBA, the seasons where $ACAP$ is near or greater than 1.0 are relatively dispersed across the age distribution of facilities in the sample. Thus it does not appear that our estimates of the size of the novelty effect are substantially biased downward because of the uneven distribution of seasons with excess demand across the age distribution of sports facilities in the sample.

As a robustness check, we estimated Equation (6) using the maximum-likelihood estimator developed by Amemiya (1973) for the case

FIGURE 2
Distribution of *ACAP* by Stadium Age



where the dependent variable is censored and the cutoff point varies across observations. This estimator relies crucially on the assumption that the equation error term is normally distributed. In this setting we have no strong priors that suggest a different distribution for the equation error term. The results are generally similar to those reported in Tables 2 and 3.[6] Thus it appears unlikely that censoring of the dependent variable is driving the estimates of the novelty effect reported here.

B. *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 (6) 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 in the top panel of Table 4. Note that we report *F*-statistics and the *P*-value for these *F*-statistics in 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

6. These results are available from the corresponding author upon request.

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**
$c_1 = 0$	12.14	0.005	1.50	0.221	0.41	0.522
$c_2 = 0$	5.41	0.020	4.59	0.032	0.74	0.390
$c_3 = 0$	4.18	0.041	2.36	0.125	0.65	0.421
$c_4 = 0$	1.89	0.169	1.05	0.306	3.36	0.067
$c_5 = 0$	3.98	0.046	3.95	0.047	4.99	0.025
$c_6 = 0$	2.62	0.106	1.75	0.186	0.81	0.368
$c_7 = 0$	2.74	0.098	4.17	0.042	0.72	0.369
$c_8 = 0$	9.04	0.021	0.46	0.406	0.61	0.434
$c_9 = 0$	1.20	0.273	1.32	0.250	2.19	0.139
$c_{10} = 0$	2.59	0.107	0.11	0.739	7.07	0.008
$c_1 = c_2 = 0$	12.10	0.001	1.48	0.221	0.40	0.522
$c_1 = \ldots = c_3 = 0$	8.79	0.001	3.05	0.058	0.57	0.563
$c_1 = \ldots = c_4 = 0$	7.28	0.000	2.82	0.038	0.59	0.616
$c_1 = \ldots = c_5 = 0$	5.94	0.000	2.38	0.050	1.29	0.272
$c_1 = \ldots = c_6 = 0$	5.57	0.000	2.70	0.019	2.03	0.070
$c_1 = \ldots = c_7 = 0$	5.09	0.000	2.54	0.019	1.83	0.090
$c_1 = \ldots = c_8 = 0$	4.75	0.000	2.78	0.007	1.67	0.112
$c_1 = \ldots = c_9 = 0$	4.88	0.000	2.49	0.011	1.45	0.140
$c_1 = \ldots = c_{10} = 0$	4.66	0.000	2.36	0.012	1.61	0.107

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 either the NFL or the NBA. In the NFL, a marginal novelty effect appears in seasons 2, 5, and 7 following the opening of a new stadium, and in the NBA a marginal novelty effect appears in seasons 5 and 10, based on a 5% level of statistical significance. Under this stricter definition of novelty effects, only MLB appears to experience the novelty 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 the parameter K in Equation (6) 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 about season three, and not strongly until season five, again suggesting that the novelty effect is quite weak in football. There is no evidence of important average novelty effects in the NBA in this test.

Recall that all of the parameters estimated from Equation (6) 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 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 nonlinear relationship between two

TABLE 5
Novelty Effects: Parameter Ratios

	MLB			NFL			NBA		
Ratio	**Value**	**Wald**	***P*-value**	**Value**	**Wald**	***P*-value**	**Value**	**Wald**	***P*-value**
$\frac{c_2}{c_1}$	0.746	12.36	0.000	1.295	4.81	0.029	0.973	5.22	0.023
$\frac{c_3}{c_1}$	0.673	9.39	0.002	1.063	3.95	0.047	0.904	5.09	0.024
$\frac{c_4}{c_1}$	0.488	5.97	0.015	0.793	2.82	0.093	1.113	5.69	0.017
$\frac{c_5}{c_1}$	0.544	6.97	0.008	1.032	3.93	0.048	1.105	5.69	0.017
$\frac{c_6}{c_1}$	0.448	4.97	0.026	0.720	2.54	0.111	0.664	3.42	0.065
$\frac{c_7}{c_1}$	0.406	4.27	0.039	0.896	3.16	0.076	0.591	2.89	0.090
$\frac{c_8}{c_1}$	0.569	7.62	0.006	0.340	0.70	0.403	0.534	2.35	0.125
$\frac{c_9}{c_1}$	0.206	1.17	0.280	0.477	1.26	0.263	0.690	3.09	0.079
$\frac{c_{10}}{c_1}$	0.273	2.08	0.150	0.132	0.11	0.737	0.923	4.09	0.044

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. Greene (2000, p. 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 10 seasons following the opening of a new facility in each professional sport.

The results for MLB and the NFL 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. The novelty effect in the NFL lasts only two seasons, a much shorter period than in MLB.

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 AND CONCLUSIONS

A large majority of new sports facilities in the United States 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 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 imply that average attendance at professional sporting events, especially in 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 revenue 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.

Table 6 shows the estimated increase in revenues from increased attendance in each year after new MLB stadiums opened in Chicago in 1991, in Baltimore in 1992, in Cleveland in 1994, and in Detroit in 2000. These revenue estimates are based on the predicted increase in annual average attendance due to a new stadium from the results in Table 3, the number of home games played in each season, and the average ticket price in each stadium shown in the table. To the extent that these new attendees purchase concessions and souvenirs and pay for parking, the figures in the table are underestimates of the new revenues to the team associated with the novelty effect. Only two years of revenue estimates are shown for Detroit because this

TABLE 6
Novelty Effects: Estimated Team Revenues

		Baltimore Orioles		Chicago White Sox		Cleveland Indians		Detroit Tigers	
Year	Novelty attendance	Ticket price	Revenue	Ticket price	Revenue	Ticket price	Revenue	Ticket price	Revenue
1	6668	9.65	5,212,042	10.26	5,541,508	12.06	6,513,702	24.83	13,410,881
2	5076	11.12	4,572,054	11.70	4,810,525	12.06	4,958,541	20.95	8,613,718
3	4384	11.17	3,966,511	11.70	4,154,716	14.52	5,156,110		
4	3388	13.14	3,605,983	12.91	3,542,865	15.29	4,196,004		
5	3660	13.14	3,895,484	12.93	3,833,227	17.35	5,143,581		
6	2784	17.02	3,838,078	14.11	3,181,861	18.43	4,156,038		
7	2591	19.77	4,149,149	13.33	2,797,580	20.58	4,319,145		
8	3075	19.82	4,936,666	14.48	3,606,606	22.33	5,561,844		

stadium opened at the end of our sample period.

In each case, the opening of a new stadium increased attendance and revenues by a large amount in the first eight seasons played in the new stadiums. The increased attendance provides an easily identifiable target for user fees imposed on attendees to offset the public subsidization for the construction of new sports facilities.

New stadium and arena construction projects are typically financed through the sale of government bonds with a maturity period of 20 or more years. The annual report of the Illinois Sports Facility Authority—the agency that issued the bonds that financed the construction of the new stadium in Chicago—shows that the 1989 bond issue for this stadium contained bonds maturing from 1990 until 2010. The annual report of the Maryland Stadium Authority—the agency that issued the bonds that financed the construction of the new stadium in Baltimore—shows that the 1989 bond issue contained bonds maturing until 2019. Our results suggest that the novelty impact of new facilities on average attendance occurs over a much shorter period of time, as little as 4 to 10 seasons. Financing a new facility over two or three decades when that facility increases attendance for only 5 to 10 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.

The revenues reported in Table 6 can be compared to the principal and interest costs paid by the local governments on bonds issued to finance new stadium construction. The Illinois Sports Facility Authority issued about $150 million in bonds in 1989 to pay for construction of a new baseball stadium. Initial annual principal and interest payments were about $14.7 million; following a refinancing in 1999, the annual principal and interest payments fell to about $12.3 million per year. The annual principal and interest payments made by the Maryland Stadium Authority are roughly $11.8 million per year. As Table 6 clearly shows, the additional ticket revenues generated by the new stadiums in Chicago and Baltimore never cover even half of the principal and interest payments on the construction financing. Put differently, in the best years, the White Sox and Orioles reaped $5.5 and $5.2 million in new ticket revenues, respectively, while the city and state governments pay $12.3 and $11.8 million in bond payments. Handing a dollar of subsidy to the Chicago White Sox costs the Illinois Sports Facility Authority, and the taxpayers of Illinois, $2.23; that same dollar subsidy to the Baltimore Orioles costs the Maryland Stadium Authority, and Maryland taxpayers, $2.27. By any stretch of the imagination, subsidizing professional baseball through the issuance of government-backed construction bonds is inefficient.

Of course, the comparison above has not accounted for the increases in concession and parking revenues, and other new revenue streams that team owners obtain from the new attendance and the more attractive facility. Given the figures above, in the best year again, each new attendee at a White Sox game would have to provide more than $12.50 of net revenue on concessions and parking for the new revenue to the team to rise to the level of the bond financing charges paid by the city and state. In Baltimore, the net revenue per new attendee to bring team profits up to the level of the state costs is about $12.20.

Building a new stadium or arena increases average attendance at professional sporting events held in these new facilities. The evidence in this article suggests that this effect is strongest, and most persistent, in MLB, somewhat smaller and less persistent in the NBA, and relatively weak and short lived in the NFL. 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 10 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 3 and 11 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. However, such fees would have to be on the order of several dollars per ticket to cover the interest and principal payments incurred by many state and local governments. For example, at the average annual attendance in our entire sample of 1.85 million, the user fee on each ticket to Baltimore Orioles' games would have to be about $6.40 to cover the entire $11.8 million in annual principal and interest payments. Even in the latest year for which we have data, $6.40 amounts to 32% of the average ticket price to an Orioles game; the *optimal* user fee would likely be higher, as the imposition of such a fee would lead to a decline in demand for tickets.

Moreover, 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. In addition, the possibility that novelty effects are becoming smaller and shorter in duration means that the inefficiency of the current methods of subsidizing professional sports through stadium and arena construction will only get worse.[7]

Our results also provide some support for the findings that professional sports are not generally strong engines of local economic development. Our estimates of the novelty effect suggest that the increase in fans coming into the area surrounding a sports facility is small and short lived. In these circumstances, it is not surprising that the literature finds little impact of new stadiums on local economies. However, the duration of the novelty effect implied by our results is considerably shorter than the duration used in the economic impact literature. Many studies assume that the economic impact of a new sports facility on the local economy lasts about 10 years and that this effect has the same duration across sports. Our results suggest that future research on the economic impact of new sports facilities should explore the possibility that the economic impact is concentrated in the first few years after the opening of a new facility and varies across sports.

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,

7. We estimated models for MLB to assess the possibility that the novelty effects were getting shorter. The results did not support this interpretation. One possibility is that too little time has passed and that there are too few of these facilities in our data to adequately identify the differences. These results are available from the corresponding author upon request.

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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