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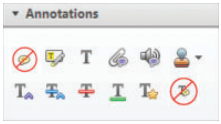

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A Natural Experiment to Determine the Crowd Effect Upon Home Court Advantage

Christopher J. Boudreaux[1], Shane D. Sanders[2], and Bhavneet Walia[2]

Abstract

Spectator effects represent a central concept in (behavioral) sports economics. A thorough understanding of the phenomenon promises to further our understanding as to the nature of performance production under pressure. In traditional home advantage studies, it is difficult to isolate the net crowd effect upon relative team performance. In a typical sports setting, multiple factors change at once for a visiting team. Experimental evidence suggests that supportive crowds may hinder task performance. In that it serves as home stadium to two National Basketball Association teams, the Staples Center in Los Angeles offers a rare natural experiment through which to isolate the crowd effect upon competitive output. Each team possesses equivalent familiarity with built environment, and teams face similarly sparse travel demands prior to games between one another. However, the team designated as "home team" in a contest enjoys a largely sympathetic crowd due primarily to season ticket sales. Moreover, crowd effects are sizable in motivating a home team win, raising the likelihood of such an event by between an estimated 21 and 22.8 percentage points. The point estimate implies that essentially the entire home advantage between the two teams is attributable to the crowd effect.

We are grateful for advice from two anonymous reviewers and the Editor-in-Chief, Professor Leo Kahane. Any remaining errors are our own.

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supportive audience, crowd factors, performance, production, behavioral economics, home advantage

Introduction

The home advantage is typically defined as the tendency of home teams in (sport) competitions to win more than half of games played under a balanced home and away schedule (Courneya & Carron, 1991). The phenomenon has been observed in countless sporting venues. Hockey (Agnew & Carron, 1994; Bray, 1999; Pace & Carron, 1992), soccer (Clarke & Norman, 1995; Nevill, Newell, & Gale, 1996; Pollard & Gomez, 2009; Seckin & Pollard, 2008; Yiannakis, Selby, Douvis, & Han, 2006), basketball (Greer, 1983; Harville & Smith, 1994; Jones, 2007; Jurkovac, 1985; Moore & Brylinsky, 1993), football (Schwartz & Barsky, 1977), and baseball (Courneya & Carron, 1992) are among the sports in which a consistent home advantage has been observed. For a broader overview of this literature, one can read Nevill and Holder (1999) or Courneya and Carron (1992). More recently, Pollard (2006, 2008) provides a review of the literature pertaining to home field advantage in soccer. Past studies in the areas of behavioral sports economics and sport psychology have suggested that spectator effects upon performance production are an important cause of this advantage. However, it has proven difficult to truly isolate the spectator effect in a natural setting, as stadium familiarity and crowd sympathy are typically strongly collinear. The present article seeks to isolate the spectator effect by considering a rare natural experiment. Namely, the Los Angeles Lakers and Los Angeles Clippers have shared a stadium, the Staples Center, since 1999. This series of games offers a setting by which to isolate crowd sympathy from stadium familiarity.

In a seminal article, Schwartz and Barsky (1977) advance three major sources of home advantage: learning factors, travel (fatigue) factors, and crowd factors.[1] They explain that the home team has typically learned to play more effectively in the built (i.e., to adjust to factors such as lighting, playing surface texture, and rim flexibility). Home advantage may also result from greater expected travel demands of the visiting team. In sports such as professional basketball, a typical visiting team is more likely to have played a previous game and subsequently traveled in recent days. Lastly, biased spectators can influence a competition outcome by affecting performance and match refereeing.

Several important studies have improved our understanding of individual factors upon home advantage. In a novel natural experiment, Pollard (2002) finds that 24% of the advantage of playing at home may be lost for the year that a team relocates to a new facility. Largely, it has been found that travel (fatigue) effects do not contribute to home advantage (Courneya & Carron, 1991; du Preez & Lambert, 2009) or that travel effects provide a small but significant contribution to home advantage (Entine

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& Small, 2008; Steenland & Deddens, 1997). Nutting (2010) finds that distance traveled has little effect on game outcomes but that fatigue from prior game frequency decreases the likelihood of a win in the National Basketball Association (NBA). This fatigue effect is accumulative such that it becomes stronger in the second half of the season. Of particular interest to the present article, the nature of the crowd effect upon performance is not well understood in natural settings (although some progress has been made). Schwartz and Barsky (1977) and Agnew and Carron (1994) find that the magnitude of home advantage significantly increases in crowd density. These studies certainly suggest a possibility that crowd factors are significant in establishing home advantage. The approach of the studies is limited, however, in that it is not made clear *why* crowd density varies. If crowd density is positively related to expected likelihood of a home team win, then there may be no causal relationship between crowd density and home advantage. Greer (1983) finds that home team (visiting team) performance improves (declines) following spells of crowd booing. Greer's result is intriguing and suggests that home teams may influence the *overall* outcome of a contest by directly influencing team performance levels.[2]

One potential mechanism by which crowds can help the home team is by exerting productive pressure upon referees. Sutter and Kocher (2004) find that referees are, on average, partial to the home team in making discretionary decisions. They explain that this may be an unintentional reaction to processes of positive and negative reinforcement undertaken by the home crowd. If the (counterproductive) social pressure effect dominates the sum of all other (productive) crowd effects, then sympathetic crowds will exert a negative influence upon (relative) home performance. Dohmen (2008b) also finds that referees exhibit a home team bias in the German premier soccer league that is influenced by the crowd's composition, size, and proximity. Price, Remer, and Stone (2012) also find evidence from the NBA that referees display significant home bias in their play-calling decisions.

Experiments in social psychology suggest that the marginal crowd effect may be to produce a home *disadvantage*. Wallace, Baumeister, and Vohs (2005) find that supportive audiences cause performers to "avoid failure rather than to seek success," In many cases, such a behavioral modification can lead to performance decrements. Indeed, Butler and Baumeister (1998) show, across three experiments, that subjects perform less proficiently before supportive audiences than before unsupportive audiences, provided that the task is sufficiently difficult. Moreover, the authors find that performers are unaware of this perverse effect.

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Dohmen (2008a) and Sanders and Walia (2012) note various possible crowd effects upon performance. Supportive spectators may enhance a (home) player's performance through social support, inadvertently harm a (home) player's performance through social pressure, or intentionally harm a (visiting) player's performance through conscious techniques of distraction. This article finds that sympathetic crowds are significantly productive in raising the likelihood of the home team's win likelihood, ceteris paribus. Moreover, crowd effects are sizable in motivating a home team win, raising the likelihood of such an event by between an

estimated 21 and 22.8 percentage points. The point estimate implies that essentially the entire home advantage between the two teams is attributable to the crowd effect. The range of the 95% confidence interval for the point estimate is 0–42 percentage points. By comparison, the overall (uncontrolled) home team advantage across all NBA teams was 20.4% over the period of the data, where seasonal home team advantage ranged between 16.2% and 25.6%.

The remainder of the article proceeds as follows. The second section describes institutional features of the competitive environment of interest within the study. In the third section, data from Lakers–Clippers games in the Staples Center era are described and analyzed. Following a Hausman specification test, the regression analysis uses both standard logistic regressions with (season) cluster robust standard errors and logistic regression with random effects to determine whether (in what direction) biased observer effects influence relative performance production. The fourth section concludes.

An Institutional Background of the Competitive Environment

The case of the Los Angeles Lakers and the Los Angeles Clippers offers a rare lens through which to observe the effect of biased spectators upon relative performance. Since October 1999, the two teams have shared the Staples Center as a home arena. Interestingly, one team must be designated as "visitor" when the two teams oppose one another in the Staples Center. The teams have competed against each other in 59 regular season games from the 1999-2000 season through the 2013-2014 season (i.e., in the first 15 seasons of the Staples Center era).[3] With the exception of the lockout-shortened 2011-2012 season, the teams have opposed one another 4 times per year in the regular season, with each team serving as the home team in two games.[4] The Lakers have served as home team in 29 of the 59 games, while the Clippers have served as home team in the remaining 30 games. A χ^2 test for independence suggests that the ordering with which each team serves as home team within a season is independent of team designation (p value = .457).

From the 1999-2000 season through the 2013-2014 season, the Clippers won 13 of 30 games (43.3%) against the Lakers when designated the home team and 7 of 29 games (24.1%) against the Lakers when designated the visiting team. These 59 contests, though somewhat sparse, serve as an uncommon natural experiment. In the case of Lakers and Clippers games since 1999, the Clippers (Lakers) experience the same (familiar) stadium characteristics (e.g., lighting and rim flexibility) whether designated as home team or away team. With respect to learning factors, therefore, it is as if there are two home teams when the two teams oppose one another. These features of the matchup will allow us to more cleanly isolate the crowd effect upon relative performance.[5]

This set of games provides a relatively "clean" natural experiment in one other sense. Neither ~~team, home nor away,~~ typically travels to Los Angeles from another city within a day of a game between the two teams. In sampled games between the two teams, the Lakers (Clippers) returned to Los Angeles within a day of the game for only 3 (3) of the 59 games. In other words, a team in the matchup returned to Los Angeles within a day of a game between the two teams in 6 of 118 cases, where the home team was actually *more* likely to have traveled. For a typical NBA team matchup, the visiting team would *almost always* travel within a day of the game, and the home team would seldom travel within a day of the game. There exists both a dearth and equality of pregame travel in the Lakers–Clippers matchup. Therefore, we expect the effect of travel upon relative team performance to be minimal.

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In contests between the Lakers and Clippers during the Staples Center era, there is the strong evidence that home team designation is systematically related to fan attitude alone. Due to substantial advanced season ticket purchases, the crowd is considerably more sympathetic to the Lakers (Clippers) when said team is deemed the home team rather than the visiting team. This is apparent when watching a game between the teams or by viewing the general clothing colors of the crowd for a given pair of games. Note 6 contains web addresses for two pictures/videos that illustrate the relationship between home team designee and crowd in the rivalry. Home team designee is apparent in each picture because this designation determines the color and design of the playing floor.[6] However, there exist no direct measures of crowd sympathies in a large-scale sports match (to the knowledge of the authors).[7] Controlling for factors such as (relative team abilities during) season of play, recent travel behavior, injuries, and maturity of season when a game is played, we explore the importance of home team designation in determining outcomes for this series of games. Given the environment of the study, we take any remaining home advantage (disadvantage) to be indicative of (net) biased spectator effects alone.

Data

We examine all regular season games between the Los Angeles Lakers and Los Angeles Clippers from the 1999-2000 season through the 2013-2014 season (e.g., during the first 15 regular seasons of the Staples Center era). This includes 59 regular season games, of which the Clippers (Lakers) have won 20 (39).[8] Table 1 details each team's winning percentage in the matchup by (home and away) designation.

Within the empirical model of the study, the (anterior) likelihood that the Lakers will win game i in season j of the sample, p_{ij}, is estimated using logistic regression. The dependent variable in each regression is a binary dependent variable that equals 1 (0) if the Lakers win (lose) game i against the Clippers in season j. Each independent variable controls for other factors that may affect the situational likelihood that the Lakers win a given game. These variables are defined as follows: $\text{home}_{i,j}$ is a dummy variable that equals 1 (0) if the Lakers were home (visiting) in game i of

Table 1. Winning Percentage by Designation.

Status | Team	Lakers	Clippers
Home	75.9	43.3
Away	56.7	24.1
Percentage differential	+19.2	+19.2
Sample size	59	59

season j, diffpercent$_j$ represents the Lakers' winning proportion in season j (against teams other than the Clippers) minus the Clippers' winning proportion in season j (against teams other than the Lakers), difftravel$_{i,j}$ is the difference in the number of games played 3 days prior to the game for which travel was required after the game, and diffgames3$_{i,j}$ is the difference in the number of games played in 3 days prior to game. The variables difftravel$_{i,j}$ and diffgames3$_{i,j}$ have a fairly high correlation coefficient (.38) and are included in separate regression specifications. Lastly, game1$_{i,j}$ (game2$_{i,j}$, game3$_{i,j}$, and game4$_{i,j}$) equals 1 (0) if game i in season j is the first (second, third, and fourth) meeting between the two teams of the season. We also take advantage of recent advances in APBR-metric research to construct the variable WS_lost_diff$_{i,j}$, which measures the proportion of team win shares or average output that is unavailable in game i of season j due to player injury or illness. The win shares variable itself estimates (using regression analysis) the number of team wins in a season attributable to each of a team's players. For example, Kobe Bryant accumulated 15.3 win shares during the 2005-2006 season. That is, he is attributed to have created 0.34 proportion of (the 45) Laker wins during that season. During the two games that Bryant missed in 2005-2006, this proportion of the Lakers' typical output was unavailable. For a given game, the WS_lost_diff$_{i,j}$ variable simply sums unavailable win shares from among a team's seven most win-productive players, divides this sum by the team's total wins during the course of the season, and takes the difference of this quotient across teams. By accounting for the aggregate value of missing players, we expect to better explain variability in outcome throughout the 59 games. Lastly, we consider year or season effects to account for unobserved characteristics that affect how the two teams matchup with one another from year to year. For example, the Lakers may be better in a season against third-party teams but may not matchup particularly well against the Clippers (specifically).

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Respectively, these variables control for differences in the ability of the two teams as observed from outside games, asymmetry in travel-induced fatigue (potential changes in motivation or ability due to), period of season, loss of ability due to injury or illness, and unobserved (season specific) characteristics governing the outcome of a given game. It should be noted that we control for period of season for several potential reasons. Whereas teams may begin the season with similar levels of extrinsic motivation, it may become increasingly clear whether a team is likely or unlikely to reach the playoffs as a season unfolds. This clarity can greatly influence team motivation level, as playoff teams are typically vying for (what else but)

Table 2. Summary Statistics.

	Observations	Mean	*SD*	Minimum	Maximum
Won	59	.6610169	.4774274	0	1
Home	59	.4915254	.5042195	0	1
Diffpctadj	59	.2064407	.2466313	−.244	.634
Diffpctadjsq	59	.1024137	.1153037	0	.4019558
Lakpctadj	59	.6293051	.1123516	.41	.808
Clippctadj	59	.4321525	.1470985	.192	.692
WSlostdiff	59	−.0690232	.1740078	−.5421053	.2520741
Game1	59	.2542373	.4391693	0	1
Game2	59	.2542373	.4391693	0	1
Game3	59	.2542373	.4391693	0	1
Difftravel	59	.1016949	.9594344	−2	2
Diffgames3	59	.1186441	.7675475	−1	2

home court advantage in the playoffs. Moreover, the Clippers accumulated a greater number of early (lottery) draft picks throughout the sample period and, therefore, likely receive a greater level of contribution from first-year players. Accordingly, the Clippers may benefit from within-season player development to a greater degree than do the Lakers. Independent variables are summarized in Table 2.

The first consider a logistic regression model that features (season) cluster robust standard error terms to account for unobserved factors related to the manner in which the two teams matchup with one another in a given year. The basic model is specified in Equation 1:

$$\ln\left(\frac{\hat{p}_{ij}}{1-\hat{p}_{ij}}\right) = f(\text{home}_{i,j}, \text{diffpercent}_j, \text{diffpercent}_j^2, \text{Game1}_{ij}, \text{Game2}_{ij}, \text{Game3}_{ij}, \text{difftravel}_{ij}, \text{Diffgames3}_{ij}, \text{WS\_lost\_diff}_{i,j}). \quad (1)$$

Results for this set of regressions are provided in Table 3.

Each model finds the coefficient of $\text{home}_{i,j}$ to be positive and significant at the $\alpha = .01$ or $\alpha = .001$ level. We take this to be a strong indication that a supportive crowd has a positive effect upon (relative) own team performance. Team characteristics naturally eliminate any significant heterogeneity in stadium (court) familiarity. Moreover, we have controlled for any effects of asymmetric travel, while noting that these effects are infrequent and occur almost symmetrically (between home and visiting team) as compared to the case of a traditional NBA team matchup.

This result suggests a sympathetic crowd effect that is positive on net. It is interesting to note that the present result may actually be consistent with that of Wallace et al. (2005) who find that supportive audiences cause absolute performance decrements. The present result simply finds that home team *relative* performance

Table 3. Logistic Regression Results (Cluster Robust Standard Errors).

	Won			
	(1)	(2)	(3)	(4)
Home	2.033**	2.178***	2.034**	2.178***
	(2.51)	(3.07)	(2.52)	(3.05)
Diffpctadj	6.416***	6.564***	6.433***	6.561***
	(4.90)	(4.64)	(4.15)	(3.72)
Diffpctadjsq			−0.0635	0.0121
			(−0.02)	(0.00)
WSlostdiff	−6.188**	−6.002*	−6.191**	−6.001*
	(−2.05)	(−1.96)	(−2.04)	(−1.95)
Game1	2.520	2.564	2.520	2.564
	(1.51)	(1.53)	(1.51)	(1.53)
Game2	2.598**	2.511**	2.599**	2.511**
	(2.23)	(2.16)	(2.22)	(2.15)
Game3	2.005	1.766	2.005	1.766
	(1.33)	(1.15)	(1.33)	(1.15)
Difftravel	0.245		0.246	
	(0.73)		(0.71)	
Diffgames3		0.218		0.217
		(0.65)		(0.64)
Constant	−3.267**	−3.297**	−3.266**	−3.297**
	(−2.34)	(−2.47)	(−2.33)	(−2.47)
N	59	59	59	59

Note. t Statistics values are in parentheses.
*$p < .10$. **$p < .05$. ***$p < .01$ (two-tailed).

improves with a supportive audience. Such a result may obtain even if a supportive audience causes the home team's absolute performance level to decline (i.e., if the same audience causes a greater decline in vising team absolute performance). In the NBA, there is sometimes a systematic relationship between home games and prior travel. We do not expect such a relationship in this case, as each team faces the same constraint in games between the two teams (i.e., traveling to each team's home city of Los Angeles). However, we test for such collinearity to be certain. The variance inflation factors for specified independent variables range between 1.16 and 2.21 (i.e., well below reasonably "acceptable" levels). Thus, we can be reasonably confident that the standard errors of our coefficient estimates are not greatly inflated by the presence of multi-collinear independent variables.

We now consider a set of regressions featuring (season) random effects to account for unobserved characteristics with respect to how the two teams match up in a given year. A Hausman test suggests selection of the random effects model rather than selection of the fixed effects model (i.e., that the individual specific effect is uncorrelated with other explanatory variables).[9] The results of these specifications are provided in Table 4.

Table 4. Random Effects Logistic Regression Results.

	Won			
	(1)	(2)	(3)	(4)
Home	2.034**	2.034**	2.178**	2.178**
	(2.13)	(2.13)	(2.15)	(2.14)
Diffpctadj	6.417**	6.434**	6.565***	6.561**
	(3.06)	(2.16)	(3.04)	(2.12)
Diffpctadjsq		−0.062		0.0132
		(0.01)		(0.00)
WSlostdiff	−6.188*	−6.191*	−6.002*	−6.002*
	(−1.93)	(−1.92)	(−1.92)	(−1.91)
Game1	2.521*	2.521*	2.565*	2.565*
	(1.92)	(1.92)	(1.93)	(1.93)
Game2	2.598*	2.599*	2.512*	2.512*
	(1.94)	(1.94)	(1.92)	(1.91)
Game3	2.005	2.005	1.766	1.766
	(1.44)	(1.44)	(1.36)	(1.36)
Difftravel	0.245	0.246		
	(0.65)	(0.64)		
Diffgames3			0.217	0.217
			(0.47)	(0.47)
Constant	−3.267**	−3.266**	−3.297**	−3.297**
	(−2.31)	(−2.30)	(−2.29)	(−2.29)
N	59	59	59	59

Note. t Statistics values are in parentheses.
*$p < .10$. **$p < .05$. ***$p < .01$ (two-tailed).

Each random effects model finds the coefficient of $\text{home}_{i,j}$ to be positive and significant at the $\alpha = .05$ level. We again take this to be reasonably strong evidence that a sympathetic crowd has a positive effect upon (relative) own team win performance.

Lastly, we estimate the marginal effect of home team designation upon win likelihood. Through such an analysis, we can gauge the *magnitude* of the crowd sympathy effect in terms of win probability. Table 5 lists marginal effects for the four random effects model specifications.

We estimate that home team designation increases win likelihood by between 21 and 22.8 percentage points.[10] Within the environment studied, home team designation is estimated to be pivotal in one of every five games.

Conclusion

In the article, we test for the effect of a supportive crowd via a natural experiment of sorts. Since 1999, the Los Angeles Lakers and Los Angeles Clippers have both

Table 5. Marginal Effect of Home Designation Across Specifications.

	(1)	(2)	(3)	(4)
	0.21	0.222	0.212	0.228
N	59	59	59	59

Note. *Home = (0, 1) and all other covariates are held at their mean value. The model numbers refer to the model of Table 4.

AQ6 Please drop the asterisk. Also, the note contains an error and should end as follows: "The model numbers refer to the random effects model of endnote 10."

played in the Staples Center. Moreover, neither team typically travels a day prior to a matchup between the two teams. By examining games between the two teams, it is therefore possible to isolate the sympathetic crowd effect within the context of a natural environment. In doing so, we find that a supportive crowd causes the home team to be more likely to win, ceteris paribus. We further find this effect to be sizable, raising home team win likelihood by an estimated 21–22.8 percentage points. Therefore, we conclude that biased crowd effects are significant and sizable in raising home team win likelihood.

There are possible extensions to the present work. For example, the manner by which supportive crowds contribute to home advantage is not well understood. They may do so simply by causing the visiting team (competitor) to be less effective. Alternatively, a supportive crowd may reduce the effectiveness of both home and visiting teams (competitors) in an asymmetric manner. An understanding as to the effect of supportive crowds upon absolute performance levels would further our understanding as to the roles of the social support effect, the social pressure effect, and distraction effects in altering performance. An anonymous referee suggests that a within game analysis of free throw performance may provide a methodology to address such issues.

Declaration of Conflicting Interests

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Notes

1. Courneya and Carron (1992) and Nevill and Holder (1999) also consider sequence-of-play rule factors as a potential source. As an unbiased "tip-off" is utilized to establish first possession in a basketball game, rule factors do not tend to be important in basketball.
2. Given the nature of his performance metrics, Greer suggests that crowd effects upon referee decision making are not responsible for the results that he observes.

3. We consider only regular season games in this analysis. Preseason games typically feature reserve players to a much larger extent than regular season games and, therefore, are not generally comparable.
4. This tradition was temporarily altered during the lockout-shortened 2011-2012 season, in which the Lakers hosted the Clippers only once.
5. In the National Football League, the New York Jets and New York Giants have shared a stadium since 1984. However, they have played against one another in only nine regular season games over that period.
6. When the Lakers are the home team, purple and gold are noticeably more prevalent in the Staples Center (see, e.g., http://www.wcbsports.com/battle-of-los-angeles-lakers-vs-clippers-highlights/2013/10/29/). When the Clippers are the home team, blue and red are noticeably more prevalent (see, e.g., http://espn.go.com/losangeles/photos/gallery/_/id/6027941/image/6/kobe-bryant-lakers-vs-clippers).
7. As an anonymous referee notes, home team designation may also influence spectator expectations, which may further influence the game outcome.
8. The two teams have not faced one another during the postseason.
9. The χ^2 value from the Hausman test in Model 1 is 5.96 (with a p value of .428) and the χ^2 value for Model 2 is 9.14 (with a p value of .166).
10. This is very similar to ordinary least square estimates found using random effects with season clusters. This point estimate using the specification from Model 1 of Table 4 is 0.21, with a 95% confidence interval [0, 0.42]. This change is good. Thank you.

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