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Impacts of Performance-Enhancing Drug Suspensions on the Demand for Major League Baseball

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Abstract

In 2005, Major League Baseball (MLB) introduced a new policy regarding the use of performance-enhancing drugs (PEDs) wherein the league would not only suspend but also publicly name any player who tested positive for banned PEDs. Using the estimated television audience size of MLB games from 2006 to 2012, these PED suspension announcements provide a unique natural experiment to test how consumers react to news of PED use. This study finds that PED announcements have two major impacts on the demand for baseball. First, there is on average an immediate 9.3% reduction in the television audience of the PED player's team. Second, the magnitude of the effect gradually decreases over time yet remains negative and significant for a period of 37 days or approximately 33 game-broadcasts. This is the first study to link PED use to an adverse reaction by consumers in a systematic way using television audience while controlling for the change in team quality caused by removing the suspended player from the team.

Keywords

performance-enhancing drugs, doping, baseball, Major League Baseball, television audience

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Professional sports has a very contentious and convoluted history with doping. While consumers pay great sums of money for the chance to witness an exceptional athletic performance, they also generally disavow the use of any performance-enhancing drug (PED) in order to achieve it. A 2005 poll found that 86% of Major League Baseball (MLB) fans say PEDs are either "a serious problem" or "ruining the game" while only 5% think PEDs "make [the] game better."[1]

Yet, no matter how outraged a random sample of self-purported baseball fans may seem, very few studies have found systematic evidence that consumers respond adversely to PED use. Surveys are also not necessarily guaranteed to be well representative of individuals who pay to take in sports. A preferred approach may be to use consumer expenditure on sports as a proxy for demand, such as ticket sales and home-game attendance, to measure any changes resulting from news of PED use. This study suggests using the television audience of MLB game-broadcasts to measure the impact of PED suspensions on the demand for baseball. It is argued that television audience is a more meaningful proxy for demand for three reasons: (a) due to the nature of the data, there is potentially a limit to the observed response to news of a PED announcement when using attendance ("paid attendance" measures ticket sales regardless of a ticket holder's decision to physically attend), (b) impacts of a PED announcement can be measured immediately using television audience (can only be measured beginning the next available home game when using attendance), and (c) a PED announcement can potentially have a much larger economic impact on the television audience for the PED player's team (affects television audience of home- and away-game broadcasts; television audience is much larger than home-game attendance).

The top-left panel of Figure 1 illustrates the first-order impact of a PED announcement on the television audience of MLB game-broadcasts. Using the pitcher Eliezer Alfonzo as a case study, deviations from the predicted television audience are plotted for 15 days before and after his PED suspension announcement (the dashed vertical line indicates the day of the announcement and the x-axis represents the number of days since the suspension was first announced).[2] This high-level evidence suggests that consumers have a quite prompt and pointed reaction to news of PED use. Yet, since the guilty PED player is also removed from competition, much or all of this effect could be explained by the change in the quality of the team. However, comparing the deviation when Eliezer Alfonzo was suspended to that of when he was injured (the top-right panel of Figure 1), there does not appear much support for this second conjecture.

Shifting the focus from an anecdotal to a systematic relationship, this study estimates the effect of PED suspension announcements and finds it has two major impacts on demand. First, there is on average an immediate 9.3% reduction in the television audience of the team. Second, the magnitude of the effect gradually decreases over time yet remains negative and significant for a period of 37 days (approximately 33 game-broadcasts). This negative impact on television audience is found to exist even after considering the change in quality of the team stemming

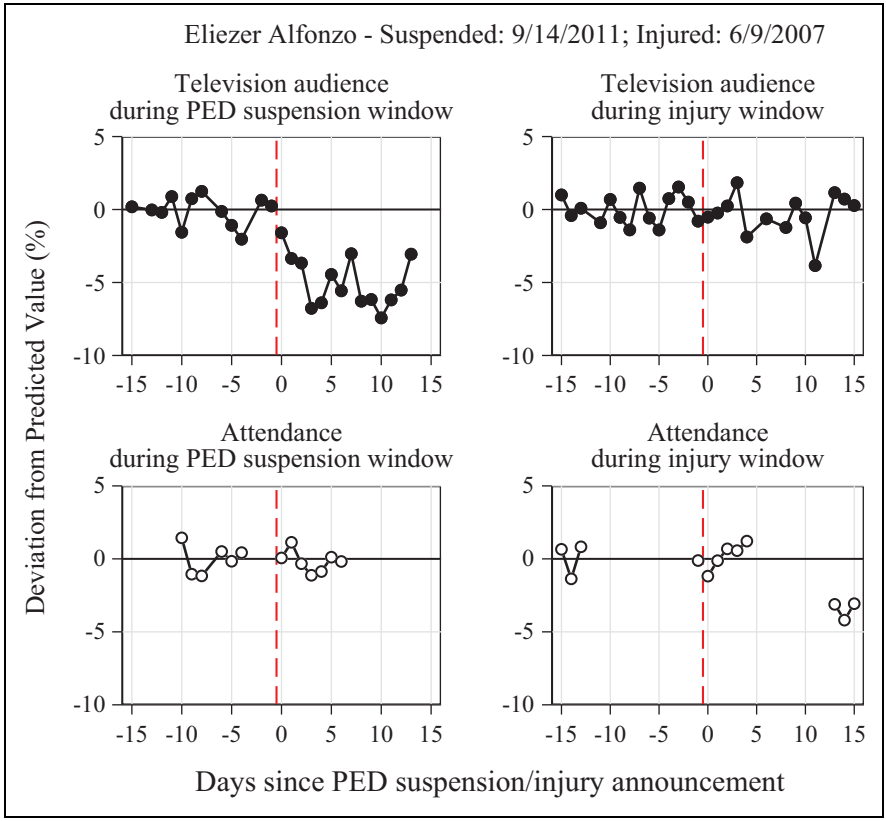

Figure 1. Example of the impact of a PED suspension and an injury announcement on proxies for Major League Baseball demand using pitcher Eliezer Alfonzo. *Note*. Predicted values come from a linear regression of natural logarithm of television audience/attendance and day of week, month, year, and team fixed effects.

from the removal of the PED player while they are suspended. This is the first statistical evidence of a systematic negative relationship between PED use and television audience.

Background and Literature Review

Broadly speaking, a PED is any substance taken to increase athletic performance. This includes a wide range of drugs such as anabolic steroids or amphetamines otherwise used to treat attention deficit hyperactive disorder. Beginning in 2005, MLB implemented PED testing, selecting players at random and publicly announcing the names associated with positive test results. Since 2006, regulations for PED

testing have been set forth by the Joint Drug Prevention and Treatment Program (JDP).[3] Under the JDP, all MLB players are subject to at least three random PED tests per year. Within 72 hours of a positive PED test, MLB reveals the name of the guilty player and said player is immediately suspended without pay. The length of the suspension depends on the individual's number of previous positive tests as well as the type of substance. Although the severity of punishment per offence has since increased, the punishment regime was consistent from 2006 to 2013—see Appendix Table A1 for details. Most importantly, by publicly announcing the names of the players caught using PEDs, MLB under the JDP becomes an ideal natural experiment where one can empirically test the effects of exogenous shocks—news of a positive result of a random PED test—on a dependent variable—the demand for live baseball.

There is already a large and well-developed body of demand estimation of professional sports dating back to the mid-1970s (Noll, 1974). Traditionally, this demand estimation has been accomplished by using attendance as a proxy for sports demand (see Borland and MacDonald, 2003, and Villar and Guerrero, 2009, for a list of approximately 100 such unique studies). However, issues with the caveats of home-game attendance in addition to a need for a more varied approach have led researchers to investigate alternative proxies for demand (Buraimo & Simmons, 2015; Tainsky, 2010).

There is also a second relevant body of economic literature regarding issues related to the use of PEDs. Most of the focus is on understanding what it means to be compliant with PED regulations and how best to achieve said compliance. Studies can then be split into two categories on the debate of approaches to achieve compliance (preventative vs. punitive), and most studies make use of a model of an individual's expected utility as a function of the risk-weighted costs and benefits of using PEDs (Eber, 2008; Haugen, 2004; Maennig, 2002, 2009, 2014).

However, for all the research into the theory of how to best limit the use of PEDs in sports, very few studies show there are any real consequences to league organisers for failing to do so, that is, that consumers react adversely when athletes use PEDs. There is but a small intersection of the previous two bodies of literature that attempt to explore consumer behaviour in light of PED revelations. First, surveys have been utilised to show that consumers have little tolerance for PED use in sports and suggest that there is at least a potential for PED use to impact consumer demand (Engelberg et al., 2012; Solberg et al., 2010). Relatedly, Buechel et al. (2016) illustrate how such a potential consumer backlash to PED use could actually exacerbate PED prevalence by incentivising league stake holders to underreport and/or under-test for its use: athletes could therefore further dope with a low probability of having their transgressions revealed. However, the intentions of survey respondents can often differ wildly from their own real-world actions (Brenner & DeLamater, 2016). This issue is compounded by the fact that surveys can often underrepresent the particular subset of the population that actually pay, with money and/or time, to consume sports (Cisyk & Courty, 2017).

To correct for the lack of external validity and/or representativeness in surveys, Cisyk and Courty (2017) use home-game attendance as a proxy for the MLB demand and measure the impact of PED suspension announcements on attendance. The authors find PED announcements lead to a short-term reduction in attendance which is shown to directly impact the PED player's team's revenue. However, the authors use home-game attendance, which, as eluded to above, has many constraints hence the need to consider television audience as a proxy for demand (see Data section for a detailed explanation).

Van Reeth (2013) makes the first attempt to link a sport's television audience and PED use in a systematic way but ultimately finds an inconclusive and negligible impact. The author makes use of two television audience metrics of the Tour de France, the average and the maximum audience size during a broadcast, but finds these metrics are not all that dissimilar when used to explain the larger trend in television viewership. The author is able to explain many patterns observed in the data but ultimately does not distinguish between the consumer reaction to PED use and the consumer reaction to the change in quality of the remaining athletes after the PED user is removed from competition.

Taking a unique approach, Brave and Roberts (2019) illustrate that PED announcements impact a local MLB team's nonticket revenue at a rate of -1.7% per additional PED suspension. Despite this negative effect, the authors note that due to the impacts PED suspensions have on player costs, the profit-maximising number of PED announcements is actually greater than zero—an issue that is revisited later.[4]

Data

The data used herein come from four main sources. The first data source is the estimated number of viewers, known as the television audience, of each MLB game-broadcast as reported by the Nielsen Company or simply Nielsen. Nielsen is recognised as the industry standard for, among other things, television audience measurements. More specifically, the television audience is defined as the number of televisions currently tuned to a given broadcast within a predefined area, known as the designated marketing area (DMA). The sample of television audience used in this study spans seven MLB regular seasons from 2006 to 2012, where the 30 MLB teams are scheduled to play 162 games each season.[5]

Each MLB team is located within a single DMA. For example, the Atlanta Braves' local DMA is Atlanta, GA. Typically, each team participating in a game creates its own television broadcast which is aired only within its local DMA.[6] As a result, each game ordinarily has two broadcasts and produces two observations in the data.[7] Hereinafter, when referring to a specific team of a game, the "local" audience refers to the audience within the team's local DMA (i.e., the audience of the Atlanta Braves' game-broadcast in the Atlanta DMA) and the "opponent's" audience refers

Table 1. Descriptive Statistics.

Variable	Mean	*SD*	Minimum	Maximum
Audience ('000s)	95.21	81.27	1.00	750.00
Playing-season suspension	0.02	0.14	0.00	1.00
Off-season suspension	0.01	0.08	0.00	1.00
Inactive	0.00	0.06	0.00	1.00
Broadcast of home team	0.50	0.50	0.00	1.00
Predicted season wins	80.68	9.31	51.71	103.83
Probability of winning game	0.50	0.09	0.21	0.79
Divisional rival	0.44	0.50	0.00	1.00
Interleague	0.10	0.30	0.00	1.00
Opening day	0.01	0.08	0.00	1.00
Broadcast length (minutes)	175.64	27.02	85.00	399.00
In-market NFL Game	0.02	0.14	0.00	1.00
In-market NBA Game	0.07	0.25	0.00	1.00
In-market NHL Game	0.04	0.20	0.00	1.00

Years: 2006-2012
Observations: 29,648

Note. NFL = National Football League; NBA = National Basketball Association; NHL = National Hockey League.
Definitions for each variable can be found in Table A2.

to the audience within the opponent's local DMA (i.e., the audience of the Philadelphia Phillies' game-broadcast in the Philadelphia DMA if the Philadelphia Phillies were to play the Atlanta Braves), regardless of the home/away designation of the two teams.

Note that several games per week are broadcast nationally. Nationally broadcast games are excluded from the sample because the audience measurement includes viewers outside of either participating team's own DMAs. Lastly, the local DMA of the Toronto Blue Jays is outside of the United States and local audience estimates are subsequently unavailable. The final sample contains audience information for a total of 29,648 observations. Table 1 displays descriptive statistics for the television audience variable. Note that Nielsen reports television audience per thousand of individuals, and values are rounded to the nearest thousand. As shown in Table 1, the average audience size is 95,214 with a standard deviation of 81,273.

As noted in the Background and Literature Review section, numerous previous studies have used home-game attendance as a proxy for demand. Although in most scenarios the use of attendance is entirely appropriate, the use of television audience is potentially a superior metric for measuring the impact of PED announcements for three main reasons. First, the "attendance" measure used in these studies is often actually "paid attendance" which represents the number of tickets sold to a game as declared in each games' official MLB box score. Consequently, after purchase of a ticket, the consumer is counted as part of the paid attendance regardless of actually

attending. This limits the ability of the empiricist to measure the reaction of consumers if tickets have been sold prior to a PED announcement. Furthermore, even if attendance was measured by actual number of individuals attending a game, rational consumers may view their tickets as sunk costs and attend regardless of what their actions would be if the decision to purchase tickets came after a PED announcement.

Second, recall audience information is available for most games. This includes both home and away games of the local team. Therefore, when a PED announcement occurs, it is possible to measure any potential impact from the day of a PED announcement regardless of if the PED player's team is playing a home or an away game. The initial impact measured on attendance is instead limited to the subsequent home game of the PED player's team after a PED announcement.

Third, the measured effect of a PED announcement has the potential to have a larger economic impact on television audience than home-game attendance: because the sample contains information on home- and away-game broadcasts, the impact of a PED announcement can be observed for all affected game-broadcasts of the PED suspension. As illustrated in Figure 1, despite the fact that each attendance panel makes use of the same dates as its corresponding television audience panel, systemic 'gaps' exist in the attendance data simply because a local team must play games outside of its home DMA where the attendance is attributed to its opponent. Moreover, the television audience represents a far greater number of consumers than those in attendance: the ratio of television audience to home-game attendance is roughly 6:1.[8]

Lastly, there are several smaller issues to consider. First, a stadium's capacity places an upper bound to the number of tickets sold and therefore an upper bound to attendance. Any measured effect of a positive demand shock would thereby be limited in its ability to be represented through attendance. Conversely, it is highly improbable a single television event would be constrained by an analogous upper bound.[9] Second, although there is no evidence to support such a practice, it is not unimaginable that a team would manipulate ticket prices in light of demand shocks, thereby easing variation in the attendance. For all these reasons above, television audience is explored to estimate PED impacts on demand.

The second source of data is the moneyline odds of each MLB game collected from Covers.com. The moneyline odds $M_{t,s,i}$ are used to calculate the probability team t will win game i in season s. The moneyline odds are converted into a decimal value of win probability as follows:

$$\text{Prob}(\text{win}_{t,s,i}) = \begin{cases} \dfrac{M_{t,s,i}}{M_{t,s,i} - 100} & \text{if} \quad M_{t,s,i} < 0 \\ \dfrac{100}{M_{t,s,i} + 100} & \text{if} \quad M_{t,s,i} > 0 \end{cases}. \tag{1}$$

An adjustment is then made to the win probability of team t and team $-t$ to ensure $\text{prob}(\text{win}_{t,s,i}) + \text{prob}(\text{win}_{-t,s,i}) = 1$, where $-t$ is the opponent of t. This adjustment is necessary because to the gambling nature of the data, the sum of the decimals odds

will be greater than 1 due to the bookmaker's take or margin (Štrumbelj, 2016). For simplicity, a basic normalisation is applied as follows:

$$\text{Prob}(\text{win}_{t,s,i}) = \frac{\text{prob}(\text{win}_{t,s,i})}{\text{prob}(\text{win}_{t,s,i}) + \text{prob}(\text{win}_{-t,s,i})}. \quad (2)$$

The probability is also used to calculate a proxy for the quality of each team. This proxy is termed the predicted season wins and measures the expected number of wins of a team for the entire season prior to playing a given game. It is calculated as follows:

$$\text{Predicted season wins}_{t,s,i} = \sum_{j=1}^{i-1}(1|\text{win}_{t,s,j} = 1) + \sum_{k=i}^{162}\text{prob}(\text{win}_{t,s,k}). \quad (3)$$

Stated alternatively, the predicted season wins is the actual number of wins of a team for the entire season prior to playing a given game plus the expected future number of wins in the remainder of the 162-game regular season.

The third source of data is the information on substitutes to MLB game-broadcasts, namely that of competing sports broadcasts of the National Football League (NFL), the National Basketball Association (NBA), and the National Hockey League (NHL). When the local MLB team's DMA is also home to a substitute sports team, the substitute team is said to be "in-market." For a list of in-market teams of the substitute sports leagues for each MLB team, see Appendix Table A3. Schedules of substitute sports' game-broadcasts are collected from Sports-Reference.com, and incidences where a game-broadcast of the local MLB team overlaps with an in-market substitute sports team are flagged. For example, Table 1 shows that for 7% of the observations, a local MLB game-broadcast occurred on the same day as an in-market NBA game.

The final source of data is the variable of interest, PED events, from ProSportsTransactions.com. A summary of these events is presented in Appendix Table A4. Two types of PED events are identified based on the timing of the suspension announcement: the first type of PED event, the off-season suspension, indicates the player was tested and found guilty of PED use outside the window of the MLB regular season. There are six of these events in the sample. Recall that PED testing is random, and suspension announcements would therefore be exogenous. However, this is not to say all suspensions must be exogenous. Off-season suspensions are identified separately due to the fact that they are always served at the beginning of the subsequent regular season, and therefore the timing of the game-broadcasts affected by an off-season suspension is endogenous.

The second type of PED event is termed the playing-season suspension, wherein a player has tested positive for PEDs and their suspension has been announced during the months of the MLB regular season. There are 12 playing-season suspensions

within the sample period and 2% of all observations are game-broadcasts featuring a local team with a currently suspended player (see Table 1).

Information is also collected on injury spells of each of the PED players from ProSportsTransactions.com where available. This information can be found in Appendix Table A4. For seven of the PED players, an injury spell that is closest in time to their PED event is identified and matched with the suspension. The injury event represents game-broadcasts for which the PED player did not participate for the local team due to their physical injury.

As mentioned in the Background and Literature Review section, MLB announces the name of a guilty player within 72 hours of a positive PED test result, news of which is then covered and circulated by traditional and social media. Information on injury events are typically announced through the same channels as PED events, and the speed and extensiveness of the dissemination of these two types of announcements are expected to be similar.

Empirical Framework

Let A denote the local television audience of a game-broadcast. The following specification is estimated:

$$ln(A) = \beta_0 + \mathbb{I}_{PED}(\beta_{PED} + \beta^e_{PED}e) + \mathbb{I}_{OFF}\beta_{OFF} + \mathbb{I}_{INJ}(\beta_{INJ} + \beta^e_{INJ}e) + \beta_X X + \varepsilon. \quad (4)$$

The variable $\mathbb{I}_{PED}$ is a dummy that takes the value of one if the local team has a player currently serving a playing-season suspension and zero otherwise. Within the associated parentheses, the variable e measures the time elapsed between the PED announcement and the observed game-broadcast, measured in days. The impact of the playing-season suspension announcement on the local television audience of the game-broadcast e days later can then be calculated by summing $\beta_{PED} + \beta^e_{PED}e$. The variable $\mathbb{I}_{OFF}$ is a dummy that takes the value of one in game-broadcasts where the local team has a player currently serving an off-season suspension. Similar to the playing-season suspension, $\mathbb{I}_{INJ}$ is a dummy indicating a PED player is currently injured and the corresponding e is the time since the injury announcement and game-broadcast. Lastly, X represents a set of control variables which are consistent with past baseball demand estimation and includes controls for demand cycles (day of the week, afternoon/evening, month, year, and availability of substitutes) as well as controls for both teams of the game-broadcast (probability of winning, and local team and opponent fixed effects).

There are several potential issues with this approach regarding endogeneity. First, game-broadcasts associated with PED announcements that occur in the off-season are not exogenous. These game-broadcasts are always the first observations of a playing season. As mentioned earlier, the off-season PED announcements are treated separately by use of the variable $\mathbb{I}_{OFF}$.

Another area of concern deals with reverse causality: note that PED use increases both demand for baseball and probability of a PED suspension. This conjecture would require PEDs to have very strong and immediate effects on not only the PED player but also on the demand for the PED player's team. While both of these aforementioned phenomena occurring simultaneously seems unlikely, robustness checks in the following section explore this issue further to rule out the possibility of reverse causation.

Lastly, PED announcements may be correlated with team quality. As referenced in the Background and Literature Review section, the suspended player is removed from the team, thereby likely changing the quality of the PED player's team. To separate the impact of the PED announcement from the impact of the change in team quality, another event is studied where the same PED players are removed from competition for long period—this time in less dubious circumstances—due to injuries. Then, similar to a difference-in-differences approach, $\beta_{INJ} + \beta^{e}_{INJ}e$ is the effect of the change in team quality on demand for baseball and $(\beta_{PED} + \beta^{e}_{PED}e) - (\beta_{INJ} + \beta^{e}_{INJ}e)$ is the isolated effect of the PED announcement absent the change in team quality.

Results

Estimates of Equation 4 were run on various specifications. Below is a presentation of the core results which form the basis of the conclusions, additional robustness checks, and a discussion of the implications of the findings.

Impacts of PED Announcements on Local Television Audience

Core results of Equation 4 can be found in Table 2 with *t*-statistics displayed below each estimated coefficient along with asterisks indicating the conventional significance levels. Each model is reported with heteroscedasticity-consistent standard errors.

Column 1 reports a simplified version of Equation 4. All control variables have the predicted sign and are significant while the model is able to explain 80.5% of the variation in the television audience. Positive coefficients are estimated for dummy variables indicating features of the game-broadcast such as teams of the same division (+6.7%), interleague play (+7.7%), the first home-game broadcast of the season (+42.5%), and an evening game-broadcast (+51.0%). All else equal, game-broadcasts receive an 8.6% increase in television audience when the local team is playing at its home ballpark. Generally speaking, higher values of predicted season wins indicate a stronger local team and positively affect the number of viewers at a rate of +3.4% for each additional expected win. Also, consistent with the uncertainty of outcome hypothesis, the model suggests television audience is largest for game-broadcasts where the local team is approximately twice as likely to win than to lose (win probability of 66.7%; Rascher, 1999).[10] Lastly, as expected, the audience size for game-broadcasts also declines when substitutes are readily available: this includes NFL games (−37.7%), NBA games (−7.1%), and NHL games (−3.5%).

Table 2. Regression Output.

ln(Local Television Audience)	(1)	(2)	(3)	(4)
Local team has a(*n*) . . .				
Playing-season suspension	−0.0346**	−0.0978***	−0.0977***	−0.0965***
	(−1.975)	(−3.537)	(−3.534)	(−3.487)
Time elapsed		0.0019***	0.0019***	0.0019***
		(3.188)	(3.190)	(3.170)
Off-season suspension	−0.1298***	−0.1312***	−0.1311***	−0.1297***
	(−3.885)	(−3.924)	(−3.919)	(−3.876)
Injury			−0.0304	−0.0299
			(−0.710)	(−0.699)
Time elapsed			0.0026	0.0026
			(0.875)	(0.882)
Local team's opponent has a(*n*) . . .				
Playing-season suspension				0.0259
				(0.901)
Time elapsed				−0.0003
				(−0.440)
Off-season suspension				0.0392
				(1.068)
Injury				−0.0495
				(−0.686)
Time elapsed				0.0028
				(0.659)
Broadcast of home team	0.0824***	0.0825***	0.0826***	0.0825***
	(13.212)	(13.231)	(13.237)	(13.217)
Predicted season wins	0.0330***	0.0330***	0.0330***	0.0330***
	(78.466)	(78.439)	(78.354)	(78.346)
Probability of winning game	1.6570***	1.6542***	1.6519***	1.6480***
	(5.918)	(5.912)	(5.904)	(5.889)
Probability^2	−1.1938***	−1.1918***	−1.1895***	−1.1847***
	(−4.434)	(−4.429)	(−4.421)	(−4.402)
Divisional rival	0.0652***	0.0652***	0.0651***	0.0651***
	(11.815)	(11.817)	(11.804)	(11.807)
Interleague	0.0738***	0.0738***	0.0738***	0.0736***
	(6.918)	(6.912)	(6.912)	(6.901)
Opening day	0.3540***	0.3538***	0.3537***	0.3533***
	(9.668)	(9.660)	(9.655)	(9.636)
Evening game	0.4121***	0.4122***	0.4122***	0.4122***
	(41.484)	(41.498)	(41.492)	(41.490)
Length of broadcast	0.0017***	0.0017***	0.0017***	0.0017***
	(17.295)	(17.361)	(17.358)	(17.333)
In-market NFL game	−0.4726***	−0.4726***	−0.4727***	−0.4730***
	(−17.341)	(−17.338)	(−17.342)	(−17.340)
In-market NBA game	−0.0732***	−0.0730***	−0.0730***	−0.0731***
	(−5.773)	(−5.765)	(−5.768)	(−5.785)

(continued)

Table 2. (continued)

ln(Local Television Audience)	(1)	(2)	(3)	(4)
In-market NHL game	−0.0358***	−0.0357***	−0.0357***	−0.0354***
	(−2.620)	(−2.618)	(−2.616)	(−2.596)
Day of week FE	Yes***	Yes***	Yes***	Yes***
Month FE	Yes***	Yes***	Yes***	Yes***
Year FE	Yes***	Yes***	Yes***	Yes***
Local team FE	Yes***	Yes***	Yes***	Yes***
Opponent FE	Yes***	Yes***	Yes***	Yes***
R^2	.8051	.8052	.8052	.8052
Observations	29,648	29,648	29,648	29,648

Note. Model estimated with heteroscedasticity-consistent standard errors; *t*-statistics shown in parentheses. Definitions of each variable can be found in Table A2. NFL = National Football League; NBA = National Basketball Association; NHL = National Hockey League; FE = fixed effect.
*$p < .10$. **$p < .05$. ***$p < .01$.

However, as for the variable of interest, the model presented in Column 1 implicitly assumes that the effect of a playing-season PED announcement is constant across the entirety of the suspension. Under this constant-impact assumption, the model suggests there is but a small negative impact of a suspension announcement on the television audience.

Instead, the same model is estimated and shown in Column 2, now allowing the impact of the PED announcement to vary over the length of the suspension as achieved by the inclusion of the time elapsed variable. The results of the control variables from Column 1 largely remain unchanged; however, Column 2 shows the playing-season PED announcement to now have an initial 9.3% decline in television audience.[11] The time elapsed variable suggests the negative effect dissipates as time passes the PED announcement at a rate of 1.9 percentage points every 10 days.[12] This is an interesting find. Certainly, the estimate of the time elapsed variable could be negative if information of the PED suspension is disseminated slowly, zero if time does not affect the reaction of consumers, or nonmonotonic if there are other factors at play. Instead, a positive estimate of time elapsed indicates a "decaying" effect of the impact of PED announcements on television audience. This is consistent with a hypothesis that consumers may not be able to recall that a player is suspended or may have ended their temporary boycott (Cisyk & Courty, 2017).

The full estimation of Equation 4 is shown in Column 3. Similarly, the model finds an immediate 9.3% decline in television audience the day of a PED announcement which wanes over time. The negative effect of a PED announcement is found to be significant for 37 days or approximately 33 game-broadcasts.[13] A graphical depiction of this effect is shown in Figure 2 where the black line illustrates the average effect, the blue shaded area represents the confidence interval, and the red dashed line indicates the final day the effect is statistically significant.

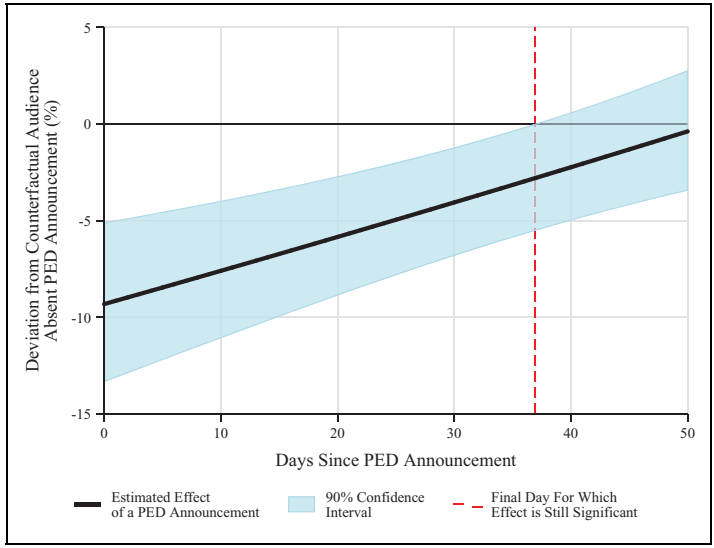

Figure 2. Illustration of the effect of a PED suspension announcement on the local Major League Baseball television audience (see Column 3 of Table 2).

Column 3 also addresses the concern that PED announcements are correlated with team quality by adding the controls for when the PED player is removed due to injury. As with the controls for playing-season suspensions, a linear form is imposed on the time elapsed between injury announcement and the game-broadcast. However, the model suggests the injuries to the PED players have no statistical impact on the television audience. Instead, consumers are reacting solely to the news of the PED suspension.

Each aforementioned model also estimates the effect of an off-season suspension on television audience. However, recall that off-season suspension events are identified separately because the affected game-broadcasts are correlated with the beginning of the regular season. Therefore, because game-broadcasts are not observed in the same regular season before the off-season suspension treatment, the estimated coefficient is more difficult to interpret due to the possibility of other demand shocks that may occur coincidently.

The final model shown in Table 2, Column 4, attempts to uncover any spillover effects of a PED announcement. This is achieved by adding additional regressors to Equation 4 to control for when the local team's opponent has an injury or is currently serving a PED suspension. However, there appears to be no evidence of a collective response from viewers to an opponent after a PED announcement—all estimated coefficients of the opponent variables are not significant. This suggests there is no support for any spillover effects from PED suspensions and/or injuries to PED players.

Instead, the impact of a PED announcement is said to be localised (affecting only the local audience). One possible explanation may be that news of PED

announcements may be disseminated more thoroughly within, rather than outside, the local DMA of the PED player's team. Another possible explanation may be that fans do not equate watching their local team to providing support for its opponent. This is not entirely inconsistent with the conjecture that PED news causes withdrawal of consumer support. Instead, under this hypothesis, consumers would not necessarily display their displeasure by boycotting their local team because of its opponents' PED suspension.

Robustness Checks

Numerous robustness checks are performed. Table 3 displays the most noteworthy variations while others are described and not shown. Column 1 begins by considering only PED players for which there is an injury event corresponding to their suspension. Appendix Table A4 lists seven such "balanced" events for which there is a valid counterfactual to the playing-season suspension. The remaining suspension-treated observations are removed from this specification. While the point estimates of the playing-season suspension variables are slightly different, following a *t*-test, they remain statistically unchanged.

As eluded to in the Empirical Framework section, there still remains the possibility of reverse causality wherein a PED player is able to avoid detection long enough to impact demand before the PED announcement. In this scenario, the negative playing-season suspension coefficient would measure the return of an 'artificially inflated' demand to its otherwise expected level. To address this concern, the dummy variable for the presuspension window of Column 2 takes a value of 1 for a period of 50 days prior to the PED announcement. Despite the concern, there is no evidence to support this reverse causality hypothesis: the coefficient of the window variable is insignificant, and all other results remain unchanged. This remains true regardless of the window length considered, such as 10, 15, or 30 days.

Column 3 addresses any remaining concern of correlation between team quality and PED announcement by directly controlling for the quality of the PED player. This specification uses a performance metric named Wins Above Replacement (WAR) which illustrates how important the PED player is to his respective team prior to suspension. Values of WAR are based on an individual's performance relative to an entry-level player where positive values of WAR indicate greater individual performance.[14] If consumers react not to the news of the PED announcement but to the quality of the suspended PED player, the coefficient on the WAR variable would be negative and significant (in turn likely causing the coefficient of the playing-season suspension variable to be insignificant). Instead, the WAR coefficient is found to be statistically no different than zero, and estimates of the playing-season suspension variables are unchanged. Although not shown, similar results are found when considering the salary of the PED player.

Column 4 adds a control for PED events of players who, at the time of announcement, were members of a Minor League Baseball (MiLB) team.[15] Among these

Table 3. Robustness Checks.

ln(Local Television Audience)	(1)	(2)	(3)	(4)	(5)	(6)
Playing-season suspension	−0.0704**	−0.0986***	−0.1133***	−0.0975***	−0.0965***	−0.0976***
	(−2.037)	(−3.563)	(−3.718)	(−3.527)	(−3.426)	(−3.519)
Time elapsed	0.0020***	0.0019***	0.0020***	0.0019***	0.0019***	0.0018***
	(3.116)	(3.194)	(3.319)	(3.191)	(3.296)	(3.126)
Off-season suspension	−0.1377***	−0.1320***	−0.1316***	−0.1313***	−0.1310***	−0.1321***
	(−4.097)	(−3.947)	(−3.933)	(−3.931)	(−3.918)	(−3.946)
Injury	−0.0262	−0.0291	−0.0299	−0.0314	−0.0302	−0.0299
	(−0.611)	(−0.678)	(−0.699)	(−0.728)	(−0.707)	(−0.689)
Time elapsed	0.0027	0.0025	0.0026	0.0026	0.0026	0.0033
	(0.907)	(0.851)	(0.875)	(0.886)	(0.876)	(1.097)
Presuspension Window		−0.0200				
		(−0.810)				
WAR			0.0148			
			(1.192)			
MiLB suspension				0.0038		
				(0.240)		
Second offence					−0.0212	
					(−0.570)	
Reinstatement						−0.0276
						(−1.447)
Broadcast of home team	0.0823***	0.0826***	0.0825***	0.0826***	0.0826***	0.0826***
	(13.126)	(13.242)	(13.233)	(13.237)	(13.237)	(13.245)
Predicted season wins	0.0330***	0.0330***	0.0329***	0.0330***	0.0330***	0.0330***
	(77.927)	(78.450)	(78.152)	(78.309)	(78.353)	(78.529)
Probability of winning game	1.6241***	1.6513***	1.6540***	1.6515***	1.6532***	1.6559***
	(5.783)	(5.902)	(5.911)	(5.902)	(5.908)	(5.920)

(continued)

Table 3. (continued)

ln(Local Television Audience)	(1)	(2)	(3)	(4)	(5)	(6)
Probability^2	−1.1598***	−1.1892***	−1.1909***	−1.1893***	−1.1909***	−1.1936***
	(−4.292)	(−4.420)	(−4.426)	(−4.419)	(−4.425)	(−4.436)
Divisional rival	0.0651***	0.0652***	0.0651***	0.0651***	0.0651***	0.0651***
	(11.745)	(11.815)	(11.794)	(11.803)	(11.803)	(11.805)
Interleague	0.0722***	0.0737***	0.0735***	0.0738***	0.0738***	0.0739***
	(6.710)	(6.903)	(6.891)	(6.909)	(6.913)	(6.923)
Opening day	0.3532***	0.3538***	0.3537***	0.3537***	0.3536***	0.3537***
	(9.603)	(9.707)	(9.654)	(9.656)	(9.654)	(9.652)
Evening game	0.4107***	0.4122***	0.4123***	0.4122***	0.4122***	0.4122***
	(41.313)	(41.502)	(41.504)	(41.492)	(41.492)	(41.483)
Length of broadcast	0.0017***	0.0017***	0.0017***	0.0017***	0.0017***	0.0017***
	(17.185)	(17.366)	(17.342)	(17.360)	(17.348)	(17.377)
In-market NFL game	−0.4713***	−0.4727***	−0.4730***	−0.4727***	−0.4727***	−0.4726***
	(−17.157)	(−17.343)	(−17.356)	(−17.341)	(−17.343)	(−17.337)
In-market NBA game	−0.0725***	−0.0727***	−0.0733***	−0.0730***	−0.0731***	−0.0731***
	(−5.701)	(−5.739)	(−5.786)	(−5.764)	(−5.770)	(−5.769)
In-market NHL game	−0.0378***	−0.0354***	−0.0357***	−0.0356***	−0.0356***	−0.0356***
	(−2.769)	(−2.601)	(−2.616)	(−2.609)	(−2.606)	(−2.607)
Day of week FE	Yes***	Yes***	Yes***	Yes***	Yes***	Yes***
Month FE	Yes***	Yes***	Yes***	Yes***	Yes***	Yes***
Year FE	Yes***	Yes***	Yes***	Yes***	Yes***	Yes***
Local team FE	Yes***	Yes***	Yes***	Yes***	Yes***	Yes***
Opponent FE	Yes***	Yes***	Yes***	Yes***	Yes***	Yes***
R^2	.8053	.8052	.8052	.8052	.8052	.8052
Observations	29,409	29,648	29,648	29,648	29,648	29,648

Note. Model estimated with heteroscedasticity-consistent standard errors; *t*-statistics shown in parentheses. Definitions of each variable can be found in Table A2. WAR = Wins Above Replacement; MiLB = Minor League Baseball; NFL = National Football League; NBA = National Basketball Association; NHL = National Hockey League; FE = fixed effect.

*$p < .10$. **$p < .05$. ***$p < .01$.

events, only those featuring MiLB players with some MLB experience (either prior to or post-suspension) are considered—see Appendix Table A4 for this list of MiLB PED suspension events. However, no significant effect is found from a MiLB PED suspension announcement. While this may be unexpected, it is not all that entirely surprising as a similar result has already been illustrated with the spillover effect, or lack thereof, with PED events of the local team's opponent (see Column 4 of Table 2). Related to the result that local consumers do not respond to their opponent's transgressions, fans may not be aware of the local team's MiLB PED suspension (MiLB teams are often in very different DMAs than its MLB affiliate[16]) or do not equate support for the local MLB team with support for the associated MiLB team. Note that while various specifications of a decay effect were explored, none were found to be significant.

Several PED players within sample also have a second PED suspension.[17] By adding a dummy for a PED player's second suspension, Column 5 explores the consumer's reaction to recidivism. This estimated effect could plausibly have either sign: a negative value indicating a stronger condemnation for repeated indiscretions or a positive value—possibly even negating the playing-season suspension effect—indicating apathy and indifference to a known PED user. Instead, results suggest consumers have the same reaction to repeat offences.

The final column of Table 3 tests for the consumer reaction to the end of the PED suspension. Similar to Column 2, the model adds a dummy variable for the prefer post-suspension window of 50 days after the PED player's reinstatement. Oddly enough, consumers do not undergo a second round of (temporary) boycotts when the PED player returns to the team. This is an interesting find, although it is not entirely inconsistent with the conjecture that consumers may not recall a player is suspended (the hypothesised reason there exists the decay effect given a playing season suspension). These results hold after varying the reinstatement window length and considering decay.

Various forms of standard error estimators are considered in order to address any remaining concern of correlation of the error term that may lead to overstating the impact of the results. As mentioned in the Results section, all specifications report heteroscedasticity-consistent standard errors; however, there remains alternative options to explore. This includes clustering standard errors by opponent year or opponent series.[18] This also includes bootstrap and jackknife standard error estimation techniques. In each case, the significance of the results is unchanged, and the inference thereof remains the same.

Other specifications are explored—such as unilaterally removing each PED suspension event from the estimation sample or considering alternative definitions of in-market substitute sports—all with similar results. One such specification asks whether fans react stronger to PED suspension announcements when the team is experiencing great success—a reaction perhaps fueled by the belief their team's performance was driven by PED use. This is done by splitting events by the prominence of the PED player's team using the predicted season wins at the time of the suspension event. Results suggest fans have equal reactions regardless of the team's performance; however, local fans may not be the correct reference group to

investigate this concern. Instead, one may want to consider the viewership patterns of individuals with no obvious allegiance to one team, such as consumers outside of all DMAs of MLB teams or consumers within DMAs with multiple MLB teams, and observe any substitution away from the PED player's team or away from the sport entirely. This is left for further research.

Another item for future research would be to investigate alternative definitions of the control group, that is, injury spells. While there appears to be no effect on demand from injury announcements of PED players, the average length of these events is not necessarily equal to that of the PED suspensions. Other events worthy of exploration could be consumer reaction to other types of suspensions. For example, in 2015, MLB introduced a formal policy on domestic violence that has already brought about 10 suspensions against MLB players ranging in length from 15 to 100 games.[19]

Lastly, although the sample covers seven years of MLB television viewership, there are considerations to make for external validation. Recall that the entirety of the sample occurs under one punishment regime; however, the punishment regime has since been toughened, and bans for the same offence are now much longer.[20] Assuming the rate of PED suspensions since the end of the sample has not declined dramatically, there would necessarily be a higher frequency of suspension-treated game-broadcasts in the period since 2013. Within sample, 2% of game-broadcasts carry a PED treatment, and these relatively rare events may provide large informational value to consumers. However, it is not entirely obvious that more suspension-treated game-broadcasts would have the same average effect. Future research should explore the PED suspension announcement across the various punishment regimes to test for time-dependent recidivism and consumer habituation to PED announcements.

Protecting the Financial Integrity of Baseball

While clandestine use of PEDs may actually be a benefit to the commercial viability of sports, league organisers may still have strong economic incentive to enforce anti-PED regulations (Preston & Szymanski, 2003). Because public news of PED use is generally not well received, one such incentive would be to stop the outflow of consumer support and protect the sport's financial integrity (Mazanov & Connor, 2010). For example, as illustrated by Cisyk and Courty (2017), news of a PED announcement results in a loss of close to US$743,000 in forgone ticket revenue to the PED player's team.

However, the decline in television audience does not necessarily provide the same incentive: consider that each MLB team can bargain with a local television station for the rights to locally broadcast each of its regular-season games. Typically, a team enters into a large contract with often a single television station for rights to broadcast its games. The dollar value of its contract is primarily predicated on the number of viewers the local television station expects to receive and the value of advertisement it can sell during the game-broadcasts.

Information on each team's television contract can be found in Appendix Table A5. There are two important features to note of each television contract, the first of

which is the team's ownership share of the local television station. While the average share is 22%, 13 teams have zero ownership of the local television station and, therefore, have little incentive in preserving the financial integrity of the game-broadcasts for the remainder of its current contract.

Second, television contracts are often very lengthy—the largest observed value in Appendix Table A5 is 30 years. In the short run, these contracts become fixed costs for the television station regardless of realised advertisement revenue. Bargaining for a new television contract may include updated information on the financial integrity of the team but, as already found by Brave and Roberts (2019), teams may forgo long-term profits for short-term gains from PED use. Thus, such lengthy contracts suggest that a team need not have a large discount rate to greatly discount a decline in future television contract revenue.

Summary and Conclusion

This study finds when a PED suspension is announced, the PED player's team on average experiences a 9.3% decline in television audience in the subsequent game-broadcast. The magnitude of this negative response to the announcement begins to wane over time yet is statistically significant for at least 37 days. This study also finds there is no effect on television audience when the same players are removed from their teams due to injuries suggesting that consumers are responding solely to the PED announcement and not to the change in the talent featured in the game-broadcast.

This study also finds that while there is a strong localised response to PED suspension, there is no evidence of a collective response, that is, the PED player's opponent does not see a decline in its own television audience. A similar finding that consumers do not react to PED suspensions of the local team's affiliated MiLB players suggests news of PED transgressions does not travel far outside the local team's DMA or that fans do not equate support for their local team with support for the opponent and/or MiLB team.

Further robustness checks are considered such as PED player performance controls, recidivism, and reaction to the PED player's reinstatement from suspension: all return similar results. Other specifications raise important questions for further research such as the reaction to a PED suspension from fans who have other MLB options available or consumer reaction in light of suspensions stemming from the relatively new MLB policy on domestic violence.

The findings of this study are consistent with the hypothesis that consumers do care about PED use in sports. While PEDs are said to be a potential benefit (greater chance to see an exceptional athletic performance) as well as a potential hindrance (loss of consumer support) to the financial integrity of sports, this study certainly points to the latter, although it has been illustrated that teams may not fully internalise the cost of its own player's PED suspension.

Appendix

Table A1. Performance-Enhancing Drug (PED) Suspension Punishments (2006-2013).

	Length of Suspension	
Positive Tests	Non-stimulant PEDs	Stimulants
First	50 games	Follow-up testing
Second	100 games	25 games
Third	Up to lifetime	80 games
Fourth	—	Up to lifetime

Source. Major League Baseball's Joint Drug Prevention and Treatment Program.

Table A2. Variable Descriptions.

Variable Name	Description
Playing-season suspension	Takes a value of 1 when a PED player from the team is currently serving a suspension announced during the regular season, 0 otherwise. Time elapsed refers to the number of days since the announcement of the suspension.
Off-season suspension	Takes a value of 1 when a PED player from the team is currently serving a suspension announced outside the regular season, 0 otherwise.
Inactive	Takes a value of 1 when a PED player from the team is inactive due to an injury, 0 otherwise. Time elapsed refers to the number of days since the PED player was placed on the injured list.
Local team is home team	Takes a value of 1 when the local team is the home team, 0 otherwise.
Predicted season wins	The expected number of total season wins of the local team.
Probability of winning game	The expected probability the local team wins the game.
Probability^2	The squared value of probability of winning game.
Divisional rival	Takes a value of 1 when the local team and non-local team are within the same division of the same league, 0 otherwise.
Interleague	Takes a value of 1 when the local team and non-local team are not within the same league, 0 otherwise.
Opening day	Takes a value of 1 for the first game-broadcast in each season where the local team is the home team, 0 otherwise.
Evening game	Takes a value of 1 when the game is played after 18:00, local time.
Length of broadcast	Length of the game-broadcast, measured in minutes.
In-market NFL game	Takes a value of 1 when the game-broadcast occurs on the same day as a game of an NFL team in the local team's DMA.
In-market NBA game	Takes a value of 1 when the game-broadcast occurs on the same day as a game of an NBA team in the local team's DMA.
In-market NHL game	Takes a value of 1 when the game-broadcast occurs on the same day as a game of an NHL team in the local team's DMA.

Note. PED = performance-enhancing drug; NFL = National Football League; DMA = designated marketing area; NBA = National Basketball Association; NHL = National Hockey League.

Table A3. Available Substitutes in Each DMA, 2006–2012

DMA	MLB	NFL	NHL	NBA
Atlanta, GA	Atlanta Braves	Atlanta Falcons	Atlanta Thrashers	Atlanta Hawks
Baltimore, MD	Baltimore Orioles	Baltimore Ravens		
Boston–Manchester, MA	Boston Red Sox	New England Patriots	Boston Bruins	Boston Celtics
Chicago, IL	Chicago Cubs, Chicago White Sox	Chicago Bears	Chicago Blackhawks	Chicago Bulls
Cincinnati, OH	Cincinnati Reds	Cincinnati Bengals		
Cleveland–Akron–Canton, OH	Cleveland	Cleveland Browns		Cleveland Cavaliers
Dallas–Ft. Worth, TX	Texas Rangers	Dallas Cowboys	Dallas Stars	Dallas Mavericks
Denver, CO	Colorado Rockies	Denver Broncos	Colorado Avalanche	Denver Nuggets
Detroit, MI	Detroit Tigers	Detroit Lions	Detroit Red Wings	Detroit Pistons
Houston, TX	Houston Astros	Houston Texans		Houston Rockets
Kansas City, KS–MO	Kansas City Royals	Kansas City Chiefs		
Los Angeles, CA	Los Angeles Angels of Anaheim, Los Angeles Dodgers		Los Angeles Kings, Anaheim Ducks	Los Angeles Clippers, Los Angeles Lakers
Miami–Ft. Lauderdale, FL	Miami (Florida) Marlins	Miami Dolphins	Florida Panthers	Miami Heat
Milwaukee, WI	Milwaukee Brewers	Green Bay Packers		Milwaukee Bucks
Minneapolis–St. Paul, MN	Minnesota Twins	Minnesota Vikings	Minnesota Wild	Minnesota Timberwolves
New York, NY	New York Mets, New York Yankees	New York Giants, New York Jets	New York Islanders, New York Rangers, New Jersey Devils	New York Knicks, Brooklyn (New Jersey) Nets
Philadelphia, PA	Philadelphia Phillies	Philadelphia Eagles	Philadelphia Flyers	Philadelphia 76ers
Phoenix–Prescott, AZ	Arizona Diamondbacks	Arizona Cardinals	Arizona Coyotes	Phoenix Suns
Pittsburgh, PA	Pittsburgh Pirates	Pittsburgh Steelers	Pittsburgh Penguins	
San Diego, CA	San Diego Padres	San Diego Chargers		
San Francisco–Oakland–San Jose, CA	Oakland A's, San Francisco Giants	Oakland Raiders, San Francisco 49ers	San Jose Sharks	Golden State Warriors
Seattle–Tacoma, WA	Seattle Mariners	Seattle Seahawks		Seattle SuperSonics

(continued)

Table A3. (continued)

DMA	MLB	NFL	NHL	NBA
St. Louis, MO	St. Louis Cardinals	St. Louis Rams	St. Louis Blues	
Tampa–St. Petersburg–Sarasota, FL	Tampa Bay (Devil) Rays	Tampa Bay Buccaneers	Tampa Bay Lightning	
Washington–Hagerstown, DC–MD	Washington Nationals	Washington	Washington Capitals	Washington Wizards

Note. MLB = Major League Baseball; NFL = National Football League; DMA = designated marketing area; NBA = National Basketball Association; NHL = National Hockey League.

Table A4. Suspension and Injury Events (2006-2012).

Playing-Season Events		Suspension			Injury		
Player	Position	Team	Date	Length[a]	Team	Date	Length[a]
Yusaku Iriki	P	NYM	4/28/2006	50			
Jason Grimsley	RP	ARI	6/12/2006	50			
Juan Salas	RP	TBR	5/7/2007	50			
Neifi Perez (1)	IF	DET	7/6/2007	25			
Neifi Perez (2)	IF	DET	8/3/2007	80			
Manny Ramirez (1)	OF	LAD	5/7/2009	50	LAD	4/23/2010	14
Edinson Volquez	SP	CIN	4/20/2010	50	CIN	5/21/2009	10
Manny Ramirez (2)	OF	TBR	4/8/2011	100	LAD	7/3/2010	9
Eliezer Alfonzo (2)	C	COL	9/14/2011	48[b]	SFG	6/9/2007	8
Guillermo Mota (2)	RP	SFG	5/7/2012	100	SFG	8/23/2010	13
Freddy Galvis	IF	PHI	6/19/2012	50	PHI	8/17/2012	43
Melky Cabrera	OF	SFG	8/15/2012	50			
Bartolo Colon	SP	OAK	8/22/2012	50	OAK	6/23/2012	10
Off-Season Events		Suspension					
Player	Position	Team	Date	Length[a]			
Carlos Almanzar[c]	RP	TEX	10/4/2005	10[d]			
Guillermo Mota (1)	RP	NYM	11/1/2006	50			
Mike Cameron[e]	OF	SDP	10/31/2007	25			
Dan Serafini	RP	COL	11/27/2007	50			
Jose Guillen	OF	KCR	12/6/2007	15			
J.C. Romero	RP	PHI	1/6/2009	50			

(continued)

Table A4. (continued)

Minor League Events		Suspension		
Player	Position	Team	Date	Length[a]
Felix Heredia[f]	RP	NYM	10/18/2005	10[d]
Ramon Ramirez	P	CIN	4/11/2006	50
Nerio Rodriguez	P	PIT	5/19/2006	50
Abraham Nunez	OF	SFG	5/24/2006	50
Yamid Haad	C	SFG	5/31/2006	50
Daniel McCutchen	P	NYY	8/8/2006	50
Francisco Cruceta	P	TEX	5/9/2007	50
Lino Urdaneta	P	NYM	5/16/2007	50
Angel Salome	C	MIL	7/24/2007	50
Ryan Jorgensen	C	CIN	9/7/2007	50
Luther Hackman	P	TEX	10/30/2007	50
Jordan Schafer	OF	ATL	4/8/2008	50
Eliezer Alfonzo (1)	C	SFG	4/30/2008	50
Humberto Cota	C	COL	5/28/2008	50
Jorge Sosa	P	SEA	8/21/2008	50
Runelvys Hernandez	P	HOU	9/6/2008	50
Henry Owens	P	MIA	11/11/2008	50
Sergio Mitre[g]	P	MIA	1/6/2009	50
Pablo Ozuna	IF	PHI	6/11/2009	50
Prentice Redman (1)	OF	LAD	6/25/2010	50
Pablo Lopez	IF	WAS	7/27/2010	50
Prentice Redman (2)	OF	LAD	7/27/2010	100
Omar Quintanilla	IF	COL	8/11/2010	50
Matt Kinney	P	SFG	8/24/2010	50
Kevin Frandsen	IF	PHI	5/11/2011	50
Mark Rogers	SP	MIL	8/19/2011	25

(continued)

Table A4. (continued)

Events Not Considered		Suspension			
Player	Position	Team	Date	Length[a]	Reason
Matt Lawton	OF	NYY	11/2/2005	10[d]	Released before serving suspension in 2006
Jay Gibbons	OF	BAL	12/6/2007	15	Released before serving suspension in 2008
Marlon Byrd	OF	—	6/25/2012	50	Free agent at time of suspension

Source. ProSportsTransactions.com

Note. C = catcher; IF = infielder; OF = outfielder; SP = starting pitcher; RF = relief pitcher; P = pitcher (relief/starting unspecified) NYM = New York Mets; ARI = Arizona Diamondbacks; TBR = Tampa Bay (Devil) Rays; DET = Detroit Tigers; LAD = Los Angeles Dodgers; CIN = Cincinnati Reds; COL = Colorado Rockies; SFG = San Francisco Giants; PHI = Philadelphia Phillies; OAK = Oakland A's; TEX = Texas Rangers; SDP = San Diego Padres; KCR = Kansas City Royals; PIT = Pittsburgh Pirates; NYY = New York Yankees; MIL = Milwaukee Brewers; ATL = Atlanta Braves; SEA = Seattle Mariners; HOU = Houston Astros; MIA = Miami (Florida) Marlins; WAS = Washington Nationals; BAL = Baltimore Orioles.

[a]Measured in number of games, unless noted elsewhere. [b]One hundred-game suspension was reduced to 48 due to procedural issues with test samples. [c]Served suspension with Atlanta Braves at the start of 2006 season. [d]Suspension length measured in days. [e]Served suspension with Milwaukee Brewers at the start of 2008 season. [f]Served suspension with Cleveland's minor league affiliate at the start of 2006 season. [g]Served suspension with New York Yankees' minor league affiliate at the start of 2010 season.

Table A5. Television Contract Information, 2016

Team	Annual Value ($ Millions)	Length (Years)	Ownership (%)	Market Size (Thousands)	Average Audience (Thousands)
Los Angeles Dodgers	334.0	25	100	5,613.5	117.3
New York Yankees	190.0	30	20	7,384.3	293.5
Los Angeles Angels	150.0	20	25	5,613.5	62.6
Seattle Mariners	100.0	18	71	1,818.9	64.1
Philadelphia Phillies	100.0	25	25	2,949.3	170.4
Boston Red Sox	80.0	N/A	80	2,366.7	145.3
Houston Astros	80.0	20	0	2,215.7	20.6
Texas Rangers	80.0	20	10	2,588.0	154.1
Arizona Diamondbacks	75.0	20	N/A	1,812.0	63.0
San Francisco Giants	70.0	25	30	2,502.0	126.2
St. Louis Cardinals	66.7	15	30	1,243.5	95.2
Chicago Cubs	65.0	16	20	3,484.8	75.0
New York Mets	52.0	25	65	7,384.3	170.6
Chicago White Sox	51.0	16	20	3,484.8	75.8
Detroit Tigers	50.0	10	0	1,845.9	167.0
San Diego Padres	50.0	20	20	1,075.1	20.0
Oakland A's	47.6	21	0	2,502.0	32.8
Washington Nationals	46.0	23	18	2,359.2	57.6
Baltimore Orioles	46.0	23	82	1,085.1	52.6
Cleveland	40.0	10	0	1,485.1	64.7
Minnesota Twins	40.0	12	0	1,728.1	77.5
Atlanta Braves	35.0	20	0	2,326.8	83.7
Cincinnati Reds	30.0	10	0	897.9	75.4
Pittsburgh Pirates	25.0	10	0	1,165.7	72.7
Milwaukee Brewers	24.0	7	0	902.2	44.9
Kansas City Royals	20.0	12	0	931.3	35.1
Colorado Rockies	20.0	10	0	1,566.5	42.3
Tampa Bay Rays	20.0	10	0	1,806.6	87.0
Miami Marlins	18.0	15	0	1,621.1	31.6

Source. FanGraphs.com and Nielsen.
Note. N/A = not available.

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Notes

1. Eight percent say performance-enhancing drugs (PEDs) are "not a problem"; 1% have no opinion (see Gallup, "Baseball Fans Have Little Patience for Steroid Abuse," https://news.gallup.com/poll/15379/baseball-fans-little-patience-steroid-abuse.aspx).
2. Predicted audience comes from a linear regression of natural logarithm of television audience/attendance and day of week, month, year, and team fixed effects.
3. See MLB Joint Drug Prevention and Treatment Program available at http://mlb.mlb.com/pa/pdf/jda.pdf
4. Recall PED suspensions are unpaid and the PED player forfeits his salary for the duration of the suspension.
5. Note, the sample does not include games prior to or after the regular season, that is, the sample excludes spring training and/or the post-season playoffs.
6. Specifically, a team may broadcast any game in which it participates only within a predetermined area surrounding and including the team's designated marketing area (DMA). For more information, see MLB Constitution Article X, §3(a), http://www.law.uh.edu/assignments/summer2009/25691-b.pdf
7. Note, even if the two participating teams share the same DMA, there are still two unique game-broadcasts.
8. The average ratio of each team's annual attendance to annual television audience is 0.169.
9. For context, Nielsen also estimates the percentage of televisions tuned to a particular broadcast also known as the broadcast's ratings. The current record for the highest ratings of a nationally televised broadcast is 60.3% for the M*A*S*H finale, "Goodbye, Farewell and Amen," aired on February 28, 1983.
10. $\frac{1.6570}{2\times 1.1938} = 69.4\% \approx \frac{2}{3}$.
11. $\exp(\beta_{\text{PED}}) - 1 = \exp(-0.0978) - 1 = -9.3\%$.
12. $10 \times (\exp(\beta^{e}_{\text{PED}} e) - 1) = 10 \times (\exp(0.0019) - 1) = 1.9\%$.
13. Each Major League Baseball (MLB) regular season consists of 162 games played over the span of approximately 180 days, a rate of $\frac{162}{180} = 0.9$ games per day. One would therefore expect $37 \times \frac{162}{180} \approx 33$ game-broadcasts to occur within 37 days.
14. See MLB, "Wins Above Replacement (WAR)," available at http://m.mlb.com/glossary/advanced-stats/wins-above-replacement
15. Note, Minor League Baseball (MiLB) teams are usually (although not always) affiliated with a MLB team and consist of individuals vying for positions on said MLB team.
16. In fact, unless otherwise granted permission, no MiLB team may play its home games within the home territory of any MLB team—see MLB Rule 52(a)(4), https://registration.mlbpa.org/pdf/MajorLeagueRules.pdf
17. Alfonzo, Mota, Perez, and Ramirez (see Table A4).
18. Typically, a home-away pair play in two to four consecutive games known as a "series."

19. See MLB, MLB Players Association Joint Domestic Violence, Sexual Assault, and Child Abuse Policy available at http://riveraveblues.com/wp-content/uploads/2015/08/Domestic-Violence-Policy.pdf; see also ProSportsTransactions.com
20. As of 2014, the PED punishments are 80 games for a first infraction, 162 games for a second, and lifetime for a third—see MLB Joint Drug Prevention and Treatment Program, http://mlb.mlb.com/pa/pdf/jda.pdf

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