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DO FANS CARE ABOUT COMPLIANCE TO DOPING REGULATIONS IN SPORTS? THE IMPACT OF PED SUSPENSION IN BASEBALL†

Abstract

There is little evidence in support of the main economic rationale for regulating athletic doping: that doping reduces fan interest. The introduction of random testing for performance-enhancing drugs (PED) by Major League Baseball (MLB) offers unique data to investigate the issue. The announcement of a PED violation: (a) initially reduces home-game attendance by 8 percent, (b) has no impact on home-game attendance after 12 days, and (c) has a small negative impact on the game attendance for other MLB teams. A lower bound for the cost of a PED violation to a team is $451K. This is the first systematic evidence that doping decreases consumer demand for sporting events.

JEL Classification: D01 and L83
Keywords: baseball, demand estimation, doping and performance enhancing drug

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1 Introduction

The use of performance-enhancing drugs (PEDs) in sports, also referred to as doping, is highly controversial (Maennig, 2002). The debate is fueled by clashing views from sports pundits, policy makers (Coomber, 2013), health professionals (Savulescu, Foddy, and Clayton (2004), Hartgens and Kuipers (2004)), and economists as well. According to Preston and Szymanski (2003), the only rationale against doping that withstands economic scrutiny is that the use of PEDs devalues sport contests and decreases public interest. Buechel, Emrich, and Pohlkamp (2014) go further to argue that asymmetric information on PED use could be causing a market failure. We are not aware of systematic evidence supporting the conjecture that PED use decreases fan demand. This paper investigates whether the announcement of PED violations in baseball lowers attendance.

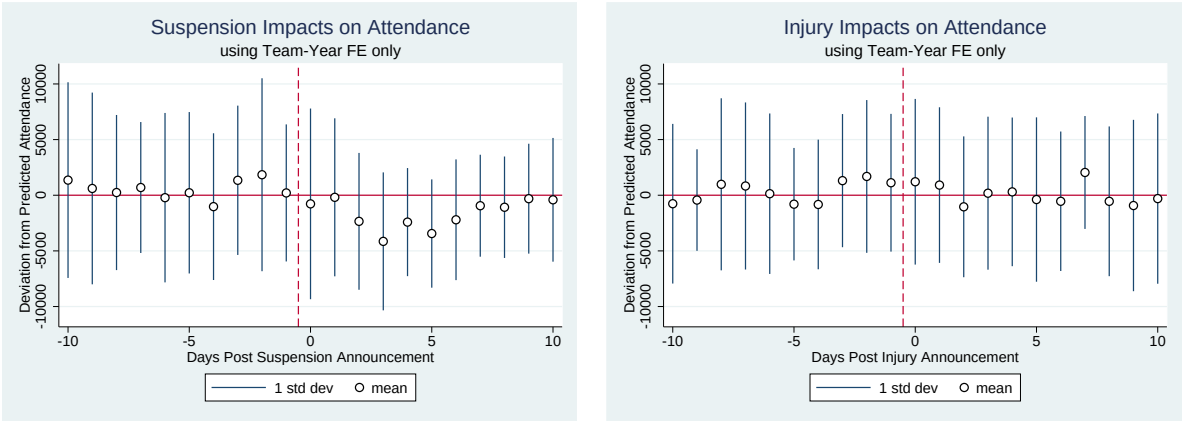
There are four main reasons for choosing baseball for this study. First, in the 2005 season, following the "steroid era" (c. 1996-2003), MLB introduced a new set of regulations calling for random tests for PED use, yielding unique data to investigate the impact of PED violation on attendance. Second, games are played on a nearly daily basis during the playing season (teams typically play 162 games over a season of approximately 180 days); this provides abundant attendance statistics for comparing home-game attendance before and after a PED announcement. Third, most baseball games are not sold out; therefore, suspension announcements can affect ticket sales even for announcements that are made only hours before the game. Fourth and finally, the large literature studying the demand for baseball provides background information and a broad range of readily available statistics. See Villar and Guerrero (2009) for a review.[1]

Figures 1a and 1b motivate our empirical approach. Figure 1a presents deviations in attendance from team-year average before and after a suspension. The figure averages these deviations across the 29 PED violations announced in the 2005–2013 seasons. If the pubic cares about PED use, we would expect a decrease in attendance following a suspension, which is, in fact, clearly illustrated by Figure 1a. In the days that follow a PED announcement, sales decrease by a few thousand tickets. One goal of this study is to precisely measure the magnitude of this decrease and to establish that it is statistically significant. There is a caveat, however. Even a significant response could be explained by a team play effect in which removing a star player from a team's roster could decrease the quality of play in the subsequent games (Rivers, DeSchriver, et al., 2002). However, only four suspended players in our sample are star players.[2] Thus, suspensions

[1] See also Baade and Tiehen (1990), Scully (1974), Knowles, Sherony, and Haupert (1992), Beckman, Cai, Esrock, and Lemke (2011), Whitney (1988), Sommers (JSE, 2008), Kahane and Shmanske (1997), Zygmont and Leadley (2005), Hill, Madura, and Zuber (1982).

[2] Two PED players were in the top 10th percentile of the league's annual salary and two different PED players

may have only a small, or even negligible, effect on team play. This is confirmed by Figure 1b which reproduces Figure 1a for the same subset of suspended players, but the window is now centred on the date it was announced that the player was removed from the team's roster due to an injury. Injury events are not associated with any decrease in attendance. Taken together, the two figures suggest that announcements of PED violations decrease demand even after controlling for team quality.



(a) Suspension Impacts on Attendance

(b) Injury Impacts on Attendance

Figure 1: Event Impacts on Attendance

Figures illustrate the deviation from average team-year attendance across 29 suspensions/55 injuries, 10 days prior and 10 days post suspension/injury announcement. Dashed vertical line represents relative timing of announcement. Solid vertical lines indicate a range of plus/minus one standard deviation.

This paper demonstrates that PED violations have a short term impact on home-team attendance that is both statistically significant and economically important: the announcement of a PED suspension initially decreases demand by about 8 percent. That effect decreases quickly to the point where, after about 12 days, it is no longer statistically significant. Rough economic estimates suggest that a PED violation costs the violating team 1.1 percent of annual revenue or, after accounting for the saving from not having to pay the suspended player, $\$451K$. The paper also shows that PED violations by any player in the league have an impact on league demand. While this additional effect is small, it is economically important because the league includes 30 teams. This demonstrates that PED violations impose negative externalities across teams.

Within the large economics literature on doping, most papers assert that compliance to doping regulation is desirable. PED use is often analyzed within an inspection game framework. The contest designer wants to minimize doping (Berentsen (2002), Eber (2007), Haugen (2004),

were in the top 10th percentile of Wins Above Replacement (see Section 3) in the season they were suspended.

Mohan and Hazari (2014), Bird and Wagner (1997)). The models from these works do not say anything about the impact of PED use on public welfare. An exception is Buechel, Emrich, and Pohlkamp (2014), who explicitly state that PED use decreases consumer interest and demonstrate that, because of the potential for loss of consumer interest, enforcement and transparency on PED testing are deliberately neglected.

There is much survey evidence showing that PED use violates the spirit of sports and has a negative impact on a sport's reputation (Solberg, Hanstad, and Thøring (2010), Engelberg, Moston, and Skinner (2012)). A problem with this evidence, however, is that the fans who are willing to pay for sporting events, are not necessarily well represented in random surveys. There is also circumstantial evidence, from cycling in particular, that news about widespread PED use negatively affects sponsor support for sporting events (Buechel, Emrich, and Pohlkamp, 2014). One argument against this is that Van Reeth (2011) finds no response in TV audiences to PED violations in the Tour de France. Another problem with the existing evidence is that it does not account for the fact that PED use also increases athletes' performance. One may speculate that fans could be willing to accept the use of PEDs, thus sacrificing the "spirit of the sport" to gain more exciting sporting events.

This paper is organized as follows: Section 2 discusses the regulation of PEDs in baseball. Sections 3 to 5 present the data, the empirical approach and the results. Section 6 summarizes the main findings and discusses the implications for the PED debate.

2 Baseball, PED Regulations, and Public Attitude Towards PEDs

"Performance-enhancing drug" (PED) is a blanket term that includes many substances taken to increase athletic ability. The Controlled Substances Act (CSA) of the United States is the US federal policy behind MLB's PED policy. Initially passed in 1970, major amendments were made to the CSA in 1990 and 2004 to counter the ever-intensifying prevalence of steroids in sports and society.[3] The information that follows on PED regulation in baseball comes from a national reporter at MLB Advanced Media as well as from press coverage.[4]

[3] http://www.gpo.gov/fdsys/pkg/BILLS-108s2195enr/pdf/BILLS-108s2195enr.pdf

[4] See Bloom (2003), Bloom (2004), Bloom (2005a) and Bloom (2005b).

2.1 A Brief History of PED in Baseball

Baseball seasons 1996–2003 are associated with a number of home-run records and a dramatic rise in attendance. This period has been referred to as the "steroid era" because several players subsequently confessed that they were using PEDs. The negative public backlash starting in 2003 forced MLB to introduce drug testing and, later, punishments. Table A2 in the appendix summarizes the three PED enforcement regimes that MLB implemented starting with the 2004 season. Partly as a pre-emptive effort to avoid outside interference, MLB administered 1,438 steroid urine tests during the 2003 season. The collected samples were analyzed anonymously to gauge the prevalence of steroids and carried no economic repercussions. However, 5 to 7% of the tests concluded positive incidence of steroids. As a response, the league mandated PED testing for the 2004 season; this involved unannounced testing with the chance of suspension and/or a fine for second and subsequent violations.

Although only 1 to 2% of the players tested positive during the 2004 suspension regime, the US Congress threatened intervention, with both Democrats and Republicans proposing that PED use in professional baseball adversely influences young athletes. To avoid the threat of Congressional intervention, MLB tightened its protocol for testing and punishment in the 2005 season, now disclosing the names of the players after the first time they tested positive for use of steroids. Shortly after, MLB introduced the Joint Drug Prevention and Treatment Program (JDP), which applied to seasons 2006–2013.[5] This study covers these two regimes (seasons 2005–2013) during which positive PED tests were revealed to the public.

2.2 The 2006 Joint Drug Prevention and Treatment Program

Under the JDP, players are randomly tested at least twice a year during the playing season (April through September) and off season (October through March).[6] A test's outcome is considered positive not only when the sample surpasses the tolerable limit, but also when a player refuses to submit to testing or attempts to alter any specimen. Tolerable limits vary by substance, except for steroids, for which there is no permissible level (except the maximum of 2ng/ml of Nandrolone).

[5] http://mlb.mlb.com/pa/pdf/jda.pdf

[6] In addition, non-random tests can also be conducted based on reasonable cause after an assigned committee reaches a majority vote in favour of testing based on evidence presented against the accused player. We could not find any evidence that the tests based on reasonable cause could happen in response to performance or any other variable that influences demand. The JDP details the standards for testing for banned substances such as drugs of abuse under Schedule II of the CSA and stimulants under Schedule III that are taken without a medical prescription.

Within 72 hours of a positive PED test, MLB reveals the guilty party and the length of suspension. During seasons 2005–2013, 44 suspensions were issued to 40 players, referred to as PED players (four PED players received two suspensions). We use the terminology playing-season and off-season suspension to refer to the period when the suspension was announced. Table A3 describes all 44 events. Given that approximately 1200 players (30 teams with 40 roster players) are tested each season, this corresponds to a low rate of violation: about 0.4% of the players tested positive per season.[7]

Consider the case of Guillermo Mota (15th line in Table A3 in the appendix), a relief pitcher for the San Francisco Giants with a 2012 expected salary at the median of the distribution of PED players. On 7 May 2012, he was handed his second PED violation of his MLB career, which dictated a 100-game suspension. His foregone salary amounted to $530,000. The Twitter account @MLB stated: "Giants RHP Guillermo Mota suspended 100 games by MLB after testing positive for Clenbuterol, a performance-enhancing substance."[8] The announcement of Guillermo's suspension quickly became viral, with 343 re-tweets, and was covered in all the sports media. On 28 August 2012, after serving his suspension, Mota rejoined his team.

2.3 PED Use and Fan Interest

There is much debate over the regulation of PEDs in sports (Smith, Smith, and Stewart, 2008). Several arguments are offered in support of prohibiting PED use. Preston and Szymanski (2003) sort these arguments into four categories: (a) protecting the health of athletes, (b) providing a fair playing field, (c) protecting the reputation of the sport, and (d) preventing public interest in sports from being undermined. They argue that only the last two rationales withstand close scrutiny.[9] Other authors concur. Buechel, Emrich, and Pohlkamp (2014) claim that PED use generates a "withdrawal of support." Engelberg, Moston, and Skinner (2012) speculate that PED "devalue sports," writing that, "an implicit rationale for anti-doping legislation is that doping damages the public image of sport and that this, in turn, has serious consequences for the sporting industry" (pg. 84). See also Savulescu, Foddy, and Clayton (2004). Our hypothesis

[7]The 40 players in the roster correspond to the players signed under a contract. Only a subset of 25 players is eligible to participate in a game.

[8]The MLB rarely reveals the banned substance that is identified in the sample. In that instance, the MLB did so. Clenbuterol is a drug designed to help alleviate asthma but is also known to be used for it's ability to suppress appetite and promote weight loss.

[9]The third rationale says that PED use among elite athletes has a negative externality on other activities associated with the sport. Taking baseball as an example, it is feared that PED drug use could trickle down to non-professional leagues and even to young aspiring athletes who idolize MLB players. For example, US Congressman Jim Sensenbrenner stated, "Several professional athletes have wrongly taught many young Americans by example that the only way to succeed in sports is to take steroids" (as cited by Bloom (2004)).

concurs that PED use in a sport reduces demand for the events.

As mentioned in the introduction, there is very little evidence that relates public interest and PED use. Our hypothesis diverges from what is suggested by past evidence in its focus on: (a) the consumers who actually pay for events (rather than random respondents interviewed in the survey literature) and (b) actual demand responses instead of consumer opinions. One challenge with the demand hypothesis is that PED use is unobserved, either by the public or the econometrician. One can learn about PED use, however, from news announcements, player testimonies, sport analysts, etc. We select the most prominent and objectively defined set of events in baseball regarding PED use: MLB violation announcements under the JDP, with a specific focus on the short-term impact of PED violations on ticket sales.

3 Data and Descriptive Statistics

Our data come from two sources. The information on game outcomes comes from Baseball-Reference.com. We collected game-specific variables in line with the demand-estimation literature. This includes box-score attendance, team-playoff history, and game outcomes. The sample spans the nine seasons from 2005–2013. In each season, the 30 teams of the league were scheduled to play 81 home games and we have information for most games.[10] In total, the sample contains 21,790 games. Descriptive statistics are provided in Table 1. Note that games are rarely sold out: median capacity utilization is 0.71 with a standard deviation of 0.23.

The main variable, paid attendance, is the number of tickets sold for a game. This is the variable used in past studies of demand for baseball (Villar and Guerrero, 2009). Ideally, we would like to use information on daily ticket sales for a given game to track the impact on sales of a PED suspension each day after its announcement. This information, however, is not available. In fact, little is known about the timing of ticket sales or even the fraction of season tickets relative to total attendance. We return to the paid attendance issue when we interpret the results.

The information on PED suspension and injury comes from ProSportsTransactions.com. From the 44 events reported in Table A3, we keep only those suspensions the player actually serves with a major-league team. For example, a suspension event is excluded if the player is released from the team (e.g. Gibbons and Lawton) or moved to the minor league affiliate, thus

[10] Some games are canceled due to inclement weather. In addition, for 81 doubleheader games where the home team hosts two games on a single day, attendance only for one of the games is available. Finally, the dataset excludes playoff games.

Table 1: Descriptive Statistics

	Median	Mean	Std. Dev.	Min	Max
Attendance					
Per Game Total	31658	31108	10681	6017	57405
Attendance to Capacity Ratio*	0.71	0.69	0.23	0.13	1.28
Playing-Season Suspensions					
Suspension Length in Games	50	43.55	28.64	10	105
Suspension Count per Year	2	3.22	2.99	0	9
Time Elapsed**	2	3.11	3.05	0	10
Off-Season Suspensions					
Suspension Length in Games	37.5	34.38	17.41	10	50
Suspension Count per Year	1	0.89	1.05	0	3
Time Elapsed**	129	144.75	41.69	89	220
Injury					
Injury Length in Games	28.00	46.60	46.57	5	200
Injury Count per Year	6	6.11	3.30	2	11

*Attendance to capacity ratio can be greater than one because attendance includes tickets sold in standing areas that are not included in capacity. **number of days between suspension announcement and first home game

never serving his suspension as part of his own team's 40-man roster (e.g. Heredia). We are left with 29 playing-season suspensions (with 3 players receiving 2 suspensions each) and 8 off-season suspensions. For playing-season suspensions, the median suspension length is 50 games and for off-season suspension it is 37 games.

Figure 2 plots the start and end of each suspension in bold lines, breaking them down by teams and seasons. Shaded vertical strips correspond to the off seasons and blank ones to playing seasons. Suspensions can be served only during the playing season: there are no bold lines in the shaded strips. Off-season suspensions start at the beginning of the playing season. Otherwise, there are no other visible patterns on the distribution of suspension across the 9 seasons and 30 teams. Across all home games in our sample, only 3.2% took place while a home player was serving a suspension, with 2.6% announced during the playing season and 0.7% announced during the off season. 36.4% of all games took place while at least one player in the entire league was suspended.

Using Mota again as an example, the time line for his second suspension is illustrated in Figure 3. On 7 May 2012, no later than 72 hours after Mota submitted to a drug test, his suspension was announced by MLB and the news was immediately disseminated by the media.

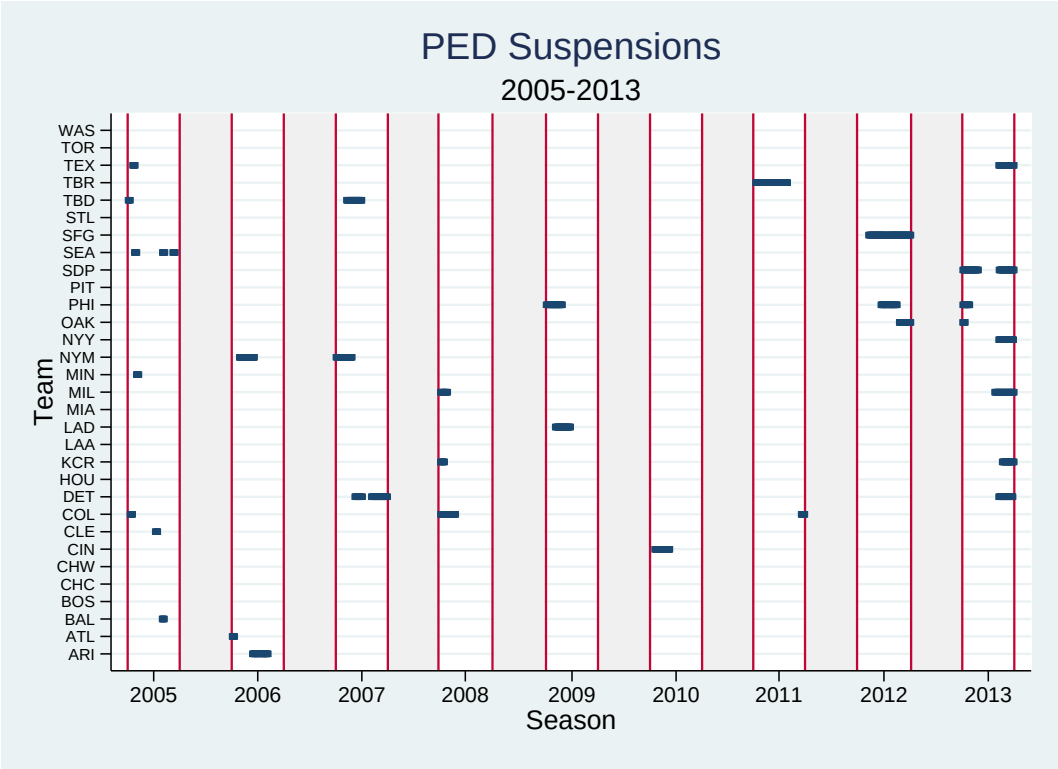


Figure 2: Games in which a player is currently serving a suspension

However, because Mota's team did not play a home game until 14 May 2012, any impact from this suspension on Mota's home-team attendance is not observed until after this 7-day period. We call the number of days between a PED announcement and any game thereafter the "elapsed time."

Table 1 reports statistics on the elapsed time between a suspension announcement and the first home game played by the team. For playing-season suspensions, the median elapsed time is 2 days (with a standard deviation of 3 days), which means the news of suspension is still fresh in the public's mind at the time of the home game. For off-season suspensions, however, the elapsed time for the first home game is, on average, 129 days, which means off-season suspensions may not have the same impact on home-game attendance. One reason is that fans may forget that a player was suspended during the off season. Another reason is that the first games after off-season suspensions fall at the beginning of the season, when attendance may be systematically different. We cannot conduct a before–after difference for off-season suspensions because we do not observe home-games in the same season before and after the suspension. For these reasons, we will treat off-season and playing-season suspensions separately.

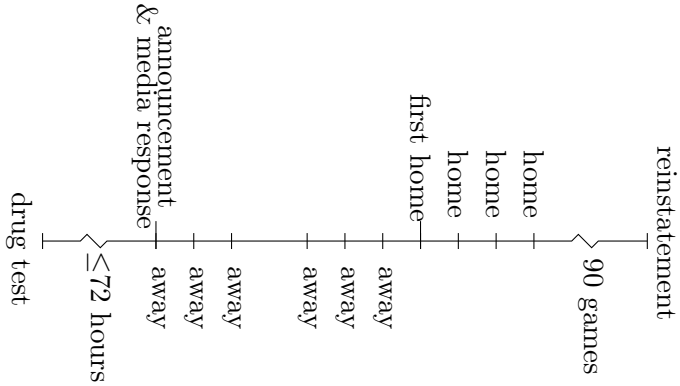


Figure 3: Suspension Time Line – Guillermo Mota

We collected injury spells from ProSportsTransactions.com. For 21 of the 29 PED events in our sample over the 2005–2013 seasons, at least one injury occured to match the suspension. An injury event indicates that a PED player is removed from the home-team roster (placed on a disabled list) for a number of games, and the injury events are announced to the public through the same channels as PED events. For each suspension event, we matched the injury event that is closest in time to the suspension, giving us a matched sample of suspensions and injuries. Lastly, we collected from Baseball-Reference.com the expected salary of players and a standard measure of individual productivity called Wins Above Replacement (WAR).[11]

4 Empirical Framework

Let $A_{t,s,i}$ denote attendance for home team t in season s and in game $i = 1..N$. We run specifications of the following type:

$$ln(A_{t,s,i}) = \beta_0 + I_{t,i}(\beta_I + \beta_{I,e}e_i) + PED_{t,i}(\beta_{PED} + \beta_{PED,e}e_i) + \beta_T PED^T_{t,i} + \beta_X X_{t,s,i} + \beta_{t,s} + \epsilon_{t,s,i} \quad (1)$$

where $I_{t,i}$ is a dummy equal to one if at least one player from home team t is inactive in game i due to either injury or PED suspension; $PED_{t,i}$ is a dummy equal to one if a player from home team t is suspended in game i and the suspension occurred during playing season; PED^T is a dummy equal to one if the suspension occurred during off season; e_i measures the elapsed time (measured in days) between the day it was announced that the player would be inactive (due to PED suspension or injury) and the day game i takes place; X is the set of control variables

[11] "Wins Above Replacement" is a widely used measure of a baseball player's marginal contribution to his team.

used in past baseball demand studies; and $\beta_{t,s}$ is a set of team-season fixed effects.[12] The X variables control for demand cycles (day of the week, afternoon/evening, month of the year) and past performance of home and away teams. The full list of control variables is presented in Table A1. For the sake of exposition, equation 1: (a) assumes a linear relation for elapsed days e_i but this is not necessary, and (b) does not include elapsed time for off-season suspensions (the results do not change when it is added).

Following the treatment literature approach, we call the games with a suspension the "treated games." The parameters of interest are β_{PED} and $\beta_{PED,e}$. The sum $\beta_{PED} + \beta_{PED,e}e$ is interpreted as the impact of announcing a PED suspension on attendance for a game that takes place e days later. Three sets of empirical issues are associated with this approach.

The main empirical challenge addresses endogeneity. Drug tests are random. However, this does not imply that announcement is exogenous in equation 1. To start, the drug tests that take place during the off season result in suspensions on the opening days of the playing season when demand may be different. As mentioned earlier, these suspensions have to be treated independently because they could be correlated with demand. The impact of an off-season suspension on attendance, β_T, is identified under the assumption that early-season and later-season attendance are not systematically different.

Pertaining to playing-season suspensions, announcement may be correlated with demand even if testing is random. This is because a systematic and sustained use of PEDs by several players in a team increases (everything else constant) both the likelihood of announcement and team performance, which itself increases demand. This relationship between PED use and demand at the team level is unlikely to operate over a short horizon. To start, it would have to be the case that players in a team go on and off PEDs for short periods of time and that demand responds quickly to the resulting changes in team performance. Although such reverse causality is unlikely to operate in the short run, it may have an effect over long periods. Adding team-year fixed effects controls for variations in the use of PEDs across team and year that could influence both attendance and announcement. We also address this concern with a robustness test that compares only the treated games that occur a few days after announcement with games that happen the same number of days before an announcement (similar to the evidence presented in Figure 1a). This is similar to taking a first difference in attendance around the announcement events. There are other endogeneity issues but they are less plausible and are discussed in Section 5.2 on robustness.

The second empirical issue is that the time between a suspension announcement and a game

[12] No game has both an injury and a PED suspension.

day varies across treated game observations and this may have an impact on treatment for two reasons. First, the timing of consumer purchase displays fixed patterns. Some consumers buy tickets well in advance (e.g. season ticket holders) and others wait until game day. Consumers who have already bought their tickets prior to an announcement cannot respond to the announcement.[13] The longer the elapsed time between a PED announcement and game day, the greater the number of consumer who can respond. For example, if an announcement takes place on the day of the game, only last-minute buyers have a chance to respond. Note that a response is still possible even for these last-minute announcements, because for non-sold out games (about 93.5% of the games in our sample) tickets are sold until the game starts.[14]

This first effect alone suggests that the impact of announcement on attendance should increase with elapsed time. But there may be other effects at play. For example, consumers may not recall that a player is suspended (Ricoeur, 2004). Alternatively, fans may get used to the news of a PED violation. The common point is that the impact of PED suspension on attendance may decay with time. For the sake of exposition we label this effect "decay," keeping in mind that it is consistent with several interpretations. Decay is an issue for PED suspensions that are announced a long time before a game. The combination of decay and timing of consumer purchase on attendance is difficult to sign. The impact of announcement on attendance could be increasing ($\beta_{PED,e} < 0$) with elapsed time if ticket sales are constant over time and there is no decay, for example; decreasing ($\beta_{PED,e} > 0$) if most consumers buy at the last minute and there is decay; or even non-monotonic. One conclusion that can be inferred from the data is that decay must matter if $\beta_{PED,e} > 0$. Whether decay matters is an empirical issue we investigated by experimenting with a number of non-parametric and parametric specifications for elapsed time including the linear formulation, $\beta_s + \beta_{s,e} e_i$, used in equation 1.

The third empirical issue is that each PED announcement is associated with a suspension, which itself could lower the quality of the game since team quality may decrease when a player is taken off the roster. To make sure that we separated the effect of PED announcement from changes in team-play quality, we compared the effect of a suspension announcement (which includes both team quality and PED effect) with the effect of an injury announcement (which includes only the team quality effect). In the above specification, $\beta_I + \beta_{I,e}$ capture the team quality effect and $\beta_{PED} + \beta_{PED,e} e_i$ the PED announcement effect holding team quality constant. This is similar to a difference in difference: we compare attendance before and after a PED

[13] Baseball tickets are non-refundable, thus season ticket holders and other who have brought ticket before a PED announcement cannot respond.

[14] For 1,396 out of 21,790 games there are no seating tickets available. This figure is computed using maximum seating capacity information from BallparksOfBaseball.com. Even for these games, there may still exist tickets in standing sections but these tickets are not counted as part of seating capacity.

suspension with the same difference for an injury. To further remove the team quality concern, we also present (in the Robustness Section) two other pieces of evidence showing that controlling for team quality is not an issue.

5 Results

We estimated versions of model (1) with different sets of control variables. We initially addressed the three empirical issues discussed above to establish a baseline result for the impact of suspension on attendance. We then turned to a number of robustness checks. For the sake of conciseness, we report here the estimates of only 11 specifications that highlight some important features of the data. We cluster standard errors by away-team and year in all specifications reported to capture the fact that attendance could be correlated across games. In Section 5.2 on robustness, we discuss other clustering choices and conclude that the results do not change. We also discuss other specifications that are not reported here because they do not change the baseline result.[15]

5.1 Impact of PED Announcement on Own-Team Attendance

Table 2 reports the results of estimating model (1) with different sets of controls. The first two specifications have suspension dummies bunched by periods of 10 days: the first dummy is equal one for the games that fall within the first 10 days of the suspension, that is, with elapsed time lower than 9; the second dummy covers the next 10 days and so on...[16] The 10-day dummies allow for very flexible relations between elapsed time and attendance. Column one does not include any control. There is no pattern in the sign of the 10-day dummies and most dummies are not significant. This suggests no clear relationship between suspension and attendance. This conclusion does not change if we add year fixed effects and/or team fixed effects.

Only when we add team-year fixed effect do we find that suspension has a negative and significant impact on attendance. This suggests that there are team and year-specific effects that influence both suspension and attendance. This finding alone is important for future research. Column 2 reports a specification with team-year fixed effect in addition to control variables used in the literature. All control variables have the predicted sign and are highly significant with the exception of "Home Streak," which is a measure of recent team performance. Suspensions

[15] These other results are available in an online appendix.

[16] The first 10 days of a suspension are represented by days 0–9 where the 0 indicates the game played on the day of the suspension.

Table 2: Impacts of PED Suspensions on Attendance

ln(Attendance)	(1)	(2)	(3)	(4)	(5)
Time Elapsed Categories					
0-9	-0.0324	-0.0596**			
	(-0.50)	(-2.38)			
10-19	-0.0448	-0.0713***			
	(-0.52)	(-2.67)			
20-29	0.0356	-0.0778**			
	(0.41)	(-2.56)			
30-39	0.0785	-0.0078			
	(1.26)	(-0.25)			
40-49	0.1127	-0.0122			
	(1.29)	(-0.29)			
50-59	0.0729	-0.0423			
	(0.90)	(-1.41)			
60-69	-0.0317	-0.0232			
	(-0.18)	(-0.22)			
70-79	0.0556	0.0491			
	(0.28)	(1.51)			
80-89	0.1242	-0.0134			
	(0.86)	(-0.19)			
90-99	0.1939	0.0310			
	(1.42)	(0.28)			
100+	-0.1954***	0.2502***			
	(-3.20)	(4.87)			
Playing-Season Suspension			-0.0738***	-0.0800***	-0.0899***
			(-3.60)	(-3.37)	(-3.43)
Time Elapsed			0.0011*	0.0015**	0.0016**
			(1.90)	(2.13)	(2.19)
Off-Season Suspension	0.1474***	0.0600***	0.0580***	0.0576***	0.0560***
	(3.20)	(3.06)	(2.94)	(2.89)	(2.80)
Inactive				0.0049	0.0014
				(0.36)	(0.11)
Time Elapsed				-0.0004	-0.0004
				(-1.01)	(-1.00)
Game Controls					
Opening Day		0.5265***	0.5264***	0.5269***	0.5270***
		(19.29)	(19.29)	(19.30)	(19.30)
Interleague Game		0.0874***	0.0874***	0.0874***	0.0873***
		(10.29)	(10.29)	(10.29)	(10.31)
Divisional Game		0.0272***	0.0272***	0.0272***	0.0271***
		(6.90)	(6.89)	(6.85)	(6.85)
Home Cum. Win%		0.0993***	0.0992***	0.0996***	0.1004***
		(3.56)	(3.58)	(3.59)	(3.62)
Home Streak		-0.0007	-0.0007	-0.0007	-0.0007
		(-1.08)	(-1.08)	(-1.07)	(-1.06)
Home Games Behind		-0.0048***	-0.0048***	-0.0048***	-0.0047***
		(-8.08)	(-8.10)	(-7.96)	(-7.88)
Opp. Win %		0.4342***	0.4345***	0.4335***	0.4348***
		(5.64)	(5.65)	(5.64)	(5.66)
Opp. Playoffs		0.0428***	0.0427***	0.0427***	0.0425***
		(3.06)	(3.05)	(3.05)	(3.04)
Fixed Effects					
Day×Time	NO	YES	YES	YES	YES
Month	NO	YES	YES	YES	YES
Team×Year	NO	YES	YES	YES	YES
Constant	10.2740***	10.5115***	10.5105***	10.5106***	10.5097***
	(1785.79)	(44.69)	(44.73)	(44.73)	(44.77)
Observations	21790	21653	21653	21653	21653
Adjusted R^2	0.0011	0.7276	0.7275	0.7276	0.7276

***p<0.01, **p<0.05, *p<0.10. Each specification clusters standard errors by opponent×year. Control variables are defined in Table A1. Specification 1,2: Time Elapsed Categories measured in days since suspension announcement for training-season suspensions. Specification 4: The training-season suspension effect lasts 53 days and the first 12 days are significant at 95% confidence level. Specification 5: only the 21 injury events from table A4 and the 21 suspension events that match.

have a negative impact on attendance during the first 30 days that follow announcement as seen by the first three 10-day dummies, which are negative and significant at the 1 or 5% level. The impact of suspension on attendance continues to be negative up to 69 days after announcement but the estimated coefficients are no longer statistically significant at a conventional confidence level.[17]

The dummy for off-season suspension is positive and significant. This will remain the case across all specifications. This is surprising. Recall, however, that the identification assumption ($E(\epsilon|X, PED^T) = E(\epsilon|X)$) may not hold. Highlighting the difficulties in measuring the impact of PED use on attendance is the fact that treatment during the off season may be correlated with unobserved demand shocks that cannot be held constant, since we do not observe games in the same season before and after an announcement.

An issue with using 10-day dummies is that the number of observations decreases with elapsed time, that is, as one looks at games that take place a long time after an announcement. Recall from Table A3 that most suspensions last less than 80 games.[18] Thus, the 10-day dummies corresponding to higher elapsed time (a) are less likely to be significant and (b) have a smaller economic impact on attendance because they apply to fewer games. One way to find out whether the response to announcement changes with elapsed time is to use a parametric specification. Using a linear parametrization, Column 3 shows that the impact of suspension on attendance is 7.4% on the first day a suspension is announced and decreases with elapsed time: the decrease in attendance is about 1.1% every 10 days after announcement and the coefficient is significant. To conclude, both parametric and non-parametric specifications indicate that the impact of announcement declines quickly over time.

Columns 4 and 5 tackle the issue that announcement could be correlated with play quality. Column 4 presents the full specification in equation (1). We add to Column 3 a set of controls for whether a player is removed from a team's roster (either because of an injury or a suspension). As for Column 3, we allow for a linear effect of elapsed time for inactive players. The suspension variables are now interpreted as the effect of announcement after holding constant changes in team play due to having an inactive player. We find that having an inactive player has no impact on attendance. Moreover, the impact of suspension on attendance remains unchanged.

[17]The dummy for "100+" days after a suspension is positive and significant. This is caused by four outliers: observations in the same series between Tampa Bay Rays (home) and the New York Yankees (away). Past studies have shown that the Yankees have a large impact on attendance when they are the visiting team (Beckman, Cai, Esrock, and Lemke, 2011).

[18]From season 2006 onwards, the table reports the number of suspended games (the punishment decision), not the total number of days the player is suspended. This latter measure is greater than the former for two reasons: (1) teams do not play every day and (2) PED violations that occur during the off season do not apply until the season starts.

According to specification 4, a PED suspension lowers attendance by 8% on the first game, the effect is not significant at 5% confidence level after 12 games and the point estimate is zero after about 53 days.

To account for the fact that not all players in our sample have an injury in our sample, Column 5 removes the suspensions issued to players who are never injured. The outcome is a balanced sample of 21 matched suspension and injury events. The conclusions remain unchanged for this balanced sample.

5.2 Robustness

We controlled for unobserved demand shocks with team-year fixed effects. But team demand may vary within a year and off-season suspensions may be correlated with these variations.[19] We controlled for such variations by looking only at very short windows around PED announcement, similar to Figure 1. We tried different window lengths and the results did not change. The results of a window of 10 games prior and 10 games post suspension announcement are displayed in Table 3 column 1. The variable "Window" is a dummy taking the value of one for 20 games around announcement and PED is now equal to one only the 10 games that follow announcement. The results do not change. This suggests that unobserved effects correlated with attendance and suspension within a team-season is not a concern.

The severity of a suspension depends on the nature of the drug detected. Recall that suspension length varies from 10 days to more than 100 games in Table 1. To determine if longer suspensions have a greater impact on demand, Column 2 adds suspension length as a control (suspension interacted with suspension length). The effect of length is very small and insignificant indicating that, in fact, the severity of a suspension does not have an impact on attendance.

Removing high-caliber players from a team's roster may have a greater impact on attendance than removing average players, therefore it is important to control for player talent. We did so with two variables separately: salary and WAR that we interact with PED. Under the 'talent' hypothesis, suspending talented palyers should reduce attendance more and the average effect of PED on suspension should decrease. Column 3 includes salary and shows no support for the talent hypothesis. The same holds for WAR. We also removed from the sample the suspensions that correspond to star players defined by salary or WAR. This did not change the impact

[19] For example, low demand puts pressure on players to perform. Players take drugs which results in PED announcements. This could generate a negative correlation between announcement and demand. Under this interpretation, we would expect announcements to be clustered within team and year. As a preliminary check, Figure 2 suggests this not to be the case.

of PED announcement on attendance, and is consistent with the finding that inactive players do not influence attendance through play quality. Another way to look at this issue is to investigate whether attendance changes when a player returns to the team's roster at the end of his suspension. Column 4 includes a reinstatement dummy that is equal to one when a player returns and also interacts this dummy with a linear time effect. Reinstatement had no impact on attendance.

PED suspensions started in 2005. Fans who respond strongly to the first home-suspension may quickly get used to subsequent suspension announcements. We call this the "habituation effect": the magnitude of a home-team audience's response to PED use should diminish with the recurring incidence of suspensions for the same team. Under the habituation hypothesis, we would expect the decrease in attendance during the first suspension to be larger in absolute value than during subsequent suspensions. The sample of suspension events is split into two sets for each team: the first suspension and subsequent suspensions. Both suspension variables (first and subsequent) in Column 5 are negative (-6.7 and -7.7% respectively) and significant. An F-test failed to reject the hypothesis that the estimated coefficients from first and subsequent suspensions are significantly different from each other. There was no support that fans get habituated to PED announcements.

We have conducted other robustness tests that are not reported in Table 3. According to Table 2, PED announcements influence demand only when a player is suspended. Alternatively, one could argue that most ticket buyers recall only announcements. They do not know or care if the player is still suspended in a given game. If that is the case, each suspension affects the subsequent games equally, independent of whether it is active or not. We tried arbitrary windows (10, 50, 100 days) that applied equally to all games after a suspension and the results did not change.

Another concern is that the error term may be correlated in a systematic way that could overstate the significance of the results. All reported specifications cluster standard errors by away-team and year (270 relatively balanced clusters). There are other clustering options. For example, a visiting opponent typically plays three or four games against the same home team on consecutive days of the week. We would expect that demand for games with particular opponents would cause attendance to be correlated within these series. We checked the significance of the estimates by clustering by series where each set of consecutive games against an opponent forms a unique cluster. In total there are 6854 clusters of two to four games each. Doing so did not change the standard error estimates of the main variables in all models and the inference remains the same.

Table 3: Robustness

ln(Attendance)	(1)	(2)	(3)	(4)	(5)	(6)
Playing-Season Suspension	-0.0762**	-0.0839***	-0.0716***	-0.0735***	-0.0669**	-0.0680***
	(-2.21)	(-2.75)	(-3.20)	(-3.61)	(-2.36)	(-3.26)
Time Elapsed	0.0025	0.0010	0.0011*	0.0011*	0.0003	0.0011*
	(0.98)	(1.64)	(1.91)	(1.89)	(0.30)	(1.93)
Window	0.0056					
	(0.36)					
Length		0.0002				
		(0.42)				
Salary			-0.0007			
			(-0.36)			
Reinstatement				0.0185		
				(0.60)		
Time Elapsed				-0.0014		
				(-0.76)		
Subsequent					-0.0774***	
					(-2.69)	
Time Elapsed					0.0015**	
					(2.14)	
League						-0.0083**
						(-2.07)
Off-Season Suspension	0.0623***	0.0484	0.0603***	0.0571***	0.0606***	0.0631***
	(3.14)	(1.61)	(2.90)	(2.86)	(3.08)	(3.17)
Game Controls						
Opening Day	0.5271***	0.5268***	0.5267***	0.5266***	0.5266***	0.5261***
	(19.31)	(19.32)	(19.31)	(19.32)	(19.31)	(19.30)
Interleague Game	0.0876***	0.0876***	0.0876***	0.0874***	0.0877***	0.0883***
	(10.40)	(10.35)	(10.35)	(10.32)	(10.40)	(10.45)
Divisional Game	0.0273***	0.0272***	0.0272***	0.0272***	0.0273***	0.0273***
	(6.86)	(6.88)	(6.87)	(6.87)	(6.92)	(6.92)
Home Cum. Win %	0.0987***	0.0994***	0.0996***	0.0989***	0.0990***	0.0993***
	(3.56)	(3.59)	(3.60)	(3.57)	(3.58)	(3.59)
Home Streak	-0.0007	-0.0007	-0.0007	-0.0007	-0.0007	-0.0007
	(-1.09)	(-1.08)	(-1.08)	(-1.06)	(-1.06)	(-1.09)
Home Games Behind	-0.0048***	-0.0048***	-0.0048***	-0.0048***	-0.0048***	-0.0048***
	(-8.10)	(-8.07)	(-8.07)	(-8.07)	(-8.10)	(-8.06)
Opp. Win %	0.4347***	0.4339***	0.4340***	0.4344***	0.4337***	0.4333***
	(5.65)	(5.64)	(5.64)	(5.65)	(5.64)	(5.62)
Opp. Playoffs	0.0425***	0.0427***	0.0427***	0.0427***	0.0428***	0.0428
	(3.04)	(3.05)	(3.05)	(3.05)	(3.05)	(3.06)
Fixed Effects						
Day×Time	YES	YES	YES	YES	YES	YES
Month	YES	YES	YES	YES	YES	YES
Team×Year	YES	YES	YES	YES	YES	YES
Constant	10.5115***	10.5105***	10.5106***	10.5104***	10.5099***	10.5109***
	(44.51)	(44.73)	(44.72)	(44.73)	(44.82)	(44.78)
Observations	21653	21653	21653	21653	21653	21653
Adjusted R^2	0.7274	0.7275	0.7275	0.7275	0.7276	0.7276

***p<0.01, **p<0.05, *p<0.10. Each specification clusters standard errors by opponent×year. Specification 1: Training-Season Suspension defined as in Table A1 for the first 10 games of a training-season suspension, zero otherwise; Window takes the value of 1 for the 10 games prior to a training-season suspension and for the first 10 games of a training-season suspension. Specification 5: Training-Season Suspension defined as in Table A1 for the first incidence of a suspension at the team level. Subsequent defined as Training-Season Suspension in Table A1 for any suspension after at the team level. Specification 2-4,6: Training-Season Suspension as defined in Table A1.

Finally, there are a number of minor concerns that deserve mention. Teams could reduce ticket price to maintain attendance level when an announcement is made. Such a pricing response would imply that we have underestimated the potential demand response to PED announcement; however, we are not aware of any evidence suggesting the practice of reducing ticket price in response to PED announcement. Another concern is that other players might reduce their PED intake in response to a PED announcement in fear of being suspended; this could reduce game quality and cause a reverse causality if the public anticipated such response and stopped attending. Although we cannot definitely rule this out, several factors make this implausible. To start, players have no reason to decrease PED intake since testing is exogenous. Secondly, we would expect that announcement should reduce exceptional performance if the response channel is play quality. We find no such effect. Moreover, consumer anticipation cannot explain why the league attendance response is lower than the home team response as discussed in Section 5.3.

5.3 Impact of PED Announcement on League Attendance

We have assumed so far that a suspension could impact only home-team attendance. It is possible, however, that a suspension has a negative impact on attendance for other teams within the league. Model 6 in Table 3 looks for spillover effects across teams. It adds to model (1) a dummy variable "League" which is equal to one if there is at least one player currently suspended in the league. For 28.8% of the games (6,275 observations) in the sample there is at least one player suspended on any team (and the suspension is announced during playing season).

When there is a suspension in the league, we find that there is a loss of 0.83% of attendance for each team. Consistent with the hypothesis that teams in a league have a collective reputation, this indicates that the costs associated with PED use in MLB are not restricted to the teams that have suspended players. The full effect of a suspension on the home team is the sum of home suspension and league suspension. At the team level, the impact of team spillover is small for a given game. But because, for any one team, the event that another team's player is suspended happens much more frequently than their own player's suspension, this impact on their annual team attendance will be large.

In some games, multiple players from different teams are suspended. During the period we studied, a maximum of seven players were suspended concurrently in the league. Having more suspensions at the league level could further decrease attendance. We used a count variable to understand the marginal spillover effect of an additional concurrent suspension. We used only playing-season suspensions within our count (using both off- and playing-season suspensions

does not change the results).[20] The results indicated a marginal loss of 0.44% of attendance for each team per additional concurrent suspension. Thus, each additional suspension at the league level has in important negative impact on attendance.

5.4 Economic Impact of a PED Suspension on Team and League Revenues

We make simple economic calculations to assess the cost of a PED suspension on team and league revenues. The reader should keep in mind that we can assess only the costs associated with the short-term decrease in ticket revenues. PED violations may influence team and league revenues through other channels (such as concession sales, merchandizing and so on...). that are not accounted for here. Still, the figures computed here can have a significant impact on a team's bottom line because ticket revenue accounts for approximately 30 to 40% of total team revenue.

We consider the impact of a single PED suspension on the annual revenue that a team derives exclusively from ticket sales. Take the coefficient estimates from Model 4 in Table 2. A PED suspension decreases attendance by 8% the first game and this decrease is reduced by 0.15% in subsequent games, up to the 12th game, after which it is not statistically significant at a 95% confidence level. Out of the 81 home games the team plays in the season, it loses 8% revenue on the first game after the PED is announced, 7.85% on the second game, and so on for 12 games. Summing up these effects, a PED suspension decreases the entire season attendance, and thereby ticket revenue, by about 1.1%. Since average game ticket sales is 31.1K (from Table 1) and average MLB ticket price is $27.73 (from Team Marketing Report in Arpil 2013) the 1.1% figure says that the yearly loss from a single PED suspension is $743K. But the team saves the player's salary during the suspension's length. The median suspension is 50 games (Table 1) and the median salary amongst the suspended players is $1.05M (Table A.3). Given that there are 180 days in the season, the team saves $292K (=1.05*50/180) in salary delivering a net cost of $451K per suspension.

Next, we consider the impact of a single PED suspension on annual league revenues from ticket sales. Model 6 in Table 3 says that a PED suspension decreases ticket sales of subsequent games by 0.83% for all 30 teams in the league. The average suspension lasts 50 games. In addition to this, the home team with a PED suffers a decrease in sales as caclulated above. The

[20] Doing so delivers 7,926 observations or 36.4% of the games. Counting both suspensions is considered because both could influence attendance. A problem with including off-season suspensions, however, is that we may underestimate the effect (recall that off-season suspensions are associated with higher attendance probably due to violation of identification assumption).

overall impact of a single PED suspension on the league is a 0.54% decrease in ticket revenue.[21] The league's loss in ticket revenue is \$11.4m.[22] This large figure should be interpreted with care because it rests on the assumption that the externality lasts during the entire duration of a suspension (50 games). Stated differently, the 29 suspensions used in the estimation period covering 9 seasons could have cost the MLB \$330m. This number does not include the impact of the other 15 PED suspensions that were not included in the study.

6 Summary and Conclusions

When a PED suspension is announced, attendance decreases by about 8 percent in the subsequent home-team game. This negative response fades quickly to the point of being statistically insignificant 12 days after announcement. The announcement of a suspension due to an injury, however, has no impact on attendance. The announcement of a second PED violation in a given team still has an impact on that team's home-game attendance suggesting that the public does not get habituated to PED violations. Finally, the announcement of a PED violation in a given team has a negative impact on attendance for other MLB teams. Rough economic estimates suggest that a PED violation costs the violating team $\$451K$ and the league $\$11m$.

The evidence is broadly consistent with the hypothesis that the public cares about PED use. While the estimates reveal a surprisingly large response to PED announcement, we likely underestimate the overall economic impact of PED violations on team and league revenues, and also on consumer welfare. This is because the estimates capture only the demand response that take place after a PED suspension is announced. We do not capture the impact of a PED suspension on concession sales, TV rights, the utility loss incurred by no-shows, and the decreased utility of those who attend.[23]

It is not clear how to interpret the observed short term negative attendance response to PED announcements. It could be a temporary boycott by fans. Alternatively, PED announcements may change the public's perception toward drug use in baseball. This second interpretation, however, is difficult to reconcile with the facts that attendance response declines quickly with

[21] The 29 teams that do no have the suspension lose 0.512 =50*0.0083/81. Overall, the league loses 0.543=(.512*29+1.43)/30 where for consistency we recalculated the team impact of a PED as 1.43 using the coefficient estimates from Table 3, Model 6.

[22] This is assuming that league ticket revenue is \$2B (33.1K tickets x 30 teams x 81 games x \$27.27 per ticket) which is consistent with information reported on statista.com.

[23] The estimates also depend on the timing of PED announcement and ticket purchases. If all tickets were bought on game day, for example, a PED announcement that takes place soon before game day could have a larger impact on demand than what we estimate.

the time that has elapsed since announcement and that it does not depend on the length of suspension (a measure of violation strength). We leave for further research the study of the mechanisms through which doping violations are likely to influence demand.

This paper focuses on short-term demand responses to PED suspensions. An important issue that is not addressed here has to do with the long term impact of PED use on sport's demand. In the long run, PED use has two effects: (a) a positive effect on demand due to higher performance (an important determinant of the demand for sports) and (b) a negative stigma effect on demand if fans care about PED use. This study demonstrates that the second effect exists and could be economically important. Further research could expend the study to other sports and other doping violations.

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7 Appendix

Table A1: Variable Descriptions

Variable Name	Description
Playing-Season Suspension	Takes a value of 1 when a PED player from the home team is currently serving a suspension announced during the playing 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 PED player from the home team is currently serving a suspension announced outside of the playing season, 0 otherwise.
Inactive	Takes a value of 1 when a PED player from the home team is inactive due to an injury or a suspension announced during the playing season, 0 otherwise. Time elapsed refers to the number of days since the player was placed on the disabled list.
Opening Day	Takes a value of 1 for the first home game of the season, 0 otherwise.
Interleague Game	Takes a value of 1 for a game between two teams of opposite leagues (National vs. American), 0 otherwise.
Divisional Game	Takes a value of 1 for a game between two teams of the same division within same league, 0 otherwise.
Home Cum. Win%	The cumulative win percentage for the home team for the given season, lagged by one game.
Home Streak	Count of the number of consecutive wins as a positive integer or the number of consecutive losses as a negative integer, lagged by one game: range [-15,14].
Home Games Behind	Count of the number of games behind the team's respective divisional leader, lagged by one game: range [0,45].
Opp. Win%	The visiting team's final win percentage in the previous season.
Opp. Playoffs	Takes a value of 1 if the visiting team made the playoffs in the previous season, 0 otherwise.
Length	Takes the value of the total length of the suspension during all games of a suspension: range [10,105].
Salary	The annual expected payroll (in millions USD) of a PED player that is not participating in the game due to a PED suspension.
Reinstatement	Takes a value of 1 when a PED player from the home team has been reinstated from a suspension within the last 30 days, 0 otherwise. Time elapsed refers to the number of days since the reinstatement.
League	Takes a value of 1 where there is at least one player across the league currently serving a suspension, 0 otherwise.

Table A2: PED Suspension Punishments

	Date Implemented	Season(s) Affected	Punishment for Positive Test		Enforcement	Identity
Regime I	13 Nov 2003	2004	1st – Anonymous counseling 2nd – 15-day suspension		Random	Released publicly after 2nd violation
Regime II	13 Jan 2005	2005	1st – 10-day suspension 2nd – 30-day suspension 3rd – 60-day suspension 4th – 1-year suspension		Random and Probable Cause[24]	Released publicly with positive test
			PED	Stimulants		
Regime III	8 Dec 2005	2006-2013	1st – 50-games 2nd – 100-games 3rd – permanent suspension	1st follow-up testing 2nd – 25-games 3rd – 80-games 4th – up to permanent	Random and Probable Cause[25]	Released publicly with positive test

[24] Prior history or violation needed as grounds for a probable cause test
[25] Probable cause only grounds for testing for presence of stimulants or hGH

Table A3: PED Suspensions (2005-2013)

Player	Pos.	Team	Date	Length	Salary	WAR
Playing-Season Suspensions						
Agustín Montero	RP	TEX	20-Apr-05	10	0.327	-0.1
Alex Sánchez	OF	TBR	03-Apr-05	10	0.316	0.4
Jamal Strong	OF	SEA	26-Apr-05	10	0.300	0.1
Jorge Piedra	OF	COL	11-Apr-05	10	0.300	0.2
Juan Rincón	RP	MIN	02-May-05	10	0.440	1.9
Mike Morse	SS	SEA	07-Sep-05	10	0.300	-0.5
R. Palmeiro † ‡ §	DH	BAL	01-Aug-05	10	3.000	0.2
Rafael Betancourt	RP	CLE	08-Jul-05	10	0.339	1.1
Ryan Franklin † §	SP	SEA	02-Aug-05	10	2.600	1.0
Jason Grimsley †	RP	ARI	12-Jun-06	50	0.825	0.2
Yusaku Iriki	P	NYM	28-Apr-06	50	—	—
Juan Salas	RP	TBR	07-May-07	50	0.382	0.4
Neifi Pérez ‡	UT	DET	06-Jul-07	25	2.500	-0.2
Neifi Pérez (2) ‡	UT	DET	03-Aug-07	80	2.500	-0.2
Manny Ramirez † §	OF	LAD	07-May-09	50	23.854	2.2
Edinson Volquez §	SP	CIN	20-Apr-10	50	0.445	0.3
Eliézer Alfonzo[a] (2)	C	COL	14-Sep-11	48	0.414	0.1
M. Ramirez (2) † §	OF	TBR	08-Apr-11	100	2.020	-0.3
Bartolo Colon §	SP	OAK	22-Aug-12	50	2.000	2.7
Freddy Galvis	UT	PHI	19-Jun-12	50	0.480	0.6
Guillermo Mota (2)	RP	SFG	07-May-12	100	1.000	-0.5
Melky Cabrera §	OF	SFG	15-Aug-12	50	6.000	4.7
Antonio Bastardo	RP	PHI	05-Aug-13	50	1.400	1.4
Everth Cabrera §	SS	SDP	05-Aug-13	50	1.275	2.6
Francisco Cervelli	C	NYY	05-Aug-13	50	0.515	0.8
Jhonny Peralta §	SS	DET	05-Aug-13	50	6.000	3.3
M. Tejada † § ∗	UT	KCR	17-Aug-13	105	1.100	0.7
Nelson Cruz §	OF	TEX	05-Aug-13	50	10.250	2.2
Ryan Braun † § ∗	OF	MIL	22-Jul-13	65	8.500	1.9
			means	43.55	2.835	1.0
Off-Season Suspensions						
Carlos Almanzar[b]	RP	TEX	04-Oct-05	10	1.100	-0.3
Guillermo Mota	RP	NYM	01-Nov-06	50	1.800	0.7
Dan Serafini	RP	COL	27-Nov-07	50	0.300	-0.1
José Guillén †	OF	KCR	06-Dec-07	15	12.000	3.5
Mike Cameron[c] ‡ §	OF	SDP	31-Oct-07	25	6.250	3.0
J. C. Romero	RP	PHI	06-Jan-09	50	4.250	0.2
Carlos Ruiz §	C	PHI	27-Nov-12	25	5.000	4.5
Yasmani Grandal	C	SDP	07-Nov-12	50	0.990	2.8
Not Considered						
Félix Heredia[d]	RP	NYM	18-Oct-05	10	—	—
Matt Lawton[e] §	OF	NYY	02-Nov-05	10	—	—
Jay Gibbons[f] †	OF	BAL	06-Dec-07	15	5.000	—
Elizer Alfonzo[g]	C	SFG	30-Apr-08	50	0.382	-0.4
Marlon Byrd[h] §	OF	Free agent	25-Jun-12	50	—	—
A.Rodriguez[i] † ‡ § ∗	3B	NYY	05-Aug-13	162	29.000	0.5
Troy Patton[j]	RP	BAL	20-Dec-13	25	0.815	0.5

Team indicates the team at time of suspension. Length is measured in number of games, except for suspensions announced prior to 8 Dec 2005 (see Table A2). Salary is expected annual salary in millions of USD in the season during the suspension. † Silver Slugger Award (7). ‡ Gold Glove Award (3). § All-Star (12). ∗ Most Valuable Player (2). [a]Reduced from 100 games to 48 due to procedural issues with test samples. [b]Served suspension with ATL at start of 2006 season. [c]Served suspension with MIL at start of 2008 season. [d]Served suspension with CLE minor league affilitate. [e]Signed new contract with SEA but was released before serving suspension. [f]Released by BAL before serving suspension. [g]Optioned to minor league prior to suspension. [h]Did not belong to a specific franchise. [i]Did not serve suspension until 2014 season. [j]Event occurred outside of sample period.

Table A4: Matched Injuries to Playing-Season Suspensions

Player	Team	DL start	Length	Salary	WAR
Alex Sánchez	SFG	24-Jul-05	13	0.316	0.4
Jamal Strong	SEA	13-Sep-05	18	0.300	0.1
Juan Rincón	COL	01-Aug-09	23	0.750	-0.8
Rafael Betancourt	CLE	19-Apr-06	24	0.365	1.0
Rafael Palmeiro	BAL	16-Aug-05	53	3.000	0.2
Mike Morse	WAS	11-Apr-10	26	0.410	1.3
Jason Grimsley	BAL	11-May-05	50	2.000	-0.2
Manny Ramirez	LAD	23-Apr-10	14	18.695	0.8
Edinson Volquez	CIN	21-May-09	10	0.440	0.3
Manny Ramirez	LAD	03-Jul-10	9	18.695	0.8
Eliézer Alfonzo	SFG	09-Jun-07	8	0.382	0.7
Guillermo Mota	SFG	23-Aug-10	13	0.750	-0.2
Freddy Galvis	PHI	17-Aug-12	43	0.480	0.6
Melky Cabrera	TOR	27-Jun-13	19	8.000	-0.3
Bartolo Colon	OAK	23-Jun-12	10	2.000	2.7
Ryan Braun	MIL	14-Jun-13	19	8.500	1.9
Francisco Cervelli	NYY	13-Sep-11	15	0.456	0.8
Antonio Bastardo	PHI	29-Jun-09	59	0.400	-0.4
Everth Cabrera	SDP	19-Jun-13	15	1.275	2.6
Nelson Cruz	TEX	30-Aug-11	12	3.650	1.4
Miguel Tejada	SFG	19-Jul-11	25	6.500	0.0
		means	22.76	3.684	0.7

Team indicates the team at time of injury. Length is measured in number of games. Salary is annual salary in millions of USD in the season during the injury.