Do Local Businesses Benefit from Stadiums? The Case of Major Professional Sports Leagues Arenas

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November 9, 2020

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Abstract

Stadiums cost hundreds of millions of dollars to build and are often subsidized by public sources. In many cases, subsidies are allocated on the premise that sports events benefit the local economy by bringing new customers to nearby businesses. We use daily foot traffic records covering major sports league facilities and their surrounding commercial establishments to pin down the size and spatial distribution of such spillovers. By employing fixed effects and IV estimation strategies, we show that benefits are heterogeneous across sports and business sectors. We find that baseball and football stadiums generate substantial traffic to businesses in the food & accommodation and retail trade categories. However, the corresponding spillover effects of basketball and hockey stadiums are not significant across the studied business sectors. Moreover, using the data on subsidies allocated to the facilities in our sample, we show that only the top quartile of the most attended baseball stadiums generate enough spillover benefits to offset the public funds they receive.

Keywords: Stadiums; Spatial Spillovers.

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Acknowledgements We thank Anna Algina, Donald Davis, Gaston Illanes, Riccardo Marchingiglio, Robert Porter, Mar Reguant, Molly Schnell and Dmitry Sorokin for helpful comments and discussions. Special thanks to Jonathan Wolf and the Safegraph team for access to data, clarifications and thoughtful remarks.

1 Introduction

Stadiums hosting professional sports teams have received more than $12 billion in subsidies between 2000 and 2010. Subsidies are often rationalized by the idea that stadiums catalyze local economic development, and yet, according to the 2017 survey by IGM and Whaples (2006) the economics profession generally agrees that the grounds for stadium subsidies are weak. As reviewed by Coates and Humphreys (2008), this consensus has to a large extent been driven by empirical evidence based on data aggregated at a relatively crude geographic level. At the same time, recent reports by the Associated Press and CNN Business suggest that businesses near stadiums usually dependent on the sports fans' spending are currently suffering disproportionately more from the COVID-19 pandemic. This anecdotal evidence highlights a possibility that stadium spillover effects may be localized and thus difficult to detect using aggregate data. How large may these local spillover effects be? How do they differ across business industries? Do stadiums attract new consumers to local businesses or simply reallocate them from more distant businesses? In this paper, we provide new empirical evidence on these issues using daily data on foot traffic to 92 stadiums and local businesses as well as sports events occurrences in the four major professional sports leagues in the US: MLB, NBA, NFL and NHL. The assembled dataset allows us to estimate fixed effects and instrumental variable specifications that capture the number of visits to local businesses generated by the stadium visits. We find these spillover effects to be heterogeneous across stadium sports and business industries. Baseball and football stadiums generate traffic for local Food & Accommodation and Retail Trade businesses, while the corresponding effects for other sectors are substantially lower. As a preview, 100 additional baseball (football) stadium visits lead to roughly 29 (40) additional visits to Food & Accommodation businesses within 3 kilometers of the stadium. These effects are highly localized with most additional visits happening within 1 kilometer of the stadium. While basketball and hockey arenas appear to generate some spillovers in the 1-kilometer range as well, these additional visits are balanced by a corresponding small reduction in visits to further away businesses, suggesting spatial redistribution of consumption. As a result, we estimated the overall local spillovers from basketball and hockey stadiums to be statistically insignificant for all of the studied business sectors.

The spillover effects we estimated do not account for *all* aspects of spatial and temporal consumption redistribution: additional local business visits generated by the stadiums may come at the cost of lower spending on other days or in more distant localities. We thus interpret the estimated *local* spillovers as an upper bound on the *overall* spillovers. Using the spillover estimates, we also construct a corresponding upper bound on the benefits stadiums create for the local economy and compare these benefits with the actual subsidies allocated to stadiums. Our calculations indicate that spending generated by most of the football stadiums and basketball&hockey arenas does not cover the received subsidies over a typical stadium lifetime, even subject to the upper bound interpretation of the spillover effects. Correspondingly, we find that of all stadiums in our sample that received public funds, only the upper quartile of the most attended baseball stadiums generate enough consumption benefits to yield a net positive NPV when externalities are taken into account. Hence our results fall in line with the established view that the benefits created by the stadiums in most cases do not offset the public funds they receive.

These results are rendered possible by the rich dataset we assembled from several sources. First, we partnered with Safegraph, a company specializing in location data. Safegraph provided us with a database of US points-of-interest (including stadiums and businesses across a variety of industries) and their daily visit counts coming from mobile devices with participating apps installed. Second, we collected data from `sports-reference.com` to get information on the stadiums of the four major US sports leagues (MLB, NFL, NBA and NHL) including the stadium names and game dates. Finally, we gathered stadium capacity data from Wikipedia and used the amounts of stadium subsidies from Long (2013).

The assembled dataset allows us to exploit the day-to-day variation in stadium visits and the corresponding changes in visits to local businesses to estimate the causal stadium spillover effects. We use two estimation strategies – a fixed effects approach, and an instrumental variable approach – to obtain the spillover effects. In both approaches, the total visit counts to businesses located near stadiums plays the role of the independent variable, while the number of stadium visits is the independent variable. For the FE strategy, we introduce a stadium×month×day-of-week and date fixed effects to account for stadium-specific unobserved differences between sample months and days of the week as well as date-specific demand shocks common across stadiums (like public holidays). For the IV strategy, we use the game-day indicator as an instrument for stadium visits to reduce the concerns of (1) reverse-causality, (2) local non-sports events driving visits to both stadiums and businesses, (3) measurement error. While game days substantially affect foot traffic to stadiums, they are set well in advance and are unlikely to be correlated with the transitory demand conditions, thus alleviating the endogeneity concerns.

The obtained results indicate that baseball and football stadiums generate spillover visits to businesses in a subset of industries, while the null of no spillover effects cannot be rejected for the basketball&hockey arenas. Based on our preferred IV specifications, baseball stadiums induce spillovers for nearby Food & Accommodation and Retail Trade businesses, with spillovers mostly concentrated in the 1-kilometer range of the stadiums. Football stadiums appear to additionally affect foot traffic to local Recreation facilities and Other Services businesses, with spillovers propagating to further neighborhoods up to 2.5 kilometers away from the stadiums. The localized nature of the effects potentially explains the difficulty of detecting spillovers earlier research has experienced using aggregate data.

Once the local spillover effects are estimated, we use the data on total public costs allocated to stadiums (obtained from Long, 2013) to perform a simple cost-benefit analysis to evaluate the net value stadium subsidies generate for the local economy. In estimating the externality benefits, we use the data on the number of games, average event attendance statistics, and an assumption regarding the monetary value of a typical consumer for a local business. Since our estimates do not account for all redistributional aspects of stadium-generated spillovers, we interpret our benefits calculation as an upper bound of the actual stadium-induced benefits. Despite that, our results indicate that externality benefits created by the sports facilities in most cases do not offset the public costs associated with their building and financing. For a median stadium subsidy, we estimate a net present value loss of 100 million dollars. Notably, for stadiums hosting football, hockey and basketball games we find that even the upper quartile NPV is negative at about -$65M, and only for baseball stadiums, which attract the largest attendance among the four sports, we find the upper quartile to be positive, suggesting that the amounts of public funds allocated to stadiums are usually too large to be economically justified.

The rest of the paper is organized as follows. Section 2 summarizes the relevant literature. Section 3 describes our data sources. Section 4 outlines our empirical strategy and the estimation results. Section 5 discusses the policy implications. Section 6 concludes.

2 Background and Literature

In the light of the continued public financial support for the construction and operation of professional sports facilities, a sizable body of work has been developed to investigate whether these spendings are economically justified. Most of the early evidence in the literature appears to unambiguously suggest that stadiums hosting sports events have no tangible impact on the incomes and employment in their surrounding context (Coates, 2007) and that proponents of stadium and arena construction generally fail to account for substitution of spending between different types of entertainment. Although these results have led many academics in the profession to settle on the unfavorable conclusion regarding stadium subsidies (Coates and Humphreys, 2008), several of the more recently published studies seek to find alternative ways to evaluate the benefits of sports arenas to the host cities.

The first argument, which was brought into attention by Nelson (2001) and later developed in Santo (2005), contends that the more recently built stadiums are different from the earlier ones because they are often purposefully integrated into the downtown area as opposed to being surrounded by suburban parking lots, and this difference of contexts may confound the impact found in earlier studies. While later discussions in the literature (Wassmer, 2001; Coates, 2007) have found that the central claims made by Nelson and Santo are not substantiated, these among other works have drawn attention to the differences present within and across locations where the stadiums choose to locate, as well as to the issue of pinning down the actual winners and losers from the stimulus provided to sports centers. Following the latter line, Coates and Humphreys (2003) examine employment statistics for 37 MSAs over the period from 1969 to 1997 and show that professional sports have a small positive effect on wages in one sector, namely, amusements and recreation, and an offsetting negative effect on both earnings and employment in eating and drinking and on employment in services and retail trade sectors.

Another commonly contested issue is that much of the early evidence comes from the data aggregated to the county or MSA level (with sports-related activities measured mostly at the annual frequency), which might not be sufficient to capture the temporal and localized effects of interest (Baade et al., 2008). In response to these concerns, Coates and Depken (2011) study the impact of sports events on the local economy using monthly sales taxes for 23 Texas towns and cities from January 1990 through December 2008 and again conclude that "an additional regular-season game has, at best, a modest effect on sales tax collections" (Coates, 2007).

Despite the noticeable shift towards research designs that allow for richer descriptions of the local business environments, only a few studies to date are based on establishment-level data. Notably, Harger et al. (2016) use 13 new stadiums that opened between 2002 and 2006 in 12 MSAs as natural experiments to estimate the effect of entry on nearby business activity in terms of the number of new businesses and workers. Based on their analysis of the data from Dun and Bradstreet MarketPlace, they conclude that there's no tangible effect on new business openings and that the effect on employment is weakly positive for the new businesses in the eating and drinking industry within 1 mile from the new facilities.

Finally, the most up-to-date piece of evidence on the topic is offered in Stitzel and Rogers (2019)[1], who use annual establishment-level sales data from the National Establishment Time-Series (NETS) to estimate the impact of the relocation of the National Basketball Association's Seattle franchise to Oklahoma City on local businesses. Stitzel and Rogers confirm the role of the consumption substitution channel by showing that while food establishments located between 1 and 2 miles from the arena show an increase in sales, there is a similar fall in entertainment sales in the same distance range, while the combined impact on sales for all related industries is insignificant.

The present study builds on the recent trend to employ detailed establishment-level data to uncover the spatially heterogeneous effects of professional sports facilities on the local economy. One major departure of this paper from the existing studies is the use of daily foot-traffic levels for stadiums and nearby businesses, obtained through a commercial provider of mobile device positioning data, as the outcome of interest. Most importantly, the high geographic and temporal resolution of both treatment and outcome variables allows us to estimate the spatial externality gains caused by additional foot traffic attracted to major sports events while controlling for a rich set of location and time fixed effects.

[1] Propheter (2020) is another related paper. The author uses a panel of establishments in Sacramento, CA, active from 2004 through 2018, and finds that retail establishments within a half-mile of the Golden 1 Center have survival times 53% shorter than otherwise similar retail establishments further away.

3 Data

We use two data sources to estimate the spillover effects generated by the stadiums. First, we collected data from `sports-reference.com` to get information on the stadiums of four major US professional sports leagues (MLB, NFL, NBA and NHL) including the stadium names and game dates for the calendar year of 2018. Second, we partnered with Safegraph, a company specializing in location data, which provided us with a database of points of interest – defined as places outside of home where people spend time and money – across the US and their corresponding visit counts on the daily level. The foot traffic information gathered by Safegraph comes from location data of mobile devices with installed participting applications. Developers of such applications share anonymized location information with Safegraph which further aggregates the data to arrive at the visits counts on the point-of-interest level. From the full Safegraph points-of-interest dataset we selected stadiums that match with the `sports-reference.com` data, and nearby businesses located within 3 kilometers of each stadium. Additionally, we used stadium capacity data scraped off Wikipedia and stadium subsidy data from Long (2013) described in more detail in Section 5.

The rest of this section provides details on the assembled sample of stadiums and nearby businesses, depicts the variation in stadium visits and sports events over time that is essential for our empricial strategy, and explains the construction of the estimation sample.

3.1 Stadiums and their vicinities

According to the data collected from `sports-reference.com`, a website dedicated to professional sports data, there were 30, 29, 31 and 31 arenas used in MLB, NBA, NFL and NHL respectively between January and December 2018. We started from this set of stadiums and selected points of interest from the Safegraph dataset that are located in the same state and share a similar name[2], using a Levenshtein distance threshold of 0.6. We also confirmed that, according to the Safegraph data, the selected points of interest fall into Recreation category[3], manually checked the exact location of a subset of stadiums and verified that the areas of the matched points of interest is consistent with a typical stadium area. After the match, we obtain the stadium sample with 26, 25, 30 and 21 facilities in the baseball, basketball, football and hockey leagues respectively. It should be noted that 7 of the NHL arenas belong to Canadian teams and were thus not available to us in the Safegraph dataset, explaining the relatively lower match rate for hockey arenas. Next, we used the Safegraph database to select all points of interest located within 3 kilometers of each sample stadium. As a result, for the stadiums in our sample, we have the data on daily visit counts measured by Safegraph, game dates for the calendar year of 2018, and a set of nearby businesses

[2] For a subset of stadiums that were recently renamed, we also matched on the former arena name, as part of the Safegraph data was collected prior to the stadium name change

[3] Two football stadiums, Ford Field and Mercedes Benz Superdome fell instead into the Retail Trade category, which appears to be an artifact of a machine learning approach used to categorizing some points of interest.

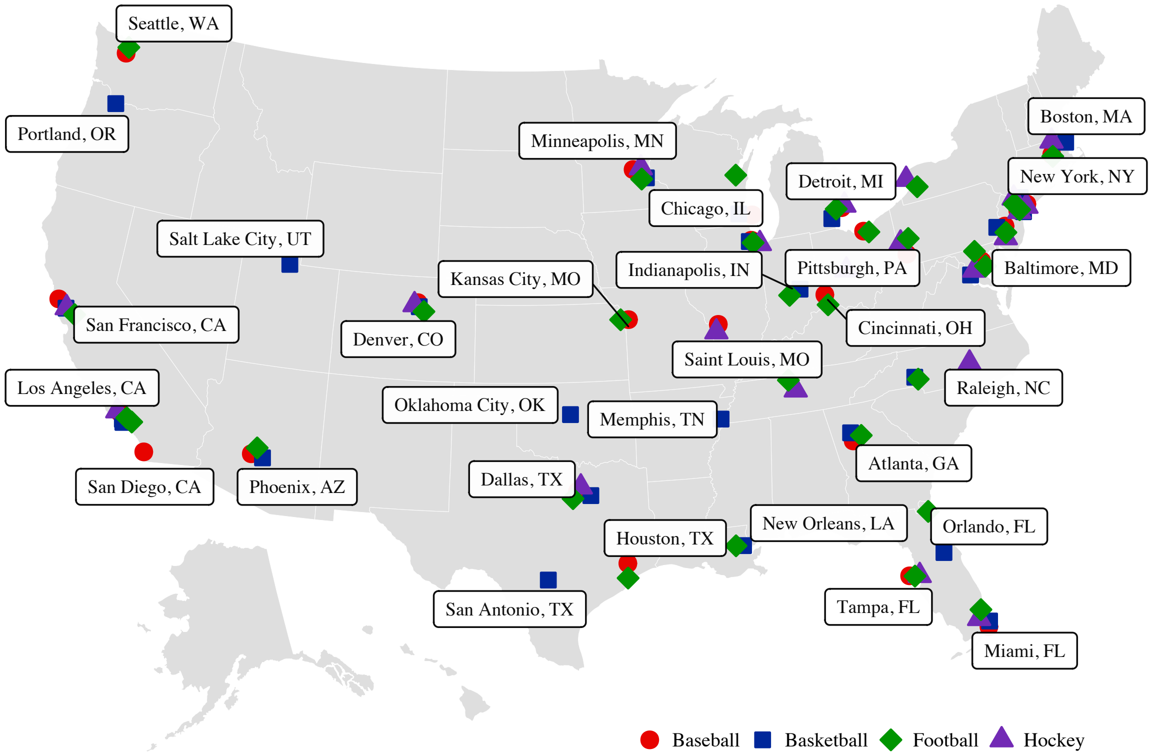

Figure 1: Sample stadiums on the map of the United States, by sport. Small amount of jitter applied to coordinates for better clarity.

with their corresponding daily visits. The seating capacity information was scraped off Wikipedia and matched to the constructed sample by stadium name.

To provide a first glance into the context in which stadiums in our sample operate, Figure 1 displays every facility by sports on the map of the United States. Expectedly, Figure 1 reveals that sports facilities are primarily scattered across the major metropolitan areas: in fact, 29 of the highest populated 30 metropolitan areas have at least one stadium within their boundary.

Table 1a provides the summary statistics for the sample stadiums, broken down by the sport associated with the stadium. Arenas hosting basketball and hockey games saw roughly 44 games of these sports on average in 2018. An average baseball arena hosted about 80 games in 2018, while there were only around 9 NFL games (including the playoff stage) played in an average football stadium. However, football stadiums are larger and more capacious compared to the other sports arenas: with an average capacity of about 71 thousand seats they scale more than three times larger than average basketball or hockey stadiums, and about 67% larger than an average baseball arena.

At the same time, football stadiums are located in less busy parts of the urban landscape. As shown in Table 1a, football stadiums have the lowest mean number of businesses nearby, 1.3 thousand in the 3km radius, compared with about 3 thousand businesses operating near an average hockey or basketball facility, and 2 thousand businesses near a typical baseball arena. Additionally, Table 1b

		Means				Average daily SG visits	
Sport	Stadiums	Games	Area	Capacity	Bus. nearby	No-game day	Game day
Baseball	26	79.8	43,911.1	42,196.5	2,029.7	83.3	1,258.6
Basketball	25	44.9	21,049.9	18,944.8	3,000.3	200.0	612.6
Football	30	8.6	59,743.8	70,625.7	1,316.8	159.8	3,248.5
Hockey	21	43.9	21,357.5	18,292.8	3,082.6	231.5	760.5

(a) Stadium sample summary statistics. 1 stadium is shared by multiple basketball teams. 1 stadium is shared by multiple football teams. 10 stadiums are shared by a basketball and a hockey team. Stadium area measured in square meters. Businesses in a 3 km radius defined as nearby businesses.

	Mean business count within 3km of stadiums				Mean yearly local business visits (thsd.)			
Industry	Baseball	Basketball	Football	Hockey	Baseball	Basketball	Football	Hockey
Admin. Services	6.7	9.7	5.7	9.3	3.5	5.0	3.7	3.3
Construction	0.3	0.3	0.3	0.3	0.1	0.1	0.2	0.1
Education	100.2	127.2	57.5	133.7	175.2	252.7	159.3	253.0
Finance	116.8	160.4	83.3	170.0	39.8	47.2	25.8	53.5
Food & Accommodation	570.7	852.6	373.2	860.4	2453.5	4070.0	1674.8	4207.2
Health	318.6	501.1	218.3	523.5	346.2	467.3	232.6	447.4
Information	43.9	58.0	28.4	61.9	66.7	110.0	48.2	111.6
Manufacturing	15.8	24.8	10.6	25.1	24.9	30.8	16.3	31.2
Other Services	291.5	411.0	173.0	418.0	275.6	317.2	147.6	323.3
Professional Services	28.3	36.8	17.2	37.8	16.3	20.9	8.8	19.0
Public Administration	5.7	8.2	3.1	8.0	11.0	11.7	7.2	10.3
Real Estate	21.0	24.6	16.1	23.2	60.9	63.8	48.1	69.2
Recreation	100.7	158.8	65.0	164.0	471.1	726.6	331.7	776.4
Retail Trade	382.2	587.3	246.1	608.2	1190.4	1647.5	719.7	1714.2
Transportation	21.8	29.7	13.7	30.7	38.5	43.7	26.5	44.5
Wholesale Trade	5.3	9.6	5.2	8.4	5.5	14.0	7.8	11.0
Utilities	0.1	0.2	0.1	0.1	0.1	0.8	0.3	0.4

(b) Summary statisitcs on businesses within 3km of stadiums.

Table 1: Descriptive statistics on stadiums and their vicinities.

provides a sectoral breakdown of business establishments within the 3km range from the stadiums. Focusing on the 2-digits NAICS classification[4], we find substantial presence of businesses related to Food & Accommodation, Retail Trade, and Health near stadiums. The same business categories are also the most visited ones, as displayed in the right panel of Table 1b.

In terms of attendance, football events attract the largest crowds as measured by the Safegraph visit counts. We observe more than 3,200 Safegraph visitors on an average football game day, while basketball and hockey games attract only about 600 and 800 Safegraph visitors respectively. At the same time, basketball and hockey arenas also display substantial traffic of roughly 200 Safegraph visitors on no-game days, suggesting that non-sport events hosted by stadiums can generate a flow of potential consumers to the stadium neighborhood. Baseball and football stadiums, which are

[4]We group 2-digit NAICS codes 31, 32 and 33 into a single Manufacturing group; 44 and 44 codes into a Retail Trade group; 48 and 49 codes into Transportation group; and omit the 11 and 21 codes entirely due to negligible presence in the stadium vicinities.

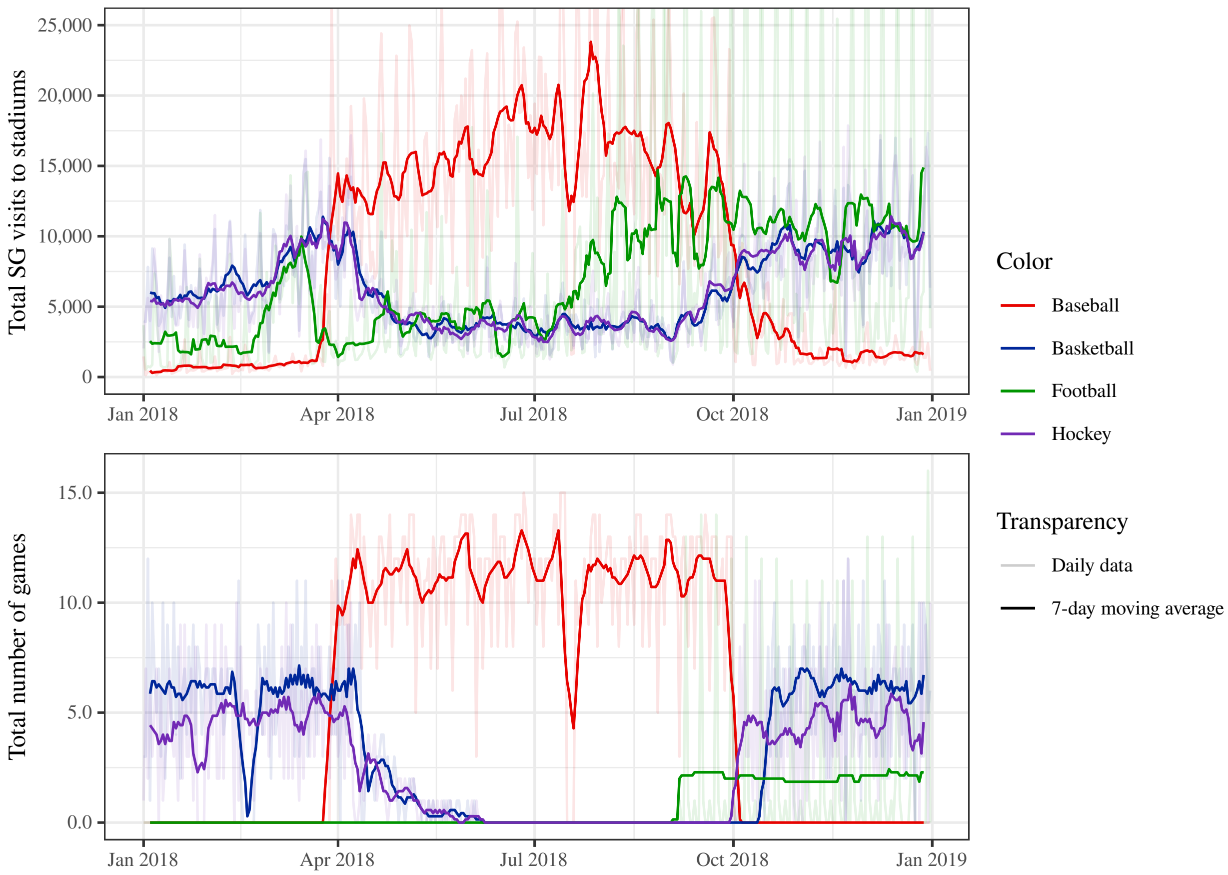

Figure 2: Game events and corresponding visits inferred from Safegraph

more popular on the game days compared to basketball&hockey arenas, are less visited when there are no sports events with around 80 and 160 visitors on an average no-game date.

While average visits are indicative of the across-sports variation in stadium attendance, temporal variation in visits is key to our empirical strategy of estimating stadium spillover effects.

3.2 Temporal variation

Stadiums host a variety of events from sports games to music concerts to trade shows, events are spread out through the year and are different in attendance, which results in the day-to-day variation in stadium visits measured by Safegraph and displayed in the upper part of Figure 2. Although the day-to-day stadium visits variation is high, as suggested by the rugged pattern of the transparent lines showing raw total daly visits, the seasonality of visits is also apparent from the bold lines depicting weekly moving averages of total visits. In fact, in line with our expectations, the weekly moving average attendance appears to primarily follow the respective sports seasons displayed in the lower part of Figure 2 by the total daily game count timeline for each sport. At the same time it should again be noted that stadiums attract substantial crowds even when the sports season is off. For example, the daily total visits to basketball or hockey arenas vary between 2.5 and 5 thousand during the late summer of 2018, when there are no NBA or NHL games. A similar observation can be made for football stadiums and, to a lesser extent, for baseball arenas.

The temporal variation in stadium visits and sports events depicted by Figure 2 is key to our identification strategy. The following subsection explains how we construct our estimation sample.

3.3 Estimation sample

Estimation samples used across the majority of empirical specifications are at the stadium-day level. For each stadium-day observation, we construct total visit counts to nearby businesses as measured by Safegraph. As mentioned before, each observation also includes information on stadium visits and the indicator of whether the stadium hosted a sports event on the respective day.

While the discussion so far has distinguished between four different sports hosted by the sample stadiums, for the purposes of the estimation we group together the arenas that host basketball and hockey games. There are two reasons for that. First, 10 stadiums in our sample are home to both an NBA and an NHL team playing in the professional leagues. Thus grouping basketball and hockey arenas together allows us to concentrate on spillovers caused by the stadiums, rather than by the respective sports. Second, as evident from the lower part of Figure 2, NBA and NHL seasons parallel each other closely. Thus by looking at basketball and hockey stadiums as a single group, we avoid measurement error in the game date indicator.

Also, we focus our attention on the business categories that display a substantial presence near stadiums according to Table 1b. Thus for the estimation purposes we only consider visits to businesses in 7 sectors: Education, Finance, Food & Accommodation, Health, Other Services, Recreation and Retail Trade. The following section describes the empirical specifications that we estimate in order to understand how stadium visits translate into additional visits to businesses in these categories.

4 Empirical strategy and results

Our empirical strategy of estimating spillover effects relies on the day-to-day variation in visits to stadiums and the corresponding variation in visits to nearby businesses. There are several natural reasons to expect a raw positive correlation between stadium visits and local business visits beyond the stadium-generted spillovers. First, there are differences between stadiums in terms of the within-city location. If some stadiums are more accessible to the local population, resulting in higher stadium visits, the same accessibility is likely reflected in higher visits to local businesses. Second, public interest in sports events and in consumption of local goods or services fluctuates from day to day. Observationally, this may again lead to a positive relationship between stadium visits and visits to nearby businesses. Such considerations constitute a threat to the identification of the spillover effects. We first attempt to deal with this threat by estimating the stadium-date level specification that includes the stadium × month × day-of-the-week fixed effect:

$$\text{BusinessVisits}_{dsi} = \beta_{si}\text{StadiumVisits}_{ds} + \gamma_{smwi} + \delta_{di} + \varepsilon_{dsi}, \tag{1}$$

where $\text{BusinessVisits}_{dsi}$ is the sum of visits to businesses in category i near stadium s on date d, $\text{StadiumVisits}_{ds}$ is the observed visit count to stadium s itself on date d, γ_{smwi} is the business category specific stadium × month × day-of-the-week fixed effect, and δ_{di} is the date fixed effect shared by businesses in category i around all stadiums. We estimate eq. (1) separately for each sport of the stadium s and each 2-digits NAICS industry code i of the businesses near stadiums.

Columns (1), (3) and (5) of Table 2 present the resulting estimates. In that table, each coefficicent comes from a separate regression estimated on a subset of data. Column groups indicate the sport, by which the data was filtered, with columns (1), (3) and (5) corresponding to football, baseball and basketaball&hockey stadiums respectively. In turn, table panels indicate the industry of the businesses near stadiums that were included in the estimation sample. That is, the coefficient in column s and panel i is the estimate of β_{si}.

For each sport, the stadium visits are strongly correlated with the visits to local Food & Accommodation businesses. An additional visit to a baseball stadium is associated with 0.3260 additional visits to nearby Food & Accommodation places. The similar coefficients for basketaball&hockey and football stadiums stand at 0.7129 and 0.2890 respectively. The observed association is lower is substantially lower in magnitude for the Retail businesses: an additional stadium visit corresponds to 0.0716 (0.1795, 0.0868) additional retail visits for the case of baseball (basketball&hockey, football). Additionally, visits to Recreation facilities appear to be related to basketball&hockey and football stadiums visits, the respective coeffient estimates are 0.1058 and 0.0703 respectively. The remaining fixed effects estimates in columns (1), (3) and (5) of Table 2 are either statistically insignificant or very modest in magnitude. Thus the observed associations between stadium visits and visits to nearby businesses in Other Services, Health, Finance and Education sectors appears to be negligible.

Although the fixed effects specification is likely to partly resolve the issues preventing the estimation of the true causal spillover effect, some threats to identification remain. First, the demand conditions can vary even for a given stadium, a fixed month and day of the week. If unobserved demand shocks are correlated for the stadium and its vicinity, the fixed-effect specification can overestimate the causal effect of interest. Second, there is a potential concern of reversed causality: if customers of local businesses make last-minute decisions to visit, say, a concert on a stadium, then the coefficients estimated in the FE specifications again do not provide a valid measure of spillover effects, but likely, an overestimate. Finally, since the visits are measured using mobile device location information and some misattribution is inevitable, there is a concern of measurement error

	Dependent varible: business visits within 3km					
	Baseball		Basketball & Hockey		Football	
	FE	IV	FE	IV	FE	IV
	(1)	(2)	(3)	(4)	(5)	(6)
Food & Accommodation						
Stadium visits	0.3260***	0.2929***	0.7129**	0.1963	0.2890***	0.3978***
	(0.0538)	(0.0612)	(0.2169)	(0.1153)	(0.0436)	(0.0685)
Retail Trade						
Stadium visits	0.0716**	0.0648**	0.1795*	0.0097	0.0868***	0.1258***
	(0.0248)	(0.0228)	(0.0870)	(0.0316)	(0.0147)	(0.0258)
Recreation						
Stadium visits	0.0307	0.0089	0.1058*	−0.0406	0.0703**	0.0663***
	(0.0179)	(0.0226)	(0.0447)	(0.0525)	(0.0228)	(0.0130)
Other Services						
Stadium visits	0.0134**	0.0139*	0.0267**	0.0064	0.0217***	0.0346***
	(0.0037)	(0.0056)	(0.0084)	(0.0079)	(0.0050)	(0.0072)
Health						
Stadium visits	0.0115	0.0092	0.0405*	0.0125	0.0374	0.0617*
	(0.0071)	(0.0075)	(0.0160)	(0.0172)	(0.0237)	(0.0301)
Finance						
Stadium visits	0.0027	0.0015	0.0015	0.0052	0.0040**	0.0060***
	(0.0014)	(0.0013)	(0.0029)	(0.0032)	(0.0012)	(0.0013)
Education						
Stadium visits	−0.0011	−0.0061	0.0120	0.0078	0.0047	0.0216
	(0.0031)	(0.0036)	(0.0062)	(0.0151)	(0.0036)	(0.0117)
Stadium×Month×DoW FE	✓	✓	✓	✓	✓	✓
Date FE	✓	✓	✓	✓	✓	✓
F-stat	-	182.3	-	247.5	-	177.9
1st stage coef.	-	1127.6	-	454.0	-	3122.3
Observations	9,490	9,490	13,140	13,140	10,950	10,950

Note: *p<0.05; **p<0.01; ***p<0.001

Table 2: OLS FE and IV FE estimates. Each coefficient in the table represents an estimate from a regression specification on a subset of data by stadium sport (columns) and business industry (panels). Standard errors robust to heteroskedasticity and stadium and date clustering are reported in parentheses.

in the explanatory variable (stadium visits). Thus, a downward bias in the FE estimate is also not impossible.

To deal with the remaining threats to identification, we employ an instrumental variable strategy, using the sports game date indicator as our instrument. While game date indicator is likely to be a good predictor of stadium visit counts, it helps to identify the causal spillover effects for three reasons. First, game dates are set well in advance[5] and are thus uncorrelated with demand shocks such as weather or local festivals that drive the public to both stadiums and businesses nearby. Second, using game date as instrument rules out the reverse-causality argument: again, since game dates are set well before the actual games, they are unlikely to be systematically related to idiosyncratic visits to local businesses (translating to higher stadium attendance). Finally, using the game date instrument solves the measurement error issue.

Game date indicator is a strong predictor of stadium attendance as measued by the Safegraph sample visit counts across all of the sport groups, as indicated by the first stage estimation results summarized in the lower part of Table 2. Conditional on the stadium × month × day-of-the-week and date fixed effects, game dates are observed to have 1,128 visits more than non-game dates for baseball stadiums. The first stage coefficients for basketball&hockey and football stadiums are 454 and 3,122 additional visits corresponding to game dates. The first stage F statistics stand at 182.3 (247.5, 177.9) for baseball (basketball&hockey, football) visits, suggesting that the game day indicator is a strong instrument.

Columns (2), (4) and (6) of Table 2 present the spillover effect estimates resulting from the instrumental variable specification with the same set of fixed effects as before. These estimates indicate that there exists a strong link between stadium and local business visits for a subset of sports (baseball and football) and industries (Food & Accommodation and Retail).

Specifically, in line with the fixed effects specifications, for football and baseball stadiums the estimated coefficients indicate a positive spillover effec for Food & Accommodation and Retail businesses. For the most affected Food & Accommodation industry, 100 additional baseball stadium are estimated to spillover into additional 29.3 business visits, while additional 100 football stadium visits translate into 39.8 additional business visits. Similar estimates for the Retail sector stand at 6.5 and 12.5 additional visits for baseball and football stadiums respectively. As in the earlier reported fixed effect specifications, the remaining estimates of baseball stadiums spillovers to Recreation, Other Services, Health, Finance and Education industries are either statistically or economically insignificant[6]. In turn, football stadiums appear to affect nearby businesses across

[5] MLB released the 2018 MLB season released on January 9, 2018, more than 2 months before the first scheduled game. A similarly gap between the schedule announcement and the season start is observed in NBA, while NHL and NFL announce the schedules even earlier, more than 3 months before the first season game.

[6] For the Other Services sector the coefficient estimate indicates that for 100 additional baseball stadium visits only 1.39 additional business visits are made.

a larger variety of industries. Specifically, 100 additional football stadium visits are estimated to generate 6.63 visits to Recreation facilities and 3.46 visits to Other Services businesses. The 0.0617 coefficient estimate of spillovers generated for Health-related businesses is also marginally significant, while the Finance and Education visits are not substantially affected.

Spillover estimates corresponding to the basketball&hockey stadiums are all rendered insignificant by the instrumental variable strategy. Also, the point estimate for the effect on Food & Accommodation businesses stands at 0.1963, much lower than the fixed effects aprroach estimate of 0.7129. A similar note applies to the businesses in the Retail sector: point estimate in the IV specification is only 0.0097, a substantial decline from the FE estimate of 0.1795. These results indicate that the observed association between stadium and business visits is to the large extent driven by local demand shocks that affect both stadiums attendance and visits to businesses nearby. The IV estimates, which only reflect the variation in the stadium visits driven by sports games, are less likely to reflect the impact of such local demand shocks. This translates into coefficient estimates that are lower in magnitude (compared to the FE estimates) and statistically insignificant.

The decrease in point estimate from the FE to the IV specification is also observed for the businesses near baseball stadiums, once again corroborating the concern thath the FE estimates might be biased by the presence of local demand shocks. At the same time, the IV estimates for football spillover effects are higher than the FE estimates, highlighting the possibility that the measurement error is also inducing bias in the observed association between stadium and business visits. Football stadiums, that are anecdotally located in less busy parts of the urban landscape compared to baseball and basketball&hockey arenas, may be less susceptible to the local demand shock bias than to the measurement error. As a result, the football stadiums spillover estimate increases, rather than decreases from the FE to the IV specification.

The spillover effect from stadium to business visits is likely heterogenous across locations in different proximity to the stadium. To explore this kind of heterogeneity, we also estimate the IV specifications breaking down the affected businesses into distance ranges. Specifically, we compute total visits to business in half-kilometer distance bins around the stadiums, ranging from 0-0.5km bin to 2.5-3km bin. We then use these total visit counts as an outcome variables in separate regressions with stadium visits still playing the role of the independent variable. Figure 3 presents the resulting estimates for the two most affected industries, Food & Accommodation and Retail. The patterns of heterogeneity across distance ranges are similar for baseball and basketball&hockey arenas. Most of the generated spillovers affect businesses in the closest proximity to the stadium: the coefficient estimates are significant for the 0-0.5km and 0.5-1km distance ragnes in case of Food & Accommodation businesses, and in the 0-0.5km bin only for the Retail businesses. The spillover effects of football stadiums, however, are more spread out: positive spillovers are observed across all explored distance ranges for the Food & Accommodation industry, and for 0-0.5 to 1.5-2km

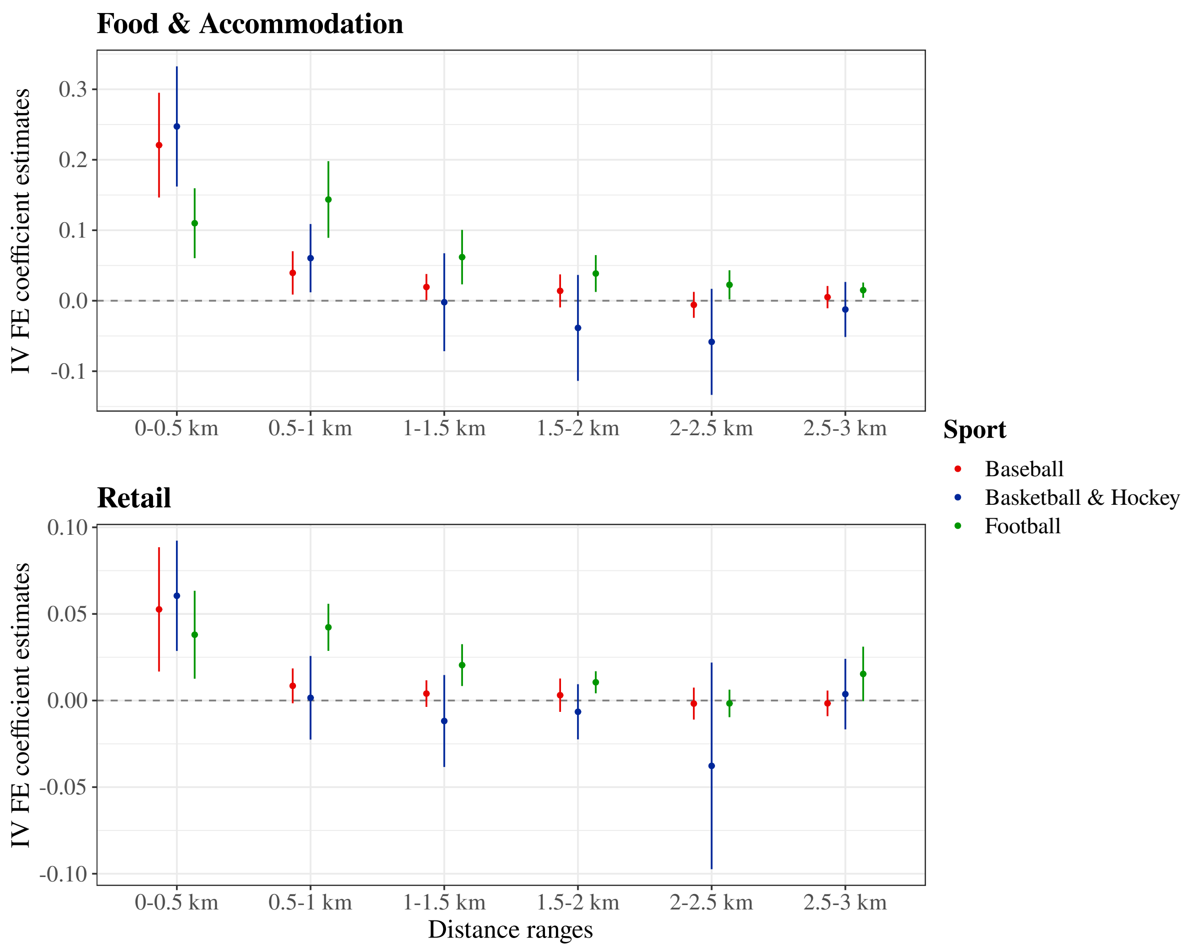

Figure 3: Regression coefficients, estimation sample broken down by distance range around stadiums.

distance ranges for the Retail sector. Still, the effects fade out fast, an additional football stadium visit translates into 0.11 additional Food & Accommodation visits in the 0-0.5km distance range and only into 0.0226 additional visits in the 2-2.5km distance range.

There is also some evidence of spatial reallocation of consumption. Specifically, the negative (although insignificant) spillover estimates for the businesses located 1-2.5km away from the basketball&hockey areans indicate that the businesses near stadiums get new customers due by stealing them from businesses located further away from the action. We also explored the possibility of temporal reallocation of consumption by including lags of stadium visits as controls into our specifications. The results presented in Table 5 for Food & Accommodation and Retail Trade sectors do not provide evidence of such reallocation.

Altough the evidence for consumption redistribution we document is relatively weak, we can not rule it out completely. It is possible that businesses near stadiums steal customers from a distance range further than the 3km radius we explore, and detecting such business-stealing can be close to impossible if it is spread out across large areas. A similar note of caution applies to the temporal redistribution. Finally, the extra spending at businesses near stadiums may actually be reallocated from channels like online consumptions on which we don't have any data. We thus conservatively interpret our results as evidence that stadiums do generate traffic for local businesses and think of them as an upper bound of the a net gain in consumer spending associated with stadiums. For that reason, when we use our estimates to compute the stadium-generated spillovers in the next section, we also interpret this benefits calculation as an upper bound of the actual stadium-induced benefits.

5 Policy implications

The empirical results presented in the previous section allow us to approximate the upper bound for the benefits local businesses receive from stadium-generated spillovers and compare them head-to-head with the actual subsidies allocated to stadium construction projects. We use the spillover effect estimate, total yearly stadium visit count obtained using total stadium capacity data and a range of assumptions on consumer spending to estimate that a median stadium generates roughly \$12.5M of benefits to the local Food & Accommodation and Retail businesses per year. Thus, based on an averge lease duraion of 30 years, we predict that a median stadium subsidy generates a negative NPV of about 100 million dollars. Hence, our results generally fall in line with the consensus in the academic literature that public spending on sports facilities are not justified based on the cost-benefit analysis.

To evaluate the externality benefits to the local businesses created by the stadiums against the actual amount of public funds distributed to them, we utilize the data provided in Long (2013). In particular, for every stadium in our dataset that was commissioned prior to 2010 we obtained the records of public costs allocated to cover the construction or operation of these facilities. Total public cost is the main variable of interest and corresponds to *Net Present Value* at 2010 of public capital, net annual ongoing public costs, and foregone property taxes associated with financing and building each facility.

Based on the data from Long (2013), the median value of public funds spent on stadiums in our sample is \$240M (measured in 2010 dollars). Correspondingly, for each stadium that received a subsidy we compute the annual externality benefits generated to the local Food & Accommodation and Retail businesses as follows:

$$\text{Est.AnnualBenefits}_s = \text{Est.Attendance}_s \times (\text{DollarPerVisit}_{F\&A} + \text{DollarPerVisit}_{Retail})$$

where

$$\text{DollarPerVisit}_i = \hat{\beta}_{si} \times E$$

is the projected benefit from an additional customer, $\hat{\beta}_{si}$ is the number of additional visits occurring to the businesses in category i for each stadium visitor during game dates (using the results from the first row in Table 2 for each sport category), and the total annual attendance is approximated using the information on stadium capacity, the number of games in 2018, and the average share of visitors who attend the stadium on the days without sports events:[7]

$$\text{Est.Attendance}_s = \text{Est.Attendance}_s^{\textit{game days}} + \text{Est.Attendance}_s^{\textit{other days}}$$
$$\text{Est.Attendance}_s^{\textit{game days}} = \text{TotalGames}_s \times \text{VisitorCapacity}_s \times f_s$$
$$\text{Est.Attendance}_s^{\textit{other days}} = \text{ShareVisitors}_s^{\textit{other days}} \times \text{Est.Attendance}_s^{\textit{game days}}$$

In the above, f_s denotes the average stadium capacity load, which we define separately for each sport category based on the data from Wikipedia. We also define the constant E that corresponds to the average amount of dollars each generated customer spends on the services of the surrounding businesses. For our baseline we use the value of $E = \$15$ as a moderate benchmark for comparison.

Based on our calculations presented in Table 3, a median arena receiving subsidies generates roughly $12.5M of additional annual revenue to the businesses in the Food & Accommodation and Retail categories. Notably, baseball stadiums appear to exhibit the most pronounced spillovers with roughly $15.2M of generated benefits in the median case, followed by football stadiums that generate about $12M. A median hockey or basketball stadium, on the other hand, generates only $6.1M of benefits, which is in line with the fact that for these sport categories we could not reject the null hypothesis of no external benefits for the surrounding businesses. To offer a more intuitive interpretation of the conducted cost-benefit analysis, for each stadium subsidy we also computed the *Net Present Value* that augments the predicted annual externalities with the estimated net public costs documented in Long (2013). To maintain consistency in calculating NPV, we assume the lease duration of 30 years and the interest rate of 6 percent – as used in Long (2013).

As follows from the results in Table 3, in the vast majority of cases stadium subsidies generate a substantial loss even when the externality benefits to the nearby businesses are taken into account. Assuming an average per-consumer spending of $15, we estimate that a median stadium subsidy leads to a negative NPV of $100M. Football, hockey and basketball facilities appear to generate consistent losses ranging from roughly 200 millions to about 60 millions with median losses of $103M and $111M resepectively. Notably, baseball stadiums is the only category for which we find the upper quartile NPV to be positive at about $12M. In Table 6 in the Appendix we allow for a higher per-customer spending value of $20, and obtain qualitatively similar results. We find that the upper quartile NPV for hockey and basketball remains negative, a median baseball stadium generates small net benefits, and for football only the stadiums in the upper quartile generate small

[7] For each stadium, $\text{ShareVisitors}_s^{\textit{other days}}$ is computed as the stadium's average attendance on no-game days divided by the average attendance on the dates of games, with both estimates obtained from Safegraph daily visit counts.

	Mean	Q25	Med.	Q75
All stadiums receiving subsidies				
Annual attendance (m)	2.22	1.67	2.04	2.79
Annual benefits ($M)	11.62	6.98	12.55	15.16
NPV over 30 years ($M)	-113.98	-170.48	-100.52	-26.52
Public costs at 2010 ($M)	273.90	189.50	240.00	324.50
Baseball				
Annual attendance (m)	2.84	2.56	2.84	2.98
Annual benefits ($M)	15.23	13.76	15.23	16.00
NPV over 30 years ($M)	-73.01	-154.45	-56.99	12.23
Public costs at 2010 ($M)	282.65	195.00	260.00	374.00
Football				
Annual attendance (m)	1.58	1.26	1.55	1.86
Annual benefits ($M)	12.43	9.88	12.14	14.60
NPV over 30 years ($M)	-164.41	-224.96	-103.27	-63.51
Public costs at 2010 ($M)	335.55	237.25	281.00	384.75
Hockey & Basketball				
Annual attendance (m)	2.15	1.75	1.98	2.23
Annual benefits ($M)	6.65	5.42	6.12	6.89
NPV over 30 years ($M)	-110.65	-153.73	-110.99	-67.41
Public costs at 2010 ($M)	202.20	157.25	195.00	235.75

Note: Assuming an average of value of 15$ per generated customer.

Table 3: Public Costs and Estimated Benefits for Stadiums Receiving Public Funds (under alternative assumptions)

net benefits of $10M.

The above results should be interpreted with caution. First, the metrics we use to evaluate the benefits inherit the margin of error from our estimator, which is statistically significant only for the baseball and football stadiums, but not hockey or basketball arenas. Second, effect dilution is possible for those facilities that host game-unrelated activities on game days, in case these activities do not attract customers to the surrounding businesses in the same way as sports events do.[8]. Finally, as previously mentioned, our local estimates do not account for certain patterns of consumption redistribution and hence should be rather interpreted as upper bounds on the magnitute of the overall spillovers.

Despite the above-mentioned concerns, we think that our results reveal a number of important patterns. First of all, for the vast majority of sports facilities we find a significant gap between the magnitudes of the subsidies and the externalities we estimate from the data. While the largest externality effect we find in Section 4 corresponds to football arenas, these stadiums typically host

[8]As suggested by the daily data we have, the latter issue is particularly relevant for basketball and hockey arenas

only a limited number of games each year and, as a result, can not generate enough additional consumption to compensate for the public funds they receive. For basketball and hockey arenas our estimates are not statistically significant, and based on the point estimates, we find that they generate the smallest median benefits for the surrounding businesses. And even though baseball stadiums appear to generate the largest externality benefits due to both consistent attendance and significant externality effects, only the most attended ones seem to be able to generate net benefits after 30 years of lease, which suggests that the amounts of public funds spent on the construction and operation of sports facilties are rarely economically justified.

6 Conclusion

While substantial amounts of public funds have been historically allocated to stadium construction projects on the grounds of potential positive spillover effects stadiums generate for nearby businesses, the lack of detailed data has rendered difficult the task of actually estimating these local spillovers. In this paper we use daily visit counts to Major Sports Leagues stadiums and local businesses as well as the information on game dates to overcome these difficulties, estimating the spillover effects and exploring the heterogeneity of spillover benefits by industries and distance. Our results indicate that spillovers from baseball and football stadiums are present and concentrated in entertainment-related businesses in the closest proximity to stadiums. However, the local spillover estimates of basketball&hockey arenas are not statistically significant. Since our estimates do not account for all redistributional aspects of stadium-generated spillovers, we interpret them as an upper bound on the net gains created by stadiums. Still, our back of the envelope calculation indicates that the median football stadium can hardly generate enough local spending to cover the subsidies it receives over a typical stadium lifetime. Baseball stadiums, however, host more games attracting significant crowds and have a chance to pay back the allocated subsidies, possibly suggesting a need for a more subtle investigation of the net generated gains. Nevertheless, we recognize that the stadium subsidy decisions should be made upon careful consideration of alternative routes for these large investments.

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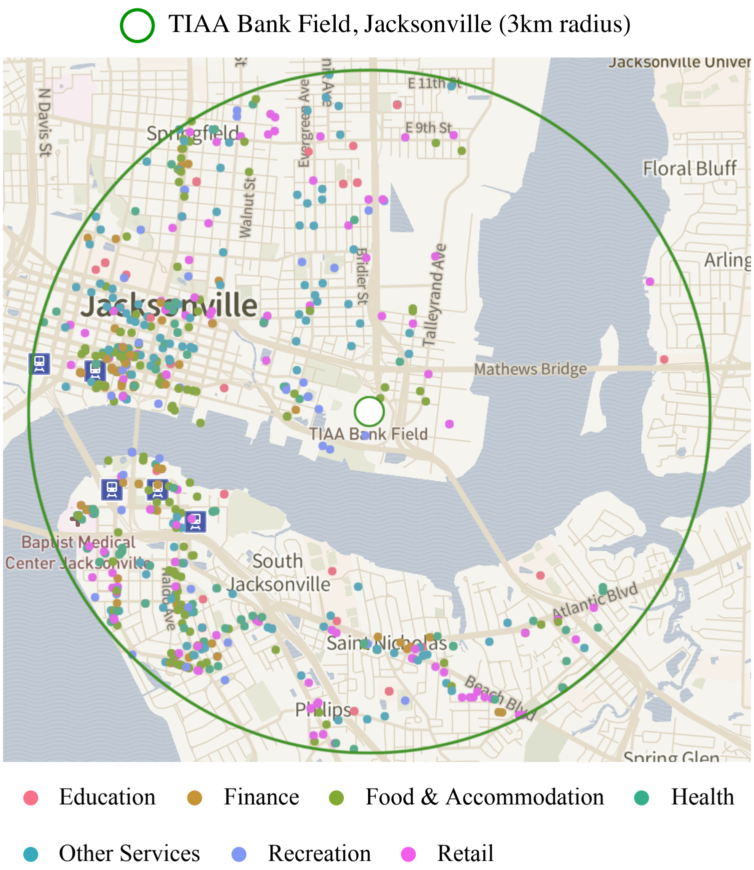

Figure 4: Establishments by category, in the 3km radius around TIAA Bank Field in Jacksonville, Florida

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	Dependent varible: establishment visits					
	Distance range					
	0-0.5 km	0.5-1 km	1-1.5 km	1.5-2 km	2-2.5 km	2.5-3 km
Football						
FoodAccommodation	0.1100***	0.1436***	0.0619**	0.0386**	0.0226*	0.0150**
	(0.0243)	(0.0266)	(0.0189)	(0.0128)	(0.0101)	(0.0053)
Retail	0.0380**	0.0423***	0.0205**	0.0105**	−0.0017	0.0154
	(0.0124)	(0.0066)	(0.0059)	(0.0031)	(0.0039)	(0.0077)
F-stat	180.9	180.9	180.9	180.9	180.9	180.9
Obs.	10,950	10,950	10,950	10,950	10,950	10,950
Baseball						
FoodAccommodation	0.2208***	0.0395*	0.0195*	0.0140	−0.0059	0.0051
	(0.0361)	(0.0149)	(0.0090)	(0.0114)	(0.0089)	(0.0077)
Retail	0.0526**	0.0085	0.0040	0.0031	−0.0018	−0.0016
	(0.0174)	(0.0049)	(0.0037)	(0.0047)	(0.0045)	(0.0036)
F-stat	190.6	190.6	190.6	190.6	190.6	190.6
Obs.	9,490	9,490	9,490	9,490	9,490	9,490
Basketball & Hockey						
FoodAccommodation	0.2473***	0.0604*	−0.0021	−0.0386	−0.0584	−0.0124
	(0.0420)	(0.0238)	(0.0342)	(0.0370)	(0.0370)	(0.0192)
Retail	0.0605***	0.0016	−0.0118	−0.0065	−0.0377	0.0037
	(0.0157)	(0.0119)	(0.0131)	(0.0078)	(0.0294)	(0.0100)
F-stat	264.5	264.5	264.5	264.5	264.5	264.5
Obs.	13,140	13,140	13,140	13,140	13,140	13,140
Note:				*p<0.05; **p<0.01; ***p<0.001		

Table 4: IV FE estimates. Each coefficient in the table represents an estimate from a regression specification on a subset of data by distance range (columns), stadium sport (panels) and business industry (rows). All specifications include stadium-month-dayofweek and date fixed effects. Standard errors robust to heteroskedasticity and stadium clustering are reported in parentheses.

	Dependent varible: establishment visits within 3km					
	Food & Accommodation			Retail		
	Football	Baseball	Bas.&Hoc.	Football	Baseball	Bas.&Hoc.
Stadium visits lags						
0	0.3921***	0.2693***	0.2273*	0.1250***	0.0749**	0.0177
	(0.0706)	(0.0638)	(0.1045)	(0.0262)	(0.0221)	(0.0316)
1	0.0212	0.0329	0.1062*	0.0041	−0.0125	0.0092
	(0.0163)	(0.0302)	(0.0514)	(0.0071)	(0.0225)	(0.0169)
2	−0.0007	0.0091	0.0319	0.0008	−0.0048	0.0068
	(0.0126)	(0.0205)	(0.0500)	(0.0065)	(0.0072)	(0.0277)
3	−0.0167**	−0.0181	0.0290	−0.0036	0.0019	0.0115
	(0.0059)	(0.0179)	(0.0722)	(0.0041)	(0.0072)	(0.0429)
Stadium-Month-DoW FE	✓	✓	✓	✓	✓	✓
Date FE	✓	✓	✓	✓	✓	✓
F-stat	173.9	182.3	247.5	173.9	182.3	247.5
Observations	10,860	9,412	13,032	10,860	9,412	13,032
Note:						*p<0.05; **p<0.01; ***p<0.001

Table 5: IV FE estimates with lagged stadium visits as controls. Standard errors robust to heteroskedasticity and stadium and date clustering are reported in parentheses.

	Mean	Q25	Med.	Q75
All stadiums receiving subsidies				
Annual attendance (m)	2.22	1.67	2.04	2.79
Annual benefits ($M)	15.49	9.31	16.74	20.22
NPV over 30 years ($M)	-60.67	-128.85	-55.31	31.21
Public costs at 2010 ($M)	273.90	189.50	240.00	324.50
Baseball				
Annual attendance (m)	2.84	2.56	2.84	2.98
Annual benefits ($M)	20.31	18.35	20.31	21.34
NPV over 30 years ($M)	-3.14	-86.12	1.39	81.04
Public costs at 2010 ($M)	282.65	195.00	260.00	374.00
Football				
Annual attendance (m)	1.58	1.26	1.55	1.86
Annual benefits ($M)	16.58	13.17	16.19	19.47
NPV over 30 years ($M)	-107.36	-185.45	-50.83	10.07
Public costs at 2010 ($M)	335.55	237.25	281.00	384.75
Hockey & Basketball				
Annual attendance (m)	2.15	1.75	1.98	2.23
Annual benefits ($M)	8.87	7.23	8.16	9.18
NPV over 30 years ($M)	-80.13	-117.09	-81.32	-41.88
Public costs at 2010 ($M)	202.20	157.25	195.00	235.75

Note: Assuming an average of value of 20$ per generated customer.

Table 6: Public Costs and Estimated Benefits for Stadiums Receiving Public Funds (under alternative assumptions)