Sports Arenas, Teams and Property Values: Temporary and Permanent Shocks to Local Amenity Flows

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Abstract

Professional sports facilities and teams generate local amenity flows in cities that may affect property values. Previous research shows evidence of important positive and negative local amenity flows based on case studies of changes in residential property values in specific cities. We analyze changes in residential property values in Oklahoma City over a period, 2000 to 2016, where both temporary and permanent exogenous shocks to local sports-related amenities occurred. Results from hedonic price models and repeat sales regression models show that nearby residential property prices increased after the opening of a new arena and the arrival of a new, permanent NBA team in the city. The presence of a temporary NBA team visiting the city also had a positive impact.

1 Introduction

A number of recent papers examine the effect of professional sports teams and facilities on nearby property values, a line of research with important economic policy implications. North America recently experienced a boom in new sports facility construction. Sixty-four new stadiums and arenas were built for National Basketball Association (NBA), Major League Baseball (MLB), National Football League (NFL) and National Hockey League (NHL) teams over the period 1991 to 2006; most involved substantial public subsidies. An increasing number new sports facility projects use Tax Increment Financing (TIF) to generate funds for these subsidies. TIFs issue bonds to pay for infrastructure, land, and facility construction costs, and use new property tax revenues generated by the construction projects to pay the principle and interest on the bonds. The Rogers Centre in Edmonton, the KFC Yum! Center in Louisville, and proposed new arenas in Chicago and Milwaukee all use TIF financing.

In this paper, we exploit two natural experiments, the unexpected, temporary presence of the New Orleans Hornets in the Chesapeake Energy Arena in downtown Oklahoma City from November 2005 through April 2007, and the arrival of the Oklahoma City Thunder, *née* Seattle SuperSonics, in the arena in 2008, to generate evidence on the effect of the presence of a professional sports team, but not the construction of a new facility, on nearby property values. We also estimate the presence of the arena on nearby housing

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prices. We exploit the arrival of NBA teams to an existing arena that hosted other events like minor league hockey, arena football, and concerts, before the team arrivals to generate exogenous variation in the external amenities and disamenities generated by professional sports teams.

Several recent papers exploit the opening of new sports facilities to estimate the impact of facilities and teams on nearby residential property values. Tu (2005) analyzed the opening of FedEx Field outside Washington DC; Ahlfeldt and Maennig (2009) use the opening of two new sports facilities in Berlin, Germany for a similar analysis. Ahlfeldt and Kavetsos (2014) exploit the opening of a new stadium built for the 2012 Summer Olympic Games in London. All report evidence that residential property values increase with distance, and generally find that properties close to facilities experience no price increases after opening.[1] In these papers, the natural experiment involves new facility construction and the presence of sport and non-sport events in the new facility. The results in these papers suggest that nearby property values may be affected by negative externalities (traffic, noise, trash, crowds etc.) generated by customers attending events in the facility while property values farther away reflect only positive amenities like the perception of "world class city" status from hosting a team in a top professional sports league.[2]

Most research examines only the overall impact of both new facilities and new games played in these facilities on economic outcomes like property values. The impact of a new facility and the games played in it may generate different amenity flows. For example, a new sports facility might be architecturally pleasing and become a local landmark, increasing the amenity flow in the area near the facility. Traffic noise associated with fans coming and going from games played in the facility would reduce the amenity flow. Increased traffic near the facility on game day makes it difficult for local residents to get around by car or foot during games reducing the amenity flow. Fans attending games who park on the street would reduce parking available to residents, reducing the amenity flow from the facility. Garbage generated by fans walking to and from the facility, in the form of trash on the streets or overflowing trash cans, would be a eyesore, reducing the amenity flow.

This paper contributes to the literature by analyzing a novel sequence of plausibly exogenous events related to sports teams and facilities in a single city, at least in terms of the timing of the arrival of the teams in the city. These events include an NBA team playing games in the city on a temporary basis due to a natural disaster and the unexpected permanent move of a different NBA team to the city as a result of a court case with an unpredictable outcome. These events, along with the opening of the new arena during the sample period, represent novel shocks to local amenity flows unlike others analyzed in the literature.

Results from hedonic price regression models and repeat sales regression models indicate that residential property values near the Chesapeake Energy Arena increased significantly only following the opening of the arena. The repeat sales regression model results also indicate a positive impact following the opening and arrival of both teams, suggesting that unobservable property- or neighborhood-specific factors play an important role in this setting. These results suggest that the playing of games in a high profile sports league is not the most important factor driving observed property value increases documented in the existing literature. The mere presence of an arena, and the non-sports related events in the arena, play an equally important role in generating increased property values.

2 The Chesapeake Energy Arena, the Hornets, and the Thunder

Chesapeake Energy Arena is a multi-purpose sports arena located in Oklahoma City, Oklahoma. Ground breaking occurred 11 May 1999 and the facility opened on 8 June 2002; it cost $89 million to build ($120 million in 2017 dollars). Construction was 100% publicly financed. The arena seats 18,203 spectators for basketball games, 15,152 for ice hockey games, and 16,591 for concerts. Oklahoma City owns the facility. From 2002 through 2009 it was home to a minor league hockey team, the OKC Blazers; from 2004 through 2008 it was home to an Arena Football League team, the Yard Dawgz.

The arena represents a key component of a larger long-term urban revitalization project, the Metropolitan

[1] Propheter (2017) shows that commercial rent increased near a new NBA arena in Brooklyn, New York.

[2] A recent paper, Stitzel and Rogers (2018), analyze a novel data set containing detailed geo-coded spatial sales data at the establishment level from Oklahoma City. This paper finds evidence of spatial displacement in restaurant sales toward the arena and spatial displacement in entertainment establishment sales away from the arena after the Thunder relocated to the city.

Area Projects, or MAPS, that began in 1993. MAPS includes both financing mechanisms, in the form of temporary increases in sales taxes to finance construction projects, and the construction of structures for cultural, sports, recreation, entertainment, and convention events designed to revitalize downtown Oklahoma City. Other MAPS-funded projects include the Chickasaw Bricktown Ballpark (cost $34 million, opened 1998), a minor league baseball stadium, the Cox Convention Center (cost $60 million, opened 1999), the Ronald J. Norick Downtown Library (cost $21.5 million, opened 2004), an interior renovation of the Civic Center Music Hall (originally opened in 1934, cost $53 million, completed 2001), and renovations to the Oklahoma State Fairgrounds in 1998. MAPS also included arena renovations and upgrades put in place over the period 2008-2010 and the construction of a practice facility for the Thunder in 2012.

Some MAPS investments likely affected property values in downtown Oklahoma City. The sales tax increases were temporary and probably did not affect property values. Only the new library and renovations to the Civic Center Music Hall and the practice facility occurred during our analysis period. The other large MAPS projects occurred before, and should be capitalized into property values throughout our period of analysis. The Music Hall, located about 0.6 miles from the arena, renovations changed only the interior of the building which likely had a minimal impact on nearby property values. The library is located about 0.5 miles from the arena; little evidence exist on the impact of libraries on nearby property values. The practice facility is not a recreation or entertainment venue.

From November 2005 through April 2007 the arena was the temporary home of the New Orleans Hornets (now called the Pelicans). Hurricane Katrina struck New Orleans on 29 August 2005 and severely damaged the New Orleans Arena, home to the Hornets. While some early reports suggested that the facility would soon be usable, on 22 September the NBA announced that the team wold play 35 games in Oklahoma City in the 2005/06 season, and 6 games in New Orleans, if the arena was ready. Repairs lagged, and on 31 January 2006 the NBA announced that the Hornets would play the entire 2006/07 season in Oklahoma City. The team again played 35 games in Oklahoma City, and 6 games in New Orleans, in the 2006/07 season. Their final game in Oklahoma City was 13 April 2007.

In November 2007, the owner of the Seattle SuperSonics, Clay Bennett, announced that he intended to move the team to Oklahoma City as soon as he could get out of the existing lease on Key Arena and requested arbitration to terminate the lease. When denied arbitration, the city sued to force the team to play in Seattle until 2010. The trial began in late June and on 2 July 2008 the team and city reached an agreement before a verdict was announced that allowed the team to move to Oklahoma City in exchange for a $45 million payment by the team.[3] The team moved to Oklahoma City, and began play in October 2008 as the Thunder. Seattle kept the SuperSonics name and team history under the terms of the settlement.

The temporary move of the Hornets/Pelicans, and the permanent move of the SuperSonics/Thunder to Oklahoma City following the 2 July 2008 settlement represent "natural experiments" that motivate a quasi-experimental differences-in-differences analysis of the effect of the presence of an NBA team playing games in Oklahoma City on nearby residential property transaction prices. The presence of two different teams in Oklahoma City reflect the impact of an unexpected natural disaster and the unexpected outcome of a court trial that could not be forecasted until shortly before each team arrived.

We assume that the Hornets/Pelicans could have been expected to play the 2005/06 season in New Orleans and the SuperSonics could have been reasonably expected to remain in Seattle until 2010, and perhaps beyond, had these unexpected events not occurred. Dehring et al. (2007) exploit similar unexpected events, in terms of several announcements about the location of a new facility to analyze the effects of a planned new football stadium on property values in Arlington, Texas.

3 Prior Literature

A number of papers analyze the impact of proximity of sports teams and facilities on residential property values. Ahlfeldt and Kavetsos (2012) show how standard bid-rent functions representing utility maximizing decisions by consumers on where to live motivate this relationship. Humphreys and Zhou (2015) develop a formal spatial general equilibrium model that generates predictions about spatial patterns of residential

[3]One of the authors of this paper, Humphreys, was employed by the SuperSonics to provide expert testimony during this trial. This research is unrelated to that trial, and no part of this research is related to his testimony.

property values near sports facilities. Utility maximizing consumers maximize well-being by choosing where they live, and utility from housing depends on the size and quality of dwellings and locational quality in this model. Location-specific quality can be thought of as a composite good reflecting access to jobs, natural amenities like environmental quality, publicly provided services, and potentially access to a professional sports team in a stadium or arena.

In competitive real estate and goods and services markets, residents' utility depends on proximity to sports facilities and teams and other location and non-location characteristics associated with their place of residence. At the margin, an increase in utility from location-specific or non-location-specific property characteristics offset any corresponding increase in rents or dwelling prices, implying the standard bid-rent function in urban economics linking rent to specific location-specific and non-location-specific characteristics, including proximity to sports facilities.

Ahlfeldt and Kavetsos (2012) observe that identification of proximity effects depends on the ability to separate facility effects from other observable and unobservable locational characteristics; these other factors could be correlated with distance to a facility. Correlation could arise from the fact that sports facilities are often located downtown in large cities. If the facility impact cannot be separately identified from the impact of other location-based factors, then the estimated hedonic impact price will be biased. Ahlfeldt and Kavetsos (2012) propose a quasi experimental approaches to reduce bias: pooling housing price data into space-time cells and performing before-and-after tests around specific events like openings or renovations. Ahlfeldt and Kavetsos (2012) further recommend conditioning on observable dwelling characteristics.

Tu (2005), Dehring et al. (2007), Ahlfeldt and Maennig (2009), Ahlfeldt and Maennig (2010), Kavetsos (2012) and Ahlfeldt and Kavetsos (2014) employ difference-in-difference methods to estimate the effect of new sports facilities on housing prices using data from before and after different facility openings. Humphreys and Nowak (2017) employ similar methods to estimate the impact of the departure of NBA teams from existing arenas in Seattle and Charlotte. Tu (2005) focuses on the opening of a new stadium with a team playing in the facility. Dehring et al. (2007) and Kavetsos (2012) focus on announcements, not actual facility openings.

Tu (2005) reported a 13% increase following the 1997 opening of FedEx Field. Dehring et al. (2007) reported a 1.5% decrease after 2004 and 2005 announcements about two alternative locations for a new football stadium in Arlington Texas. Ahlfeldt and Maennig (2009) and Ahlfeldt and Maennig (2010) reported a 2.5% increase in property values after the opening a cycling venue in Berlin, Germany, and a 15% increase after the opening of an arena in Berlin in the 1990s. Kavetsos (2012) reported a 2.5% to 3% increase after the 2007 opening of a new Olympic Stadium in London. Ahlfeldt and Kavetsos (2014) reported a 15% increase after the 2007 opening of a new stadium in London. In all cases, the opening of new facilities coincided with the arrival of new sport franchises or other sporting events; the price effect estimated in these papers can not be separated from the price effect of a facility and non-sporting events occurring inside it. Humphreys and Nowak (2017) report an increase of about 7% in nearby property values after NBA teams left Seattle and Charlotte; the arena remained in use after these team departures.

Humphreys and Nowak (2017) estimate the impact of NBA team departures on nearby property values in Seattle and Charlotte. They report evidence that the departure of an NBA team generated increases in nearby residential property values, suggesting that these teams generates local congestion disamenities like crime or traffic that were capitalized into residential property values. No prior research has investigated the impact of a new team moving into an existing facility on residential property prices.

4 Empirical Analysis

4.1 Econometric Approach

We estimate the effect of proximity to the arena before and after the arrival of two NBA teams and before the opening of the arena over the period 2000-2016. The tests are based on an difference-in-differences hedonic price model (DDHPM) and an augmented repeat sales regression (RSR) model. RSR models can be easily derived from hedonic price models. DDHPMs assume that the quality, quantity and price of characteristics of a dwelling determine observed transaction prices. In a DDHPM the log price of property j transacted at

time t is

$$p_{jt} = \delta_t + f(X_{jt}, Z_j, \beta_t) + d_j \times 1(t \geq Year) \times \theta + u_{jt} \quad (1)$$

where, p_{jt} captures the log of the transaction price, δ_t all time-varying average price levels in the local property market, $f(X_{jt}, Z_j, \beta_t)$ relates time-varying and -invariant property-specific characteristics, X_{jt} and Z_j, to service flows from the characteristics, d_j reflects the distance between residential property j and the arena, $1(t \geq Year)$ is an indicator variable equal to one the property transaction occurred after point in time when the teams arrived and 0 otherwise, θ reflects changes in the amenity value of the arena after team arrivals, and u_{jt} represents an unobserved equation error term that reflects other factors that affect transaction prices. Since we observe transaction prices before and after the arena was built and the teams arrived, this represents a difference-in-differences approach.

Repeat sales are dwellings for which multiple sales during the sample period are observed. For dwelling j sold in period s and again in period $s \leq t$, the price change across transactions is simply the difference of Equation (1)

$$\Delta p_{jt} = p_{jt} - p_{js} = \delta_t - \delta_s + f_{jt}(X_{jt}, Z_j, \beta_t) - f_{js}(X_{js}, Z_j, \beta_s) + d_j \times 1(t \geq Year > s) \times \theta + u_{jt} - u_{js}. \quad (2)$$

In Equation (2) $1(t \geq Year \geq s)$ is an indicator variable equal to one if the second observed sale occurred after a given team arrived and the first observed sale occurs before a given team arrived. This indicator function equals zero if both sales occurred before a given team arrived or if both sales occurred after a given team arrived. Repeat sales where $1(t \geq Year \geq s) = 1$ constitute the identifying sales in the data. These repeat transactions allow us to identify θ, the parameter of interest in a RSR.

RSR models can be used instead of HPMs like Equation (1) because the RSR approach eliminates the need to specify a specific functional form for the DDHPM as well as the need to collect data on property characteristics in X_{jt} and Z_j. These relaxed requirements are important because of the presence of difficult to quantify time-invariant factors affecting property values in the area near the arena. RSR model estimation requires only that

$$f_{jt}(X_{jt}, Z_j, \beta_t) - f_{js}(X_{js}, Z_j, \beta_s) = \omega_{jt}.$$

This is a simple functional form where ω_{jt} is a well-behaved random variable and $E[\omega_{jt}] = 0$. Estimation of unobservable parameters in Equation (2) proceeds using an unbalanced panel of residential transaction prices from Oklahoma City; some dwellings have multiple repeat sales but most have only one. Using differenced sales prices removes any unobserved time-invariant factors from u_{jt}.

The covariance matrix for Δu_{jt} is not diagonal. For dwellings with one repeat sale, Δu_{jt} contains unobserved factors associated with residence j and is assumed to be uncorrelated with all other $\Delta u_{k \neq jt}$s. Under these conditions, Δu_{jt}'s covariance matrix is a band matrix with non-zero values on the first off-diagonal. All RSR results reported here come from the ordinary least-squares estimator using the White-Huber correction on estimated standard errors.

Regardless of the estimator used, Equation (2) can be written

$$\Delta p_{jt} = p_{jt} - p_{js} = \delta_t - \delta_s + d_j \times 1(t \geq Year > s) \times \theta + \Delta u_{jt}. \quad (3)$$

Rewriting in this form highlights that price changes for residence j reflect market-wide changes in prices, distance to the arena, repeat sale timing, and an unobservable error term $\Delta u_{jt} = \omega_{jt} + u_{jt} - u_{js}$. Repeat sales when $1(t \geq Year > s) = 0$ represent sales where expected price appreciation is simply equal to market-wide changes over time: $\delta_t - \delta_s$. Excess price appreciation is captured by $d_j \times \theta$ for identifying sales.

4.2 Data

The data come from the Oklahoma County Assessor's office which collects comprehensive information on property transactions. We analyze only residential property – single family homes and condos – sales.

The street address for all transacted properties in the Assessor's office data were geocoded by latitude and longitude using the Google Maps API. We filtered the data to remove all transactions listing an LLC as buyer or seller to eliminate the sale of vacant properties, all transactions where the buyer and seller has the same last name to eliminate non-arms length transactions, and all repeat sales where the absolute value of the price change was greater than 100%. Following Linden and Rockoff (2008) we also trim the smallest and largest 1% of the transactions in the sample to remove the effects of outliers. The final data set contains all 106,828 residential property transactions in Oklahoma City over the period 1 December 2000 through 25 July 2016 within 10 miles of the arena location.

Geocoding the latitude and longitude of each transaction permits the estimation of the straight-line distance between the arena and each residential property in miles. To illustrate the geography of transactions we graph 20% of the transactions in the sample. Figure 1 shows the location of the arena as a black circle in the middle, and the location of transactions in the data set within 10 miles of the arena. The inner light gray circle identifies transactions within two miles from the arena, then the gray shading gets progressively darker for transactions within 3, 4, 5 and 10 miles of the arena. Transactions in Oklahoma City more than 10 miles from the arena were not included in the sample.

Figure 1: Arena and Property Sale Locations, 2000-2016

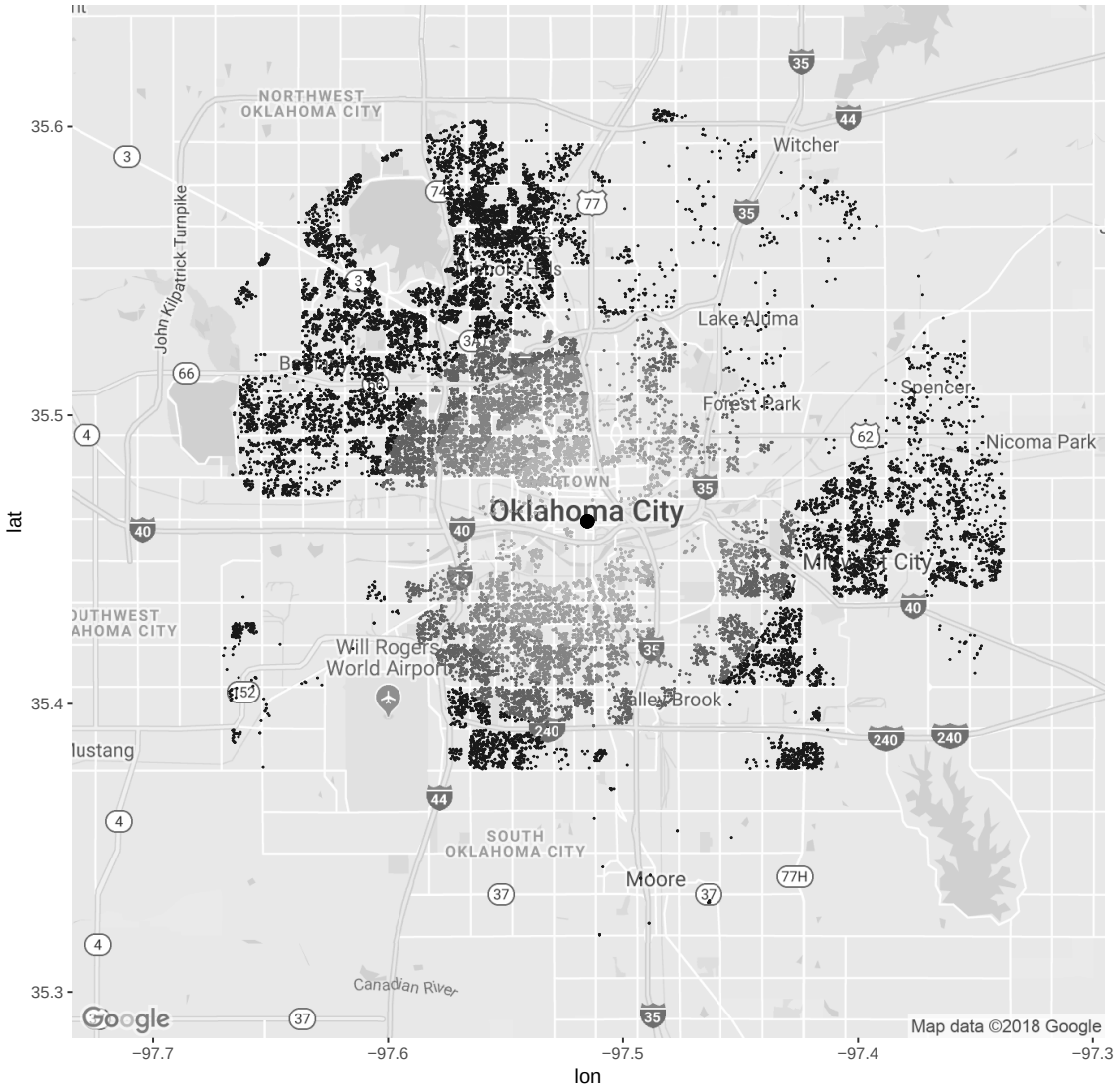


Table 1: Summary Statistics, Transactions within 10 Miles of the Arena

Variable	Mean	Std. Dev.	Min	Max
Sale Price (2016 dollars)	79,807	75,255	2,232	1,908,793
Square Footage	1,427.65	667.58	204	17,412
Post Arena Opening	0.857	0.350	0	1
Hornets	0.113	0.316	0	1
Thunder	0.426	0.495	0	1
Arena Proximity < 2 miles	0.039	0.195	0	1
Arena Proximity < 3 miles	0.136	0.343	0	1
Arena Proximity < 4 miles	0.296	0.456	0	1
Arena Proximity < 5 miles	0.479	0.500	0	1
Observations	106,828			

We restrict the impact area of arena-based amenities to properties within ten miles of the arena. Since the arena was used for concerts and minor league sporting events before the arrival of the two NBA teams, we assume that the arrival of the teams affected foot and car traffic near the arena on game day, including both positive and negative externalities generated by fans. Such externalities more likely affect properties near the arena; parked cars, crowds, trash, and noise tend to be concentrated there. Since these externalities increase in strength with proximity to the arena, we divide the sample into rings or donuts at two mile, three mile, four mile and five mile distances from the facility.

Table 1 contains summary statistics for the 106,828 residential property transactions in the sample. The sale price of each transaction was deflated to real 2016 dollars using the Consumer Price Index for All Urban Residents (CPI-U). The average sale price was $79,807 and the average transacted property had about 1,400 square feet of living space. Unfortunately, the Assessor's office data does not contain additional characteristics of the dwellings like the number of bedrooms and bathrooms, or indicators for dwelling types like detached single family homes or condos. However, square feet of living space is correlated with the number of bedrooms and bathrooms in a dwelling, and can also control for differences in dwelling type, since condos are generally smaller than single family homes.

The residential transactions data begin in 2000, the Chesapeake Energy Arena opened in June 2002, the Hornets played temporarily in the arena from November 2005 through April 2007, and the Thunder began play in the arena in October 2008. These events represent the points in time where we identify changes in the external amenities and disamenities generated by the arena and the games taking place in the arena. From Table 1 about 85% of the transactions occurred after the opening of the arena, about 11% occurred while the Hornets were playing in the arena, and about 43% occurred when the Thunder were playing in the arena.

From Figure 1, relatively few transactions occurred very close to the arena. The arena is located on the southern fringe of downtown Oklahoma City and the area south of the arena is an industrial area with many vacant lots, surface parking lots, and an interstate highway. From Table 1, only 3.9% of the transactions in the sample occurred within two miles of the arena. In practical terms, a two mile radius impact area provides relatively few transactions to analyze.

4.3 DDHPM Results

Table 2 contains the DDHPM results based on Equation (1) using the sample of residential property transaction prices within 10 miles of the arena over the period 2000 to 2016. We present DDHPM results primarily to demonstrate the superiority of the RSR results, which represent our preferred specification. The log of the transaction price is the dependent variable. Table 2 reports results for four different treatment areas around the arena: all transactions within two miles, all transactions within three miles, all transactions within four miles and all transactions within five miles. Each of these models is estimated separately and each model increases the treatment area for arena proximity.

Table 2: DDHPM Results - Transactions within 10 Miles of Arena

	Treatment Area			
	≤2 miles	≤3 miles	≤4 miles	≤5 miles
Log Square Footage	1.434***	1.399***	1.361***	1.318***
	(0.005)	(0.004)	(0.005)	(0.005)
Close to Arena	-0.515***	-0.560***	-0.404***	-0.314***
	(0.027)	(0.014)	(0.010)	(0.008)
Arena Opens	0.069***	0.067***	0.057***	0.055***
	(0.012)	(0.011)	(0.011)	(0.012)
Arena Opens × Close	0.027	0.060***	0.043***	0.026***
	(0.033)	(0.017)	(0.012)	(0.009)
Hornets in OKC	0.014	0.0148	0.023**	0.013
	(0.009)	(0.009)	(0.009)	(0.009)
Hornets in OKC × Close	-0.032	0.010	0.002	0.018
	(0.038)	(0.019)	(0.013)	(0.010)
Thunder Arrives	-0.011	-0.014	-0.014	0.003
	(0.015)	(0.014)	(0.014)	(0.014)
Thunder Arrives × Close	0.039	0.013	-0.001	-0.032***
	(0.028)	(0.014)	(0.010)	(0.008)
Observations	106,828	106,828	106,828	106,828
R-squared	0.560	0.591	0.588	0.579

Note: Robust standard errors in parentheses,*** p<0.01, **p <0.05

As expected, the parameter estimate on the dwelling size variable is positive and statistically different from zero. Larger dwellings sell for higher prices. Residential property near the arena sold at a substantial discount relative to residential property in the rest of Oklahoma City. Dwellings within two miles of the arena sell at a discount of -0.515 log points, about 50% less, relative to dwellings in the rest of Oklahoma City. The arena was built in an area with low housing prices. For the largest impact area, within five miles of the arena, the estimated coefficient drops to -0.314.

The DDHPM results on Table 2 contain three different difference-in-differences (DD) events: transactions close to the arena after the arena opened (Arena Opens × Close), transactions close to the arena while the Hornets played in the arena (Hornets on OKC × close), and transactions close to the arena after the Thunder arrived in Oklahoma to play in the arena (Thunder Arrives × Close). The parameters on these three variables, the parameters of interest, reflect the impact of each event on nearby residential property prices.

From Table 2, the opening of the arena increased nearby residential home prices, but the temporary move of the Hornets and the arrival of the Thunder had little impact. The results show that the opening of the arena increased prices in the three largest treatment areas by between 0.06 log points (0.06%) and 0.043 log points (0.04%). The estimated impact declines as the treatment area gets larger. Again, this can be interpreted as an increase in the amenities generated by the arena location after the opening of the arena compared to before, perhaps due to access to the events held in the arena or gentrification due to the presence of the arena. Recall that dwellings within two miles of the arena sold for prices substantially below the average price in Oklahoma City, so the increase in prices of nearby homes did not raise them above the average across the rest of the city.

The temporary arrival of the New Orleans Hornets and the permanent arrival of the Thunder had no effect on nearby local residential property values. The Hornets were clearly not making a permanent move to the city which likely explains the lack of impact on local residential property values. This result suggests that the impact of a professional sports team playing games in an arena on nearby property values may stem from factors unrelated to the actual playing of games, which include crowds of fans and traffic. Hornets games were being played in the arena over the period November 2005 through April 2007 and Thunder games after October 2008 but the playing of games appears to have had no impact on local real estate prices.

4.4 RSR Model Results

The DDHPM results may suffer from some econometric problems, most notably the presence of unobservable property-specific and neighborhood-specific factors correlated with the treatments. Repeat sale regression models represent one way to address the presence of unobservable property-specific characteristics in econometric analysis of residential real estate price data. RSR models use multiple observations for the same dwellings to eliminate the impact of time-invariant unobservable factors. Of course some dwelling characteristics can change between repeat sales, and renovated houses may be more likely to resell in any given time period, which would be a source of mis-specification in RSR models (Billings, 2015).

The number of repeated observations represents one key to implementing RSR models. Table 3 shows the number of repeat sales that identify each of the three arena-related events in the sample (opening, Hornets tenure, and arrival of the Thunder) for each treatment area. Identifying repeat sales represent dwellings that sell before and after one of the events. Repeat sales occurring in the same time bin cannot identify the impact of team arrivals. They effectively represent the control group in RSR models.

As expected, relatively few identifying transactions exist in the treatment area defined as transactions within two miles of the arena, since few houses exist in that small area. The other treatment areas contain relatively large numbers of repeat sales of the same dwelling. This should provide enough variation in repeat sales to identify the effect of the arena-related events in this sample.

Table 3: Number of Identifying Sales

Distance	Arena Opens	Hornets in OKC	Thunder Arrive
2 miles	289	352	562
3 miles	918	1,194	1,895
4 miles	2,137	2,627	4,305
5 miles	3,609	4,225	7,030
10 miles	7,896	8,641	15,385
Total Repeat Sales	41,701		

Table 4 shows results from estimating Equation (2) using repeat sales in the Oklahoma City data. RSR models do not include property characteristics like square footage, since the effect of these time-invariant characteristics on prices are differenced out. The effects of all unobservable time-invariant local factors are also differenced out.

The results on Table 4 generally resemble those from the DDHPM reported on Table 2 in terms of the opening of the arena. Residential property prices increased near the arena after opening and the impact diminishes as the impact area increases in size. The impact of the Thunder on nearby property values is also positive for three of the treatment areas. But this is not uniform, and the estimated effect is negative when the treatment area expands to include all transactions within five miles of the arena. This could reflect the idea that the five mile treatment area is too large and reflects the impact of other factors affecting the Oklahoma City real estate market after the Thunder moved to town.

RSR model results on Table 4 also reveal a positive effect of the Hornets during their temporary stay in the city from late 2005 through April 2007. However, this positive impact only appears in the larger treatment areas (within 3, 4, and 5 miles). These results may reflect broader market-wide increases during the period the Hornets played in the city, and not the effect of the games. Or the lack of an estimated effect in the two mile treatment area may reflect the small number of identifying transactions in that area.

The results from the RSR model confirm the results from the DDHPM specification shown on Table 2 for the arena opening and also indicate that the presence of NBA teams in the city increased nearby property values. The building of a new arena, and the attraction of an NBA team to Oklahoma City both increased property values in a relatively large area downtown. The strongest impact generally occurs in treatment areas closest to the arena and dissipates across larger treatment areas. These results likely reflect important positive amenity values flowing from the arena, and the games played by the teams in the arena, and impacting nearby residential property values. These amenity values could take the form of increased

Table 4: Repeat Sales Regression Results - Transactions within 10 Miles of the Arena

	2 miles	3 miles	4 miles	5 miles
Arena Opens	0.0057	0.002	-0.001	-0.0039
	(0.006)	(0.006)	(0.006)	(0.007)
Arena Opens × Close	0.065***	0.039***	0.027***	0.020***
	(0.020)	(0.011)	(0.006)	(0.005)
Hornets	0.016***	0.013***	0.009**	0.005
	(0.004)	(0.004)	(0.004)	(0.005)
Hornets in OKC × Close	0.009	0.024**	0.022***	0.023***
	(0.0179)	(0.010)	(0.006)	(0.005)
Thunder Arrive	-0.001	-0.011	-0.013**	-0.004
	(0.0065)	(0.0065)	(0.0065)	(0.0066)
Thunder Arrive × Close	0.039***	0.018**	0.015***	-0.010**
	(0.015)	(0.008)	(0.005)	(0.004)

Note: Robust standard errors in parentheses,*** p<0.01, **p <0.05

civic pride and an enhanced local image attributable to a major sporting venue and high-profile professional sports team in the city. They could also reflect gentrification of the neighborhood following the arrival of the teams. Since the opening of the arena generated increases in local residential property values independent of the presence of a team, some of the amenity values appear to be unrelated to the playing of NBA games in the arena alone.

Note that the estimated size of the impact of a new arena on Table 4 is substantially smaller than the DDHPM results on Table 2. For example, the effect of the opening of the new arena on property values within two miles falls from 14.5% to 7.7%. Effect sizes near 15% appear implausibly large in the context of the existing literature on positive and negative shocks to residential property prices. The DDHPM results likely reflect unobservable property-specific and neighborhood-specific factors that hedonic price models cannot adequately account for. The RSM approach addresses this limitation and represents our preferred model specification.

As a robustness check, we re-estimated the DDHPM and RSR models using a sub-sample that also dropped all transactions involving LLCs and between buyers and sellers with the same last name. This should remove un-occupied dwellings and within-family sales from the sample. We also dropped all repeat sale transactions with absolute price change greater than 100%. This dropped about 3,000 transactions from the samples. The results were nearly identical to those on Table 2 and Table 4 with respect to estimated parameter signs and significance.

5 Conclusions

Understanding the dimensions of local amenity flows generated by sports facilities and the playing of games in these facilities, and the associated impact of these amenity flows on local property values, represents an important component for developing effective local economic development policies. New professional sports facilities and teams often represent key elements in local redevelopment plans, and local government frequently subsidizes the construction of new sports facilities. These subsidies often take the form of Tax Increment Financing (TIF) districts located around the new facilities, further highlighting the importance of understanding how new sports facilities and teams affect nearby property values.

Tension exists in the literature. Some studies find increases in residential property values following the opening of a new sports facility (Tu, 2005; Ahlfeldt and Maennig, 2009, 2010; Ahlfeldt and Kavetsos, 2014) suggesting important local amenity flows while other studies (Humphreys and Nowak, 2017) find increases in residential property values following the *departure* of teams from a city, suggesting important local disamenity flows. Since research in this area consists of case studies from one or two cities, new sources of shocks to local sports-related amenity or disamenity flows need to be analyzed to move the literature forward.

This paper focuses on a novel set of shocks to the professional sports environment in Oklahoma City to help disentangle the effect of a facility from the effect of NBA games played in that facility. The evidence suggests that the presence of an arena and both a permanent and temporary NBA team amenity flows in nearby areas. Civic pride, "world class city" status, and other intangible factors represent the most likely source of these amenity flows. Arena-related gentrification could also generate these increases in property values. Evidence using stated preference data and the Contingent Valuation Method also finds strong evidence that the presence of a professional sports facility and team in a city generate important intangible benefits (Johnson et al., 2001, 2007; Fenn and Crooker, 2009). Patterns in voting on sports facility subsidy referendums also support the presence of local intangible benefits (Coates and Humphreys, 2006; Horn et al., 2015).

The results show that both a new arena and the arrival of a permanent and a temporary NBA team generated increases in local residential real estate prices. The strongest impact occurred relatively near the arena in treatment areas of between two and four miles out. The impact of temporary games played by an NBA team relocated to the city because of a natural disaster also generated amenity flows and property value increases. Increases in residential property values benefit home owners, but could generate economic harm to renters if rents increase because of the increase in property values. The limited impact area of this increase in residential property values argues for the use of relatively small TIF districts to finance those new facilities that must be subsidized.

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