UNIVERSITY OF ALBERTA
FACULTY OF ARTS
Department of Economics

Working Paper No. 2012-05

Do New Sports Facilities Revitalize Urban Neighborhoods? Evidence from Residential Mortgage Applications

Haifang Huang
University of Alberta

Brad Humphreys
University of Alberta

March 2012

Do New Sports Facilities Revitalize Urban Neighborhoods? Evidence from Residential Mortgage Applications*

Haifang Huang
Department of Economics
University of Alberta

Brad R. Humphreys
Department of Economics
University of Alberta

March 20, 2012

Abstract

Using data from 56 professional sports facilities opened between 1995 and 2008, we find what at first appears to be a substantial neighborhood revitalization effect: the opening of a facility is associated with an increase in mortgage applications to purchase homes located in the neighborhood of about 20%, compared to those in the rest of the metropolitan area. A closer examination shows that much of the differential is due to the non-randomness of facility location. The new facilities locate in poor urban areas, which grew faster over the sample period even if they were not near a new facility, perhaps because of increasing access to mortgage credit by low-income urban populations. Based on a series of regressions using census-tract level data, we find that conditioning on local income and poverty rates, under which poorer census tracts grow faster regardless of their locations, reduces the "revitalization" effect by more than a half, suggesting that characteristics of locations drive much the increase on mortgage applications associated with new sports facilities.

Keywords: sports facilities, urban redevelopment, residential mortgage applications
JEL Codes: R21, R23, R38, O18, L83

*Huang: 8-14 Tory, Edmonton, AB T6G 2H4 Canada; email: haifang.huang@ualberta.ca; phone: 780-492-1323. Humphreys: 8-14 Tory, Edmonton, AB T6G 2H4 Canada; email: brad.humphreys@ualberta.ca; phone: 780-492-5143.

1 Introduction

North America experienced a boom in the construction of new professional sports stadiums and arenas over the past 20 years. Long (2012) reports that 104 new stadiums and arenas were built between 1990 and 2010, compared to just 130 new stadiums and arenas built from 1900 through 1989. Long (2012) estimates that public financing accounted for about 59% of the spending on these 104 new sports facilities, an estimated $22.3 billion in 2010 dollars. Of course much of the economic activity that takes place in these venues benefits the owners, players, and fans of the teams that play in the facilities.

What economic justification exists for this sizable public subsidy for a private economic activity? Up until the mid 1990s, tangible economic benefits, in the form of new jobs, increases in local income, and more tax revenues, represented the primary justification for the public subsidies for the construction of new professional sports facilities. However, a mounting body of scholarly evidence refuting the generation of tangible new economic benefits by professional sports teams and facilities eroded confidence in this justification (Coates, 2007). By the late 2000s, proponents of subsidies for the construction of new professional sports facilities turned to a new justification: urban revitalization. Although sports facilities do not appear to generate new economic activity, the do have the ability to concentrate existing economic activity, both spatially in and around the facility, and temporally, on the day of events in the facility. Across North America after the turn of the century, new stadiums and arenas were trumpeted as the key centerpiece of downtown economic revitalization projects in cities like San Diego (Petco Park), Detroit (Ford Field), Pittsburgh (Heinz Field, PNC Park), and Columbus (Nationwide Arena). Rosentraub (2009) discusses several of these facilities in the context of urban revitalization policy. In this paradigm, rather than create new economic activity, new sports facilities reverse consumer flight to the suburbs, bring large numbers of consumers back to specific locations, typically downtown, on nights and weekends, and possibly induce some people to move back to the urban core. The economic activity at sports facilities generates spill over economic benefits, as new bars, restaurants, and shops co-locate with the sports facility. By proposing urban revitalization, and not tangible economic benefits, as the justification for subsidies, proponents of these subsidies shifted the focus of the debate away from the trinity of "new jobs, higher income, and more tax revenues" that had been refuted by academic research, to an area where little scholarly research existed, and benefits are more difficult to measure.

At about this time, economic research began to focus on the relationship between professional sports facilities and less tangible, as well as intangible economic impacts. In one branch, researchers used the contingent valuation method (CVM) to assess the value of the intangible benefits generated by sports facilities and mega-events using the stated preference approach (Johnson and Whitehead, 2000; Johnson et al., 2001, 2006; Fenn and Crooker, 2009; Süssmuth et al., 2010; Castellanos et al., 2011). These papers generally find CVM estimates of the intangible benefits generated by professional sports teams and facilities smaller than the subsidies provided for these facilities and events. A second branch examines the effect of professional sports facilities on housing values and rents (Carlino and Coulson, 2004; Tu, 2005; Dehring et al., 2007; Feng and Humphreys, 2007;

Dehring et al., 2008; Feng and Humphreys, 2008; Ahlfeldt and Maennig, 2009, 2010; Ahlfeldt and Kavetsos, 2011; Coates and Matheson, 2011). This literature contains mixed support for the hypothesis that professional sports facilities increase the value of residential properties in nearby areas. Increasing property values near sports facilities can be interpreted as evidence supporting urban revitalization, although it could reflect other factors. We extend this branch of the literature by examining the relationship between the opening of a new sports facility and applications for residential mortgages in nearby areas, exploiting both the timing and location of new sports facilities to estimate a difference-in-difference model (Imbens and Wooldridge, 2009).

In particular, we investigate the existence of urban neighborhood revitalization effects from professional sports facilities that were opened in the US between 1995 and 2008. A large number of new professional sports arenas and stadiums opened over this period, providing considerable cross-sectional variation in both location and neighborhood characteristics. Using data on the location and date of new sports facilities, we examine the relationship between these openings and the volume of new residential mortgage applications in census tracts within 2 or 3 miles of the new facility. We posit that a significant neighborhood revitalization effect can be proxied by increases in residential mortgage applications. We find evidence of a substantial neighborhood revitalization effect: the opening of a new sports facility is associated with an increase in residential mortgage applications in the area of the new facility, compared to applications in the rest of the metropolitan area. The average growth difference is about 20 percent. This result provides an explanation for why property values increase in proximity to professional sports facilities: these facilities increase demand for residential housing in the area. We also find that the new sports facilities tended to be located in areas with a lower household income, higher fraction of renter occupied housing, and larger fraction of the population living below the poverty line. This suggests the possibility that stadium location decisions in this period were made in order to revitalize urban areas. We also show that other similar areas that did not get new sports facilities also experienced higher than average growth in home mortgage applications, suggesting that some of the redevelopment in areas with new sports facilities would have take place in the absence of a new sports facility.

2 The importance of sports facilities for urban redevelopment

Much of the literature on the relationship between the opening of new professional sports facilities and residential housing values estimate hedonic housing price models, and use models of urban amenities (Roback, 1982) to motivate the empirical analysis. Recent research formally links urban amenities and urban growth. Professional sports facilities can be considered a type of two urban amenities identified by Glaeser et al. (2001) as drivers of urban growth: the availability of a wide variety of consumer goods and an aesthetically pleasing physical environment; major league baseball teams are identified as a consumption good found only in cities that enhance consumer welfare. In the context of the spatial equilibrium models discussed by Glaeser and Gottleib (2008), professional sports facilities could generate agglomeration effects through the increased consumer presence in these facilities on game day. Glaeser and Gottlieb (2006) pointed out the importance of the availability of variety in consumer services available in cities, including entertainment services, in explaining the resurgence of cities since about 1980. Glaeser et al. (2001) investigated the role played by consumer amenities in explaining urban growth since 1977, and identified the presence of live performance venues and restaurants as key consumer amenities. Professional sports facilities, the co-located bars and restaurants around these facilities, are one type of consumer service that could drive urban revitalization in this context. Clearly, the spatial equilibrium models that underly much of this research predict that increased demand for residential housing would follow the introduction of an urban amenity like a new sports facility in an area.

Humphreys and Zhou (2012) develop a model of the effect of a new sports facility on an urban economy. The model takes into account the location of the facility, agglomeration effects in the form of co-location of other service producers like bars and restaurants, the presence of other service producing firms, and locational decisions made by residents of the city. This model predicts that some consumers will move to the area near the sports facility in order to take advantage of the increased variety of service producing firms that co-locate with the sports facility.

Both the spatial equilibrium models in the new urban growth literature, and the agglomeration effects model developed by Humphreys and Zhou (2012), predict that the opening of a new sports facility could increase both demand for residential housing near the facility and residential property values. The driving force behind the increase in demand for residential housing is the attractiveness of the urban amenity, the sports facility in this case, and the other related service producers that co-locate with the facility.

The proponents of subsidies for the construction of professional sports facilities often simply assert that a new facility will revitalize the urban neighborhood where the facility is built. Unlike previous claims about the effect of new sports facilities on metropolitan employment and income that were backed up with evidence from regional input-output models that assumed a widespread impact and refuted using metropolitan-level employment and income data, claims about urban revitalization are more difficult to assess for several reasons. First, the claimed benefits are local, and not spread over the entire metropolitan area. Empirically assessing claims of sports facility led urban revitalization requires data at the sub-metropolitan area. The standard regional accounts data, like the Regional Economic Information System published by the US Department of Commerce, Bureau of Economic Analysis, are not available for geographical units smaller than the county, which is probably too large to identify the revitalization of a specific neighborhood. Second, urban revitalization is a difficult concept to quantify, when compared to previous claims about tangible economic benefits that often took the form "a new stadium will create X thousand new jobs in the city." Urban revitalization, in a sense, is like beauty - it's in the eye of the beholder.

As empirical analysis of the ability for a new sports facility to revitalize a specific urban area must use data available at a relatively disaggregated spatial level that can also be plausibly linked to urban redevelopment. The literature on property values mentioned above represents one possible avenue of research. Previous research in this area has used data on the assessed or market value of individual residential properties, or housing values at the census block group. However, analysis of housing data requires detailed data that are typically available for only one city or area and also entails accounting for spatial autocorrelation. Most of the studies cited above are case studies of a single city and sports facility, and most do not account for spatial autocorrelation.

We take a different, but related approach. We analyze the determinants of residential mortgage applications. The residential mortgage application data were collected as part of the Home Mortgage Disclosure Act (HMDA), which requires mortgage lending institutions to report on the characteristics of residential mortgages they originate or purchase. Since 1990, detailed information about the location of the properties, the characteristics of the applicants, and the disposition of applications have been reported and disseminated. Annual data on residential mortgage applications are available at the census tract level for most US cities. The HDMA also has an extensive coverage, mandating reports from a large number of lenders. Avery et al. (2007) suggested that these lenders together account for about 80 percent of home lending nationwide. Recent research using HMDA mortgage application data include Munnell et al. (1996), Mian and Sufi (2009), Goodman and Smith (2010), and Hanson et al. (2012). The HDMA data are available for census tracts in all US cities, so analysis of these data is not limited to a specific metropolitan area, generating considerable cross-sectional variation.

We posit that the number of home-purchase mortgage applications in an urban area reflects urban revitalization, as it indicates interest in residential property in the area. A revitalized neighborhood may include construction of new residential housing, and the new retail establishments, bars and restaurants, and other amenities may attract new residents to the area. Home-purchase loans can be used either for newly-constructed residences or for existing units. The HMDA reports do not provide information to differentiate the two. But a rising trade volume of either type would indicate a booming housing market, as there is a well-documented and positive relation between the intensity of trading activity and the growth in house prices. Examples include Stein (1995) and Berkovec and Goodman (1996) at the U.S. national level and Clayton et al. (2010) at the U.S. metropolitan level. Both Berkovec and Goodman (1996) and Clayton et al. (2010) use the turnover of existing homes to measure trading activity.

We also attempt to disentangle the potential revitalization effect of new sports facilities from an alternative explanation based on the increased availability of mortgage credit to residents of low-income neighborhoods. The new facilities in our sample tend to locate in poorer and more densely populated urban areas that have large minority populations. Such areas coincidentally experienced increases in mortgage availability over much of the sample period. The drastic manifestation of the phenomenon was the subprime mortgage expansion leading to the 2007 housing crisis. But significant policy tools were used to increase the provision of mortgage credit to low-income borrowers since the mid 1990s.[1] Low-income and minority populations appear to have gained a better accesses to mortgage credit during this period. According to a report by the *New York Times* based

[1]In 1996, the US Department of Housing and Urban Development gave Fannie Mae and Freddie Mac an explicit target on how much of their mortgage financing had to serve low and moderate income borrowers. The target was raised twice in later years. See Mian et al. (2010) for a discussion on US public policy and subprime mortgages.

on home ownership statistics from the Census Bureau, the US home ownership rate increased from 64% in 1994 to near 68% in 2001, with black and Hispanic home ownership rising faster than the country as a whole.[2] The phenomenon became more prominent in the peak of the subprime boom. As reported in Mian and Sufi (2009), *subprime* ZIP codes, defined as those in the top quartile of the distribution in terms of the fraction of borrowers with a low credit score in 1996, experienced a growth in mortgage credit more than twice as high as that in *prime* ZIP codes (those in the bottom quartile). Huang and Tang (2012) reported that the mortgage rejection rate in 1996 predicted later housing price booms, and subsequent busts, especially in cities that are more constrained in residential building. In summary, new sports facilities tend to locate in poorer areas, and these areas gained better access to mortgage credit over a majority of the sample period. This gives rise to a possible spurious correlation between new sports facility openings and increases in mortgage applications. Our analysis uses a regression approach to take into account the non-randomness of facility location.

3 Empirical analysis of residential mortgage applications

Our empirical approach is based on a standard difference-in-difference model. We ask whether the area neighboring a new stadium experienced greater increases in mortgage applications relative to further-away areas in the same metropolitan area over the same period. We divide metropolitan areas into two groups. The first group, which we call the treatment area, include census tracts whose population centroid is within a short distance, 2 or 3 miles, of a new sports facility. The second group, which we call the control area, includes census tracts in the rest of the metropolitan area. After identifying the treatment and control areas from the exact latitude and longitude of new sports facilities and the centroid of census tracts, we compare them in terms of changes in residential mortgage applications three years before the opening of the facility to three years after the opening. We ask whether there is a positive effect of new sports facilities in the treatment area, that the applications for residential mortgages in the treatment area increase by more than those in the control area in the period after the opening of a new sports facility.

Note that we adopt the terminology from standard difference-in-difference analysis but recognize that this application differs from the assumptions underlying difference-in-difference analysis in a very important way: in this case, the treatment is clearly **not** based on random assignment. Planners and other economic decision makers in metropolitan areas do not randomly locate new sports facilities. We cannot attribute increases in residential mortgage applications in nearby census tracts after a new sports facility opens to a causal relationship in this case. We use this terminology, where census tracts containing a new sports facility and located within two or three miles are called the "treatment" area and census tracts farther away from the facility but in the same metropolitan area are called the "control" area, as a matter of convenience. As stated earlier, we also recognize that the estimates of the magnitude of the treatment will be affected by the characteristics of the

[2] *The New York Times*, "Building Flawed American Dreams" By David Streitfeld and Gretchen Morgenson, October 18, 2008.

area where the new facility is located. In particular, we recognize that the estimated effect in the treatment area will be biased up if new facilities are located in areas that would have experienced higher than average growth in residential mortgage applications absent the new facility. To better address the problem, we will undertake an analysis that takes into account the characteristics of the areas where new facilities were built, which will allow us to assess the impact of these factors on the estimated effect of new sports facilities in the treatment area. But we do not have an instrument that would completely solve this econometric problem. Throughout the paper, we strive to point out the appropriate caveats associated with this issue. Despite this problem, we believe that this analysis can tell us something interesting and important about the relationship between new sports facilities and urban redevelopment, as reflected in housing markets.

The analysis proceeds in two steps. First we perform a difference-in-difference analysis of residential mortgage applications in the treatment and control areas. Second, we undertake a regression analysis to determine the extent to which the treatment areas in the sample reflect selection on unobservables. New sports facilities are not located randomly in metropolitan areas; the site selection may reflect policy objectives like urban revitalization. In addition, neighborhoods suitable for new sports facilities might also have characteristics that would lead to increases in residential mortgage applications over time even if the new facility was not located there. For example, access to residential mortgages increased over most of our sample period among low income and minority borrowers, so areas with many low income and minority residents would have experienced increases in residential mortgage application no matter what treatment occurred in the area. A failure to take this into account will bias the estimated effect in the treatment area up. We use a regression model to assess the effect of census tract characteristics on the estimated effect in the treatment area. Specifically, we assess the extent of this bias by comparing the estimated effects before and after controlling for census tract-specific socioeconomic information.

3.1 Data description

More than one hundred new sports facilities opened in North America over the period 1990 to 2010. 72 of these facilities opened in the 1995 to 2008 period that makes up our sample period. 21 of those new facilities were home to only a National Football League (NFL) team, 16 of were home to only a Major League Baseball (MLB) team, 11 were home to only a National Hockey League (NHL) team, 12 were home to only a National Basketball Association (NBA) team. The rest were home to multiple professional sport teams. For each of these facilities, we determined the longitude ad latitude of their locations and the dates of opening. Our analysis uses data from stadiums and arenas that opened between 1995 and 2008 in the US, because we need mortgage application data three years before and three years after the opening the econometric analysis. The sample for our mortgage data thus begins in 1992 and ends in 2010.[3] We omitted all facilities opened in Canada

[3]The 1990 and 1991 HMDA reports are available as well. But 1992 is the year when the HMDA adopted the census tract definition used in the 1990 Census. The 1990 and 1991 HMDA reports contain the census tract ID, but the total number of tracts in 1991 is 10% smaller than those in the 1992 report. In addition, the correlation coefficient between the 1991 mortgage applications by census tract and the 1992 numbers is 0.58, while that between

and those that were home to a Major League Soccer (MLS) team.[4] Table 1 lists the 56 facilities in the sample, the teams that played in the facility, the metropolitan area, and the year the facility opened.

Again, the numbers of home-purchase mortgage applications by census tract come from the annual reports submitted by mortgage lenders to federal regulators under the Home Mortgage Disclosure Act (HMDA). The home-purchase loans can be used for newly-constructed residences or for existing residences; the residences include single family homes, multi-family dwellings, as well as individual condominium or cooperative units in multi-unit structures.[5] We include applications for loans insured by government agencies, such as the Federal Housing Administration (FHA) and Veterans Administration (VA), as well as loans that are not insured by the government. The HMDA reports are publicly available.[6]

Census tracts are "small, relatively permanent geographic entities within counties ... [generally having] between 2,500 and 8,000 residents" (Geographic Areas Reference Manual, US Census Bureau). We use the population centroid of each census tract to determine if a property is located near a new sports facility. For this purpose we calculate the distance between stadiums and census tracts using longitude and latitude information. The Census Bureau provides its estimate of population centroid online based on the Census-2000 population counts. We use a two-mile radius from the stadium, and a three-mile radius as a robustness check, to allocate census tracts into a treatment area and a control area: those that have a population centroid within the two or three mile radius belong to the treatment area; those outside the two or three mile radius belong to the control area. Table 2 shows the total number of census tracts in each metropolitan area and the number in the treatment group for each radius. Note that only four of the facilities, the BankAtlantic Center (NHL Florida Panthers), the RBC Center (NHL Carolina Hurricanes), Gillette Stadium (NFL New England Patriots), and the University of Phoenix Stadium (NFL Arizona Cardinals) have fewer than 10 census tracts within 3 miles. Overall, the average number of census tracts in a metropolitan area in the sample is 819, an average of 24 census tracts are within a 2-mile radius, and an average of 49 within a 3-mile radius. If we define the treatment area with a 2-mile radius, the average treatment area includes about 3% of the census tracts in the metropolitan area. The 3-mile radius treatment area contains about 6% of the census tracts.

the 1992 and the 1993 reports is 0.92. It is thus clear that 1992 is the beginning of a consistent area definition in the data. For this reason, we begin our mortgage application data in 1992. The year 2010, on the other hand, is the latest available as of early 2012.

[4]Note that EverBank Field, the NFL stadium in Jacksonville, appears in the sample. Technically, this stadium contains some parts of the Gator Bowl, which was built in 1982. But the renovations to this facility that took place before the arrival of the Jacksonville Jaguars was extensive, and we treat this as a new facility.

[5]We use the what the HMDA calls "one-to-four-family dwellings," which actually includes not just one-to-four-family dwellings, but also individual condominium or cooperative units "even if the unit is located in a structure that houses five or more families" (See for example page 27 of the 2003 *A GUIDE TO HMDA Reporting: Getting It Right!*).

[6]For the years after 2003, we aggregate the application counts to census tract using the *HMDA Loan Application Register* (LAR), a loan-level database. For the years between 1992 and 2002, we used already-aggregated statistics from the *HMDA Aggregate Tables Print Image Files*. Some of the recent HMDA data are available online. The rest is available from the National Technical Information Service, US Department of Commerce.

The Census Bureau updates census tract area definitions between censuses to reflect population dynamics; the revision "often involve[s] the subdivision of an existing census tract (or census tracts) into two or more new units." Our mortgage data covers the period from 1992 to 2010 and thus encompasses one revision in the census tract area definitions. The Census Bureau provides a between-census geographic relationship crosswalk file covering the entire universe of census tracts. We use the relationship file to reconstruct, when necessary, the population centroid and mortgage counts to the 1990-Census definition. We use the 1990 definition because most of our mortgage data (those between 1992 and 2002) uses this definition. We use the Census-2000 resident population as weights in the reconstruction process, because that year is roughly the midpoint of the sample period for our mortgage data (from 1992 to 2010).

The following example illustrates the construction of the data set. Lincoln Financial Field (located at $39°54'3''N$ latitude and $75°10'3''W$ longitude), home of the Philadelphia Eagles of the NFL, opened in 2003 in Philadelphia, Pennsylvania. The facility is located in the Philadelphia-Wilmington-Atlantic City Combined Metropolitan Statistical Area (CMSA) in the 2000 Census. For each individual census tract in this CMSA, we calculated the straight-line distance between its population centroid and Lincoln Financial Field. We then use the distance information to allocate census tracts to the treatment and control areas. The treatment area includes 14 census tracts within a 2-mile radius and 43 census tracts within a 3-mile radius,) of the facility. The control area includes the rest of the 1519 census tracts in Philadelphia-Wilmington-Atlantic City CMSA. The stadium was opened in 2003; we thus use the average annual volume of residential mortgage applications between 2000 and 2002 as the before-opening application volume. The after-opening volume is the average between 2003 and 2005. We repeat the procedure for all other facilities in the sample. We then merge the residential mortgage application data into the sample.

3.2 Difference-in-difference analysis

We first examine the changes in residential mortgage applications before and after the opening of a new sports facility in each metropolitan area in the sample based on a standard difference-in-difference approach. Using the notation in Imbens and Wooldridge (2009), we have data for $i = 1, 2 \ldots N$ groups of census tracts. Building a new sports facility in or near a neighborhood represents the treatment in this case. Let G_i identify groups of census tracts where $G_i = 1$ identifies those that receive the treatment and $G_i = 0$ those that did not. The housing-market outcomes, in terms of the number of residential mortgage applications, are observed two time periods, $T_i \epsilon 0, 1$ where $T_i = 0$ is the pre-treatment period and $T_i = 1$ the post-treatment period. The outcome in the absence of the treatment is $Y_i(0)$ and under the assumption of an additive treatment, the outcome in areas in the treatment group is $Y_i(1) = Y_i(0) + \tau_{did}$, where τ_{did} is the effect of the treatment on the outcome. Imbens and Wooldridge (2009) show that the estimator for this set up is

$$\tau_{did} = (E[Y_i|G_i = 1, T_i = 1] - E[Y_i|G_i = 1, T_i = 0]) - (E[Y_i|G_i = 0, T_i = 1] - E[Y_i|G_i = 0, T_i = 0]).$$

In other words, the effect in the treatment area can be estimated by comparing the average difference in the outcome over time in the treatment group to the average difference in the outcome over time in the control group. This procedure removes any bias in the estimate of the effect in the treatment area associated with a common trend over time that is not associated with the treatment. It also controls for time-invariant metropolitan specific fixed effects. For a sample of data, the estimator is

$$\hat{\tau}_{did} = (\overline{Y}_{11} - \overline{Y}_{10}) - (\overline{Y}_{01} - \overline{Y}_{00}) \tag{1}$$

where $\overline{Y}_{gt}$ is the average outcome in group g in period t. This approach assesses housing market outcomes for each new facility, while still controlling for local housing market trends common to the control and treatment areas.

Table 3 contains details about the estimation of the average effect of a new sports facility in the treatment area using Equation (1). The table shows the the level and percent change of residential mortgage applications in the 2 mile treatment area and control areas for each facility in the sample. For each of the 56 new sports facilities, we aggregate the number of residential mortgage applications at the census-tract level to the level of control and treatment areas and calculate the percentage change in the aggregate area-wide applications from the three years before each facility opened to the three years after. The columns headed "Before" reports the average annual number of residential mortgage applications over the three-year period before the opening of a new facility. The columns headed "After" reports the annual average in the three-year period after the opening. The columns headed "% change" shows the percentage change in residential mortgage applications in that area, which simply scales $\overline{Y}_{g1} - \overline{Y}_{g0}$ in Equation (1) by $\frac{100}{\overline{Y}_{g0}}$. The column headed "% $\Delta_{Treatment}$ - % $\Delta_{Control}$" reports the difference, in percentage points, between the percent change in the two areas. Note that the control area is much larger in terms of absolute volume of residential mortgage applications, as the control area contains the rest of the metropolitan area. We perform these calculations for the treatment area and the control area separately. Our interest is on the treatment-control difference in the percent change in residential mortgage applications; A positive value indicates that residential mortgage applications in the treatment area grew faster than in the control are in the years around the opening of a new sports facility. Table 4 reports the same set of statistics for the bigger 3 mile treatment area. Our preferred definition of neighboring areas are the ones defined by the 2-mile radius. But the treatment groups under this definition cover a small proportion of census tracts (3% to be precise). The greater radius doubles the size of the treatment group. We use the 3-mile radius as a robustness test. Estimates of $\hat{\tau}_{did}$, scaled to percent changes, can be found at the bottom of Tables 3 and 4 and on Figures 1 and 2 as the sample average.

From the top line of Table 3, in the three years before the TD Garden, home of the NBA Celtics and NHL Bruins, opened there were an average of 1,406 new residential mortgage applications per year in the 54 census tracts within 2 miles of the stadium, and in the three years after the stadium opened there were an average of 2,299 new residential mortgage applications per year, an increase of 64%. In the 1,123 census tracts more than 2 miles from the new stadium in the Boston-Worcester-

Lawrence metropolitan area over that period, there were an average of 55,625 new residential mortgage applications per year, and in the three years after the new stadium opened, there were an average of 74,021 new residential mortgage applications, an increase of 33%. From the last column, new residential mortgage applications grew by 30 percentage points more in the treatment area than in the control area during the later period. We can derive the growth differences for all other facilities in a similar manner.

Before we discuss the growth differences in detail, note that the estimated difference in growth rates reported on Tables 3 and 4 represents a strictly same-area-same-period comparison. The difference-in-difference procedure removes all unobservable time invariant factors that affected residential mortgage applications in all census tracts, and all local trends in residential mortgage applications in a metropolitan area with a new sports facility. Such common elements include national or metropolitan area-wide business cycle effects, as well as changes in mortgage interest rates, lending practices, and local housing market conditions. It also removes the substantial growth heterogeneity across metropolitan areas. For example, the greater Los Angeles metropolitan area over the period 1997-2001 (when the Staples Center opened) grew much faster than the Cleveland metropolitan area over the same period (when the Cleveland Browns Stadium opened). This difference in metropolitan area growth trends does not contribute to the difference in growth rates shown on Tables 3 and 4, as we subtract the trend growth in the Los Angeles control area from the Los Angeles treatment area, and the trend growth in the Cleveland control area from the Cleveland treatment area. The difference-in-difference procedure also removes heterogeneity across time within metropolitan areas. Consider the St. Louis metropolitan area over the period 1992-1997 (when the Edward Jones Dome opened) and the St. Louis metropolitan area from 2003-2008 (when Busch Stadium opened). The earlier period was a boom period in the housing market; the latter period was a bust period in this market. But we are not comparing St. Louis in 2006 to St. Louis in 1995 on Tables 3 and 4. Instead, we compare different local housing markets in St. Louis over the same periods (either around 1995 or around 2006).

Most of the growth differentials on Table 3 are positive; the same is true for the alternative greater radius treatment reported on Table 4. Figure 1 shows the histogram of the distribution of differences in growth rates pre and post facility opening. It clearly suggests a positive effect in the treatment area: neighborhoods with new sports facilities experienced higher growth in residential mortgage applications than the rest of the metropolitan area, on average after the new facility opened. The footnote of the histograms shows the estimated mean and standard error of the growth differential. In the default case of a 2-mile radius, the average effect of a new facility in the treatment area (i.e., growth differential) is 16.8%; the standard error is 3.63%. The t-statistics is thus 4.63; thus we can safely reject the null hypothesis that the two areas have the same growth. Figure 2 reports the distribution based on the longer alternative radius. The observations are similar. The average effect falls to 11.7%, but we can still reject the null of equal growth with a t-statistics of 3.77. We also note that removing five stadiums that are located in sparsely populated areas slightly raises the estimated effect in the treatment area, to 18.4% in the case of the 2-mile radius and to 13.5% in the alternative case.[7]

The outcomes in these metropolitan areas provide context for recent case studies of the relationship between professional sports facilities and residential property values and rent. Carlino and Coulson (2004) examined the effect of new NFL stadiums in Baltimore (M & T Bank Stadium), Charlotte (Bank of America Stadium), Jacksonville (EverBank Field), Nashville (LP Field) and St. Louis (Edward Jones Dome) on rent in these cities and found rent was higher in these cities than other large cities without new NFL stadiums. From Table 3, all five of these treatment areas in these cities experienced increases in residential mortgage applications that are about 20% or more faster following the opening of the stadium. The increase around M & T Bank Stadium is 59% greater than the rest of the metropolitan area. Tu (2005) examined single family residential property values around FedEx Field in suburban Washington DC using a difference-in-difference approach and found that house prices within 2.5 miles of this stadium increased after it opened. From Table 4, census tracts within 2 miles of FedEx field experienced a 48% decline in residential mortgage applications after the opening relative to the rest of the metropolitan area. However, the hedonic price models estimated by Tu (2005) show negative and significant point estimates on the variable identifying properties close to FedEx Field after opening, which is consistent with the observed relative decline in mortgage applications. Feng and Humphreys (2008) examined the relationship between residential property values and proximity to NationWide Arena in Columbus Ohio and found that property values were higher in proximity to the facility. From Table 3, residential mortgage applications increased slightly faster in the area near this facility. Rosentraub (2009) examined successful sport facility-led urban redevelopment projects in several cities, including San Diego (PetCo Park), Los Angeles (Staples Center) and Columbus (Nationwide Arena). From Table 3, annual residential mortgage applications in the 2-mile treatment area growth faster than the control area by 84% (PetCo Park), 3% (Staples Center), and 1% (Nationwide Arena) on average in the three years following the opening of these facilities. In all cases, the observed changes in residential mortgage applications from this difference-in-difference approach are consistent with the conclusions of these case studies.

3.3 Treatment areas and selection on (un)observables

The difference-in-difference analysis above assumes that there are no systemic differences between the treatment and control areas other than the proximity to new stadiums. In particular, it assumes that the census tracts in the treatment area were not selected because of some factor unobservable to econometricians but observable to those who make the location decision. This is unlikely to be the case, as local decision makers exercise control over the location of new facilities and, as discussed above, may view them as catalysts for urban redevelopment.

Table 5 compares observable characteristics of the census tracts in the treatment areas to the

[7] These five facilities are the BankAtlantic Center in Miami-Fort Lauderdale, FL, the RBC Center (Raleigh Sports Arena) in Raleigh-Durham-Chapel Hill, NC, Gillette Stadium (CMGI) in Boston-Worcester-Lawrence, MA-NH-ME-CT, Jobing.com Arena in Phoenix-Mesa, AZ and the University of Phoenix Stadium in Phoenix-Mesa, AZ.

control areas based on their Census-2000 profiles. The difference in the characteristics of the treatment compared to the control areas is substantial and statistically significant. The treatment areas are more densely populated, poorer, have lower median house values, more renter-occupied housing units and higher percentage of black and Hispanic residents. The average population density in the treatment areas (defined with a 2-mile radius) is 4,400 persons per square kilometer versus 1,800 in the control areas. The treatment-control comparison in terms of median household income is $30,800 to $51,600. In terms of fraction of the population living below the poverty line the comparison is 27% to 10%. In terms of the share of renter-occupied housing units it is 63% to 33%. In median house value it is $132,000 to $153,000. In the share of black population it is 35% to 14%. In the share of Hispanic population it is 18% to 12%. In terms of the average age of housing units, it is 46 years t 32 years. The right panel on Table 5 repeats the comparison for the 3 mile radius treatment area. The results are similar. Of course it is not surprising that new sports facilities are located in poor urban areas, since neighborhood revitalization is often touted as a potential benefit of a new sports facility, and used to justify large subsidies for the construction of these facilities.

From the perspective of econometric analysis of residential mortgage applications, however, the location of new sports facilities in poor urban areas raises the possibility that the treatment-control differential documented above is biased upward. The observed difference in residential mortgage applications may not reflect the effect of a new sports facility on the area. It may instead reflect the tendency of poor urban areas to grow faster than other parts of metropolitan areas. One likely contributing factor is the expansion of mortgage credit in the large part of the sample period (for better or worse given the macroeconomic consequences), which will likely have a greater impact on areas with a larger low-income population, such as the poor urban areas that new sports facilities tend to occupy.

In order to assess the importance of this selection effect, we compare the increase in residential mortgage applications in poor urban areas near new sports facilities to similar urban areas that are not located near new sports facilities over the sample period. Our approach is to examine the residential mortgage application and area-specific characteristics at the level of census tracts, using a regression model to control for local characteristics. This approach allows us to determine whether census tracts near new sports facilities experienced a greater increase in residential mortgage applications relative to census tracts located further away, in the same metropolitan area, that have a similar characteristics.

We estimate the following regression model

$$\%\Delta m_{i,j} = \alpha D_{i,j}^{treatment} + \beta Z_i^{census} + \gamma_j D_j^{stadium} + u_{i,j} \tag{2}$$

The subscripts i and j indicate census tracts and sports facilities, respectively. The dependent variable is the percentage change in annual residential mortgage applications in each census tract over the three years before the opening compared to over the three years after the opening. The variable $D_{i,j}^{treatment}$ is a 0-or-1 indicator equal to 1 when census tract i is in the treatment group associated with the opening of sports facility j. The control variables include Z_i^{census} a vector of Census-2000 profile variables for census tract i, and $D_j^{stadium}$ a vector of 0-or-1 indicator variables for sports facility j. Note that the inclusion of the stadium dummy renders metropolitan area dummies and year dummies unnecessary. As the sports facility dummy incorporates both the location and year effects. All the year dummies and metropolitan area dummies will be dropped if we include them in the regression due to collinearity with the facility indicators. The inclusion of the stadium dummies means that we are comparing census tracts in the same metropolitan area during the same period of time, as in the difference-in-difference analysis above.

The regression model uses data from 56 metropolitan areas, each associated with one specific new sports facility, a total of about 45,000 census tracts. The model includes new facility indicator variables. In addition, we cluster-correct the error term $u_{i,j}$ at the treatment and control group level to account for any within-group correlation in the error term due to unobservable factors affecting all census tracts in the treatment and control areas in metropolitan areas. With 56 facilities in the sample, each having one control and one treatment group, the total number of clusters in the regression is 112. This clustering tends to increase the size of the estimated standard errors, as it indeed does in our case. The clustering thus imposes a more stringent requirement on statistical inference.

The dependent variable (percentage change in annual residential mortgage applications) is volatile, ranging from -100% to 13,433%. Examination of a histogram of the dependent variable suggests the existence of a small number of outliers. Before performing the regression analysis, we excluded observations with extreme values of the dependent variable. Specifically, we added a constant of 101 to each observation to avoid negative values before taking logs and then log transformed the dependent variable, so that the distribution appears to be normal. We then dropped observations whose value in logs were more than 2.5 standard deviations from the mean. This removes about 2% of the observations (888 census tracts out of more than 45,000 in the sample). After this elimination we converted the dependent variable back to its original form in percentages. The elimination of outliers has a large impact on the standard deviation of the dependent variable in its original form, reducing it from 137.6% to 56.2%. The minimum and maximum of the sample without those outliers are -80% and 421%, respectively.

We also note that, in a few cities, two facilities opened very close to each other in the same year (e.g., PNC Park and Heinz Field in Pittsburgh both opened in 2001). This leads to a small amount of repeated observations: the mortgage data from the same census tracts over the same period enter the sample twice. We deal with the problem by linking such census tract-period combinations to one facility while eliminating the second from the sample. This reduces the sample size to about 42,000. We emphasize that this deletion has little impact on the results. We get almost identical results from the full sample that includes the repeated observations. Summary statistics for census-tract level variables in the final sample are shown on Table 8.

Table 6 presents the results from applying OLS to Equation (2). In the regressions census tracts are weighted by resident population, so smaller and likely less volatile tracts are weighted less. The next table, Table 7, presents estimates from the alternative 3-mile treatment.

The first column in Table 6 does not include any census tract level variables. The only explanatory variables are are the treatment indicator and the sports facility indicator variables, which are not reported. The estimated impact in the treatment area is 20.7%, slightly higher than the 16.8% reported on Table 3 and Figure 1. The two estimates are not strictly comparable. The earlier figure is from a sample of 56 facilities, weighted equally even if one facility covers many more census tracts than another. The estimates in Table 6, on the other hand, are from a sample of census tracts weighted by resident population, which gives a greater weight to treatment areas containing new facilities that contain more census tracts and have more residents. Despite the difference, the estimates of the effect of a new sports facility are quite similar.

Next, we include 2000-Census variables in the regression model. The descriptive statistics for these variables are shown on Table 8. Table 6's second column reports the results when we add the population density to the regression model. This controls for the tendency of new sports facilities to be located in urban areas. The inclusion of population density reduces the estimated impact from 20.7% to 18.3%. The density variable has a positive coefficient that is statistically significant, suggesting that census tracts with higher population density experienced a larger increase in residential mortgage applications in the post-treatment period.

In the next column we add the census tract's median household income and percentage of residents living below the poverty line to reflect local economic conditions. The poverty variable enters significantly; the income variable has a statistically insignificant coefficient. But both signs indicate that poorer/lower-income areas grew faster, holding the presence of a new sports facility constant. This is consistent with the hypothesis that poorer census tracts gained increased access to credit markets over time. The inclusion of these two census tract characteristics diminishes the role of population density to statistical insignificance.

Most important for our research question, we find that including population density, income and poverty variables reduces the effect of new sports facilities on residential mortgage applications to 8.9% from the initial 20.7% and makes the estimate statistically insignificant at the 5% level. This means that much of the estimated differential between the treatment and control areas is due to the income/poverty effect: new sports facilities tend to be located in poorer areas and poorer areas experienced larger increases in residential mortgage applications over the sample period with or without a new sports facility nearby. Much of the large effects shown in Figures 1, therefore, represent upward bias due to selection of the treatment based on unobservables; new sports facilities were located in areas that would have experienced large increases in residential mortgage applications over the sample period even without the treatment.

In the remainder of the table, we add additional variables to the model in order to check the robustness of this finding. We first add three housing-related variables: median home values, the share of renter-occupied housing units and the average age of housing units. The estimated treatment-control differentials rises from 8.9% to 10.1% and regains a borderline significance at the 5% level. We then use a "kitchen-sink" approach, adding to the right hand side a lengthy list of variables: percentage of population black, percentage of population Hispanic, percentage unemployed persons, percentage population with university degrees, percentage age over 65, as well as percentage employment in manufacturing industries. The estimated treatment-control differential remains at about 10%. The set of census variables are highly correlated among themselves. Their coefficients are likely sensitive to inclusion/exclusion of one another. But throughout the different specifications, the estimated coefficient on the poverty rate is consistently positive and statistically significant. In the "kitchen-sink" regression, we find that areas with more manufacturing jobs grew slower, which likely reflects the industry's decline over time.

Table 7 uses the alternative radius of three miles to define the treatment area. The results are remarkably similar, except that all estimated impacts in the treatment areas are 2 or 3 percentage points lower. Without the inclusion of census tract characteristics, the 3-mile treatment effect is 16.7%. After the inclusion of the census tract characteristics, the treatment-control differential falls to between 6.5% and 8% and are all statistically insignificant at the 5% level.

Taken together, the results suggest that a large part of what appears to be neighborhood revitalization from new sports facilities in the sample, as reflected by increased residential mortgage applications after the opening of the 56 new sports facilities, would have taken place even without the the opening of a new facility because of the characteristics of the census tracts near the new facilities. Even the smaller estimates reported above may be biased upward, as local decision makers, armed with additional knowledge unobservable to econometricians, might have correctly identified areas where urban revitalization would take place, and located the new facilities in those areas. In either case, the results suggest that the billions of dollars in public subsidies provided for the construction of these facilities had little to do with the local urban revitalization that took place after the sports facilities opened.

Our final robustness test splits the sample period into two subperiods: one before the 2007 housing bust, the other after. Specifically, the first sub-sample excludes 5 stadiums that were opened after 2005 (2006-2008 to be exact), thus avoiding using residential mortgage application data after 2007 when the housing crisis intensified. The second sub-sample includes only the 5 stadiums that were omitted from the first sub-sample. The Appendix B shows the regression results for this robustness check. The first sub-sample, which includes 50 facilities, produces similar findings as the full sample that with all 56 facilities. Consider the results using the 2-mile radius as an example. The estimated impact is 23% before including the census tract characteristics, and drops to 10% with the inclusion of the population density, income and poverty variables; this point estimate is statistically insignificant based on the 5% significance level. The results also show that poorer areas grew faster in this pre-bust period: census tracts with a higher poverty rate, a lower median house price, a greater share of black residents and a higher unemployment rate in the 2000 Census experienced greater increases in mortgage applications than better-off census tracts. In the second sub-sample, which includes only 5 facilities that were opened between 2006 and 2008, the estimated treatment effect is insignificant, with point estimates that are essentially zero. There appears to have been a reversal of fortune in poor urban neighborhoods: the decline in mortgage applications was greater in areas with more black residents and a higher unemployment rate in 2000, even though the fraction of the population under the poverty line variable still has a positive (and thus protective) coefficient. To summarize, we find that excluding the housing bust period from the sample has little effect on our main finings. It instead provides further support to the hypothesis that poorer areas grew faster before the bust, consistent with the findings in Mian and Sufi (2009) that *subprime* neighborhoods experienced much greater growth in mortgage credit during the housing boom.

4 Conclusions

We examine the relationship between the opening of new sports facilities and residential mortgage applications to assess the ability of new sports facilities to drive urban revitalization. The results from a difference-in-difference analysis suggest that census tracts near new sports facilities saw substantial increases in annual residential mortgage applications in the three years following the opening of 56 new sports facilities in US cities over the period 1995-2008. Urban redevelopment appears to have occurred after the new facilities in the sample opened. These results are consistent with several case studies focusing on the relationship between sports facilities and housing prices in the literature.

However, a regression analysis that controls for the characteristics of the areas where the new facilities were located suggests that much of the increase in residential mortgage applications can be attributed to the characteristics of the locations. Most poor and low-income urban census tracts experienced increases in residential mortgage applications over the sample period, probably because of increased access to consumer credit markets. After controlling for observable characteristics of the facility locations, the size of the relationship between a new sports facility and subsequent residential mortgage applications declines and becomes statistically insignificant. This reduction in the estimated effect of new facilities in the treatment area suggests that much of the observed redevelopment would have occurred independent of the opening of a new sports facility in the neighborhood. Alternatively, local decision makers placed new facilities in these areas by design, so the redevelopment project would succeed. However, in this case the substantial subsidies used to build these new facilities were not needed, and those public funds could have been used for other projects.

Our analysis of the relationship between new sports facilities and residential mortgage applications provides new evidence in the debate over public subsidies for the construction of professional sports facilities. Recently, this debate shifted from the issue of tangible economic benefits generated by new sports facilities in the broader urban economy to the ability of professional sports facilities to drive urban revitalization in specific urban areas. Little evidence currently exists about localized impacts of new professional sports facilities outside the growing, case study based literature on sports facilities and property values. Our results cast some doubts on the ability of a new professional sports facility to spur urban redevelopment, at least as reflected in residential mortgage applications. However, an analysis of other indicators of urban redevelopment, notably on the commercial side in the form of new businesses or commercial real estate prices, might paint a different picture.

Our results highlight the importance of location decisions when assessing the potential impact of new professional sports facilities on the urban economy. Controlling for observable characteristics of facility locations significantly reduces the estimated effect of a new sports facility on residential mortgage applications in this setting. In the context of the literature on the econometric evaluation of program evaluation, recently reviewed by Imbens and Wooldridge (2009), the unconfoundedness assumption plays a critical role here. Imbens and Wooldridge (2009) discuss a number of alternative approaches for econometric program evaluation when the unconfoundedness assumption does not hold, including exploiting bounds, IV approaches, and regression discontinuity designs, that may be useful under some conditions. The regression discontinuity approach appears to hold some promise in this area, and future research should apply it to assess the role played by location decisions in this setting.

Finally, the rich detail in HMDA data can be further exploited to better understand the impact of the opening of a new professional sports facility in an urban area. We analyze data on residential mortgage applications aggregated to the census tract level. The data set also contains detailed information about the applicants. This information could be exploited to understand the characteristics of people interested in moving into the area around a new sports facility, relative to the the existing residents. A careful analysis of the characteristics of residential mortgage applicants could help to understand the equity implications of sports facility led urban redevelopment projects.

References

Ahlfeldt, G. and Maennig, W. (2009). Arenas, arena architecture and the impact on location desirability: the case of Olympic Arenas in Prenzlauer Berg, Berlin. *Urban Studies*, 46(7):1343.

Ahlfeldt, G. and Maennig, W. (2010). Impact of sports arenas on land values: evidence from Berlin. *The Annals of Regional Science*, 44(2):205–227.

Ahlfeldt, G. M. and Kavetsos, G. (2011). Form or function? the impact of new football stadia on property prices in London. SERC Discussion Papers 0087, Spatial Economics Research Centre, LSE.

Avery, R. B., Brevoort, K. P., and Canner, G. B. (2007). Opportunities and issues in using HMDA data. *Journal of Real Estate Research*, 29(4):351–380.

Berkovec, J. A. and Goodman, J. L. (1996). Turnover as a measure of demand for existing homes. *Real Estate Economics*, 24(4):421–440.

Carlino, G. and Coulson, N. E. (2004). Compensating differentials and the social benefits of the NFL. *Journal of Urban Economics*, 56(1):25–50.

Castellanos, P., Garca, J., and Sanchez, J. M. (2011). The willingness to pay to keep a football club in a city: How important are the methodological issues? *Journal of Sports Economics*, 12(4):464–486.

Clayton, J., Miller, N., and Peng, L. (2010). Price-volume correlation in the housing market: Causality and co-movements. *The Journal of Real Estate Finance and Economics*, 40(1):14–40.

Coates, D. (2007). Stadiums and arenas: economic development or economic redistribution? *Contemporary Economic Policy*, 25(4):565–577.

Coates, D. and Matheson, V. A. (2011). Mega-events and housing costs: raising the rent while raising the roof? *The Annals of Regional Science*, 46(1):119–137.

Dehring, C., Depken, Craig, A., and Ward, M. (2008). A direct test of the homevoter hypothesis. *Journal of Urban Economics*, 64(1):155–170.

Dehring, C., Depken, C., and Ward, M. (2007). The impact of stadium announcements on residential property values: Evidence from a natural experiment in Dallas-Fort Worth. *Contemporary Economic Policy*, 25(4):627–638.

Feng, X. and Humphreys, B. R. (2007). The spatial impact of professional sports facilities on residential housing values: Evidence from census block-group data. In *IASE Conference Papers*. International Association of Sports Economists.

Feng, X. and Humphreys, B. R. (2008). Assessing the economic impact of sports facilities on residential property values: A spatial hedonic approach. *International Association of Sports Economists Working Papers*, (0812).

Fenn, A. J. and Crooker, J. R. (2009). Estimating local welfare generated by an NFL team under credible threat of relocation. *Southern Economic Journal*, 76(1):198–223.

Glaeser, E., Kolko, J., and Saiz, A. (2001). Consumer city. *Journal of Economic Geography*, 1(1):27.

Glaeser, E. L. and Gottleib, J. (2008). The economics of place-making policies. *Brookings Papers on Economic Activity*.

Glaeser, E. L. and Gottlieb, J. (2006). Urban resurgence and the consumer city. *Urban Studies*, 43(8):1275.

Goodman, A. C. and Smith, B. C. (2010). Residential mortgage default: Theory works and so does policy. *Journal of Housing Economics*, 19(4):280–294.

Hanson, A., Schnier, K., and Turnbull, G. (2012). Drive 'til you qualify: Credit quality and household location. *Regional Science and Urban Economics*, 42(1-2):63–77.

Huang, H. and Tang, Y. (2012). Residential land use regulation and the us housing price cycle between 2000 and 2009. *Journal of Urban Economics*, 71(1):93–99.

Humphreys, B. R. and Zhou, L. (2012). Sports facilities, agglomeration, and urban redevelopment. Working Paper 2012-5, University of Alberta Department of Economics.

Imbens, G. W. and Wooldridge, J. M. (2009). Recent developments in the econometrics of program evaluation. *Journal of Economic Literature*, 47(1):5–86.

Johnson, B. K., Groothuis, P. A., and Whitehead, J. C. (2001). The value of public goods generated by a major league sports team. *Journal of Sports Economics*, 2(1):6.

Johnson, B. K., Mondello, M. J., and Whitehead, J. C. (2006). Contingent valuation of sports. *Journal of Sports Economics*, 7(3):267–288.

Johnson, B. K. and Whitehead, J. C. (2000). Value of public goods from sports stadiums: The CVM approach. *Contemporary Economic Policy*, 18(1):48–58.

Long, J. G. (2012). *Public-Private Partnerships for Major League Sports Facilities*. Taylor and Francis, New York, NY.

Mian, A. and Sufi, A. (2009). The consequences of mortgage credit expansion: Evidence from the us mortgage default crisis. *Quarterly Journal of Economics*, 124(4):1449–1496.

Mian, A., Sufi, A., and Trebbi, F. (2010). The political economy of the subprime mortgage credit expansion. NBER Working Papers 16107, National Bureau of Economic Research, Inc.

Munnell, A., Tootell, G., Browne, L., and McEneaney, J. (1996). Mortgage lending in boston: Interpreting hmda data. *The American Economic Review*, 86(1):25–53.

Roback, J. (1982). Wages, rents, and the quality of life. *Journal of Political Economy*, 90(6):1257–1278.

Rosentraub, M. S. (2009). *Major league winners: Using sports and cultural centers as tools for economic development*. CRC Press.

Stein, J. C. (1995). Prices and trading volume in the housing market: A model with down-payment effects. *The Quarterly Journal of Economics*, 110(2):379–406.

Süssmuth, B., Heyne, M., and Maennig, W. (2010). Induced civic pride and integration. *Oxford Bulletin of Economics and Statistics*, 72(2):202–220.

Tu, C. (2005). How does a new sports stadium affect housing values? The case of FedEx Field. *Land Economics*, 81(3):379.

Table 1: Sports Facilities in Sample

Facility	Team (Sport)	Metro Area	Year Opened
TD Garden	Celtics (NBA)	Boston-Worcester-Lawrence, MA-NH-ME-CT	1995
	Bruins (NHL)		
Coors Field	Rockies (MLB)	Denver-Boulder-Greeley, CO	1995
EverBank Field	Jaguars (NFL)	Jacksonville, FL	1995
Rose Garden	Trail Blazers (NBA)	Portland-Salem, OR-WA	1995
Edward Jones Dome	Rams (NFL)	St. Louis, MO-IL	1995
HSBC Arena	Sabres (NHL)	Buffalo-Niagara Falls, NY	1996
Bank of America Stadium	Panthers (NFL)	Charlotte-Gastonia-Rock Hill, NC-SC	1996
Bridgestone Arena	Predators (NHL)	Nashville, TN	1996
Wells Fargo Center	76ers (NBA)	Philadelphia-Wilmington-Atlantic City, PA-NJ-DE-MD	1996
	Flyers (NHL)		
St. Pete Times Forum	Lightening (NHL)	Tampa-St. Petersburg-Clearwater, FL	1996
Turner Field	Braves (MLB)	Atlanta, GA	1997
Oracle Arena	Warriors (NBA)	San Francisco-Oakland-San Jose, CA	1997
FedEx Field	Redskins (NFL)	Washington-Baltimore, DC-MD-VA-WV	1997
Verizon Center	Wizards (NBA)	Washington-Baltimore, DC-MD-VA-WV	1997
	Capitals (NHL)		
M&T Bank Stadium	Ravens (NFL)	Washington-Baltimore, DC-MD-VA-WV	1998
BankAtlantic Center	Panthers (NHL)	Miami-Fort Lauderdale, FL	1998
Chase Field	Diamondbacks (MLB)	Phoenix-Mesa, AZ	1998
Raymond James Stadium	Buccaneers (NFL)	Tampa-St. Petersburg-Clearwater, FL	1998
Philips Arena	Hawks (NBA)	Atlanta, GA	1999
	Thrashers (NHL)		
Cleveland Browns Stadium	Browns (NFL)	Cleveland-Akron, OH	1999
Pepsi Center	Nuggets (NBA)	Denver-Boulder-Greeley, CO	1999
	Avalanche (NHL)		
Conseco Fieldhouse	Pacers (NBA)	Indianapolis, IN	1999
Staples Center	Lakers,Clippers (NBA)	Los Angeles-Riverside-Orange County, CA	1999
	Kings (NHL)		
American Airlines Arena	Heat (NBA)	Miami-Fort Lauderdale, FL	1999
LP Field	Titans (NFL)	Nashville, TN	1999
RBC Center	Hurricanes (NHL)	Raleigh-Durham-Chapel Hill, NC	1999
SafeCo Field	Mariners (MLB)	Seattle-Tacoma-Bremerton, WA	1999
Paul Brown Stadium	Bengals (NFL)	Cincinnati-Hamilton, OH-KY-IN	2000
Nationwide Arena	Blue Jackets (NHL)	Columbus, OH	2000
Comerica Park	Tigers (MLB)	Detroit-Ann Arbor-Flint, MI	2000
Minute Maid Park	Astros (MLB)	Houston-Galveston-Brazoria, TX	2000
Xcel Energy Center	Wild (NHL)	Minneapolis-St. Paul, MN-WI	2000
AT&T Park	Giants (MLB)	San Francisco-Oakland-San Jose, CA	2000
American Airlines Center	Mavericks (NBA)	Dallas-Fort Worth, TX	2001
	Stars (NHL)		
Sports Authority Field	Broncos (NFL)	Denver-Boulder-Greeley, CO	2001
Miller Park	Brewers (MLB)	Milwaukee-Racine, WI	2001
PNC Park	Pirates (MLB)	Pittsburgh, PA	2001
Heinz Field	Steelers (NFL)	Pittsburgh, PA	2001
Gillette Stadium	Patriots (NFL)	Boston-Worcester-Lawrence, MA-NH-ME-CT	2002
Ford Field	Lions (NFL)	Detroit-Ann Arbor-Flint, MI	2002
Reliant Stadium	Texans (NFL)	Houston-Galveston-Brazoria, TX	2002
AT&T Center	Spurs (NBA)	San Antonio, TX	2002
CenturyLink Field	Seahawks (NFL)	Seattle-Tacoma-Bremerton, WA	2002
Great American Ballpark	Reds (MLB)	Cincinnati-Hamilton, OH-KY-IN	2003
Toyota Center	Rockets (NBA)	Houston-Galveston-Brazoria, TX	2003
Lincoln Financial Field	Eagles (NFL)	Philadelphia-Wilmington-Atlantic City, PA-NJ-DE-MD	2003
Jobing.com Arena	Coyotes (NHL)	Phoenix-Mesa, AZ	2003
FedEx Forum	Grizzlies (NBA)	Memphis, TN-AR-MS	2004
Citizens Bank Park	Phillies (MLB)	Philadelphia-Wilmington-Atlantic City, PA-NJ-DE-MD	2004
Petco Park	Padres (MLB)	San Diego, CA	2004
TimeWarner Cable Arena	Bobcats (NBA)	Charlotte-Gastonia-Rock Hill, NC-SC	2005
U. of Phoenix Stadium	Cardinals (NFL)	Phoenix-Mesa, AZ	2006
Busch Stadium	Cardinals (MLB)	St. Louis, MO-IL	2006
Prudential Center	Devils (NHL)	New York, Northern New Jersey, Long Island, NY-NJ-CT-PA	2007
Lucas Oil Stadium	Colts (NFL)	Indianapolis, IN	2008
Nationals Park	Nationals (MLB)	Washington-Baltimore, DC-MD-VA-WV	2008

Table 2: Number of Census Tracts in Metro Area and in Treatment Groups

Facility	Total	Within 2 miles	Within 3 miles
TD Garden	1177	54	108
Coors Field	580	29	52
EverBank Field	168	11	22
Rose Garden	393	31	55
Edward Jones Dome (Trans World)	450	15	35
HSBC Arena	290	17	34
Bank of America Stadium (Ericsson)	263	17	33
Bridgestone Arena	202	21	38
Wells Fargo Center	1522	13	43
St. Pete Times Forum (Ice Palace)	409	14	26
Turner Field	495	28	55
Oracle Arena (Oakland Arena)	1376	18	46
FedEx Field	1545	11	22
Verizon Center (MCI)	1545	60	99
M&T Bank Stadium (PSInet)	1544	47	99
Bank Atlantic Center	427	1	2
Chase Field (Bank One Ballpark)	490	15	24
Raymond James Stadium	409	10	24
Philips Arena	495	33	56
Cleveland Browns Stadium	855	27	60
Pepsi Center	579	23	55
Conseco Fieldhouse	330	20	41
Staples Center	2552	50	100
American Airlines Arena	427	17	32
LP Field (Adelphia Coliseum)	202	18	33
RBC Center (Raleigh Sports Arena)	196	2	9
SafeCo Field	615	19	35
Paul Brown Stadium	436	39	66
Nationwide Arena	343	25	51
Comerica Park	1392	31	58
Minute Maid Park (Enron Field)	793	19	43
Xcel Energy Center	648	30	50
AT&T Park (Pacific Bell Park)	1372	35	72
American Airlines Center	866	21	44
Sports Authority Field at Mile High	575	21	53
Miller Park	429	37	93
PNC Park	760	50	98
Heinz Field (Rooney)	760	46	98
Gillette Stadium (CMGI)	1159	1	4
Ford Field	1392	31	58
Reliant Stadium	791	10	25
AT&T Center (SBC Center)	249	9	21
CenturyLink Field (Qwest Field)	614	21	35
Great American Ballpark	435	41	69
Toyota Center	791	22	45
Lincoln Financial Field	1519	14	43
Jobing.com Arena	490	3	10
FedEx Forum	225	22	40
Citizens Bank Park	1522	19	49
Petco Park	437	22	40
TimeWarner Cable (TWC) Arena	265	19	34
University of Phoenix Stadium	490	2	9
Busch Stadium III	464	14	35
Prudential Center	5099	71	123
Lucas Oil Stadium	330	16	36
Nationals Park	1654	36	82
Average	818.5	24.07	48.61

Table 3: Increase in Mortgage Applications, Control Census Tracts and 2-mile Radius Treatment Area Census Tracts

		Treatment CTs			Control CTs			
Facility	**Year Opened**	**Before**	**After**	**% Change**	**Before**	**After**	**% Change**	% $\Delta_{Treatment}$ - % $\Delta_{Control}$
TD Garden	1995	1406	2299	64	55625	74021	33	30
Coors Field	1995	990	1499	51	51604	64641	25	26
EverBank Field	1995	181	330	82	15331	25020	63	19
Rose Garden	1995	791	1152	46	32209	43868	36	9
Edward Jones Dome (Trans World)	1995	128	195	53	38343	50598	32	21
HSBC Arena	1996	167	146	-12	12494	12507	0	-13
Bank of America Stadium (Ericsson)	1996	452	848	88	25825	43828	70	18
Bridgestone Arena	1996	282	379	35	21781	30882	42	-7
Wells Fargo Center	1996	588	711	21	72506	89600	24	-3
St. Pete Times Forum (Ice Palace)	1996	299	468	56	39865	56311	41	15
Turner Field	1997	483	1040	115	79458	115119	45	70
Oracle Arena (Oakland Arena)	1997	649	1017	57	88453	143017	62	-5
FedEx Field	1997	466	446	-4	109567	156977	43	-48
Verizon Center (MCI)	1997	1765	3333	89	108268	154090	42	46
M&T Bank Stadium (PSInet)	1998	953	2005	110	116050	175772	51	59
Bank Atlantic Center	1998	581	860	48	71801	99542	39	9
Chase Field (Bank One Ballpark)	1998	436	715	64	77303	109600	42	22
Raymond James Stadium	1998	477	648	36	48312	68563	42	-6
Philips Arena	1999	950	2124	124	101895	127462	25	98
Cleveland Browns Stadium	1999	151	205	35	49886	56685	14	21
Pepsi Center	1999	1712	2380	39	74616	94561	27	12
Conseco Fieldhouse	1999	497	805	62	33893	41630	23	39
Staples Center	1999	588	817	39	246640	335670	36	3
American Airlines Arena	1999	939	1670	78	80831	105649	31	47
LP Field (Adelphia Coliseum)	1999	383	530	38	30878	33971	10	28
RBC Center (Raleigh Sports Arena)	1999	209	191	-9	37145	39988	8	-16
SafeCo Field	1999	1123	1279	14	77394	91103	18	-4
Paul Brown Stadium	2000	1035	1034	0	41628	43098	4	-4
Nationwide Arena	2000	788	892	13	33605	37677	12	1
Comerica Park	2000	200	236	18	128164	130430	2	17
Minute Maid Park (Enron Field)	2000	577	1016	76	109749	118341	8	68
Xcel Energy Center	2000	1227	1435	17	69454	77508	12	5
AT&T Park (Pacific Bell Park)	2000	1639	1721	5	142401	147031	3	2
American Airlines Center	2001	1283	1480	15	147197	149896	2	14

Continued on next page...

Table 3 – Continued

		Treatment CTs			Control CTs			
Facility	**Year Opened**	**Before**	**After**	**% Change**	**Before**	**After**	**% Change**	% $\Delta_{Treatment}$ - % $\Delta_{Control}$
Sports Authority Field at Mile High	2001	2138	2102	-2	92972	88314	-5	3
Miller Park	2001	1137	1429	26	28307	30710	8	17
PNC Park	2001	657	645	-2	34007	33646	-1	-1
Heinz Field (Rooney)	2001	600	588	-2	34064	33702	-1	-1
Gillette Stadium (CMGI)	2002	89	98	9	103015	116258	13	-4
Ford Field	2002	217	317	46	138506	129230	-7	53
Reliant Stadium	2002	929	1162	25	119350	137098	15	10
AT&T Center (SBC Center)	2002	385	375	-3	36621	38869	6	-9
CenturyLink Field (Qwest Field)	2002	1455	1818	25	90926	107754	19	6
Great American Ballpark	2003	1079	1395	29	43053	50733	18	11
Toyota Center	2003	1616	2500	55	117741	160681	36	18
Lincoln Financial Field	2003	1207	1607	33	112018	139024	24	9
Jobing.com Arena	2003	809	1649	104	116955	203736	74	30
FedEx Forum	2004	305	638	109	26337	38844	47	62
Citizens Bank Park	2004	1504	2391	59	114850	146616	28	31
Petco Park	2004	1799	3671	104	73654	88737	20	84
TimeWarner Cable (TWC) Arena	2005	1427	2454	72	49576	69474	40	32
University of Phoenix Stadium	2006	1558	821	-47	203827	138619	-32	-15
Busch Stadium III	2006	855	957	12	72998	58859	-19	31
Prudential Center	2007	3861	1510	-61	409100	219537	-46	-15
Lucas Oil Stadium	2008	916	281	-69	50938	24539	-52	-17
Nationals Park	2008	2828	1499	-47	268111	111015	-59	12
Average				36.4			19.5	16.8
Standard Deviation				43			27.1	26.9
Minimum				-69			-59	-48
Maximum				124			74	98

Table 4: Increase in Mortgage Applications, Control Census Tracts and 3-mile Radius Treatment Area Census Tracts

		Treatment CTs			Control CTs			
Facility	**Year Opened**	**Before**	**After**	**% Change**	**Before**	**After**	**% Change**	% $\Delta_{Treatment}$ - % $\Delta_{Control}$
TD Garden	1995	2458	3918	59	54573	72402	33	27
Coors Field	1995	2370	3218	36	50223	62922	25	10
EverBank Field	1995	435	747	72	15077	24603	63	8
Rose Garden	1995	2288	2959	29	30713	42061	37	-8
Edward Jones Dome (Trans World)	1995	296	475	60	38175	50318	32	29
HSBC Arena	1996	511	433	-15	12150	12220	1	-16
Bank of America Stadium (Ericsson)	1996	1185	2007	69	25092	42669	70	-1
Bridgestone Arena	1996	872	1203	38	21191	30058	42	-4
Wells Fargo Center	1996	1275	1621	27	71820	88690	23	4
St. Pete Times Forum (Ice Palace)	1996	880	1356	54	39284	55423	41	13
Turner Field	1997	1270	2598	105	78671	113561	44	60
Oracle Arena (Oakland Arena)	1997	1936	3200	65	87166	140835	62	4
FedEx Field	1997	1389	1361	-2	108644	156061	44	-46
Verizon Center (MCI)	1997	2881	5244	82	107152	152178	42	40
M&T Bank Stadium (PSInet)	1998	2354	4801	104	114649	172976	51	53
Bank Atlantic Center	1998	1035	1399	35	71347	99002	39	-4
Chase Field (Bank One Ballpark)	1998	881	1287	46	76858	109028	42	4
Raymond James Stadium	1998	1213	1701	40	47576	67509	42	-2
Philips Arena	1999	2292	4258	86	100553	125328	25	61
Cleveland Browns Stadium	1999	552	710	29	49486	56180	14	15
Pepsi Center	1999	4185	5750	37	72143	91191	26	11
Conseco Fieldhouse	1999	1265	2040	61	33125	40396	22	39
Staples Center	1999	1766	2408	36	245462	334080	36	0
American Airlines Arena	1999	1757	2849	62	80013	104469	31	32
LP Field (Adelphia Coliseum)	1999	972	1320	36	30289	33181	10	26
RBC Center (Raleigh Sports Arena)	1999	1202	1194	-1	36152	38985	8	-8
SafeCo Field	1999	2737	3217	18	75779	89164	18	0
Paul Brown Stadium	2000	2072	2112	2	40591	42020	4	-2
Nationwide Arena	2000	2058	2381	16	32336	36188	12	4
Comerica Park	2000	291	488	68	128073	130178	2	66
Minute Maid Park (Enron Field)	2000	1999	2788	39	108326	116569	8	32
Xcel Energy Center	2000	2684	3081	15	67997	75862	12	3
AT&T Park (Pacific Bell Park)	2000	3773	3574	-5	140267	145178	4	-9
American Airlines Center	2001	2392	2698	13	146087	148678	2	11

Continued on next page...

Table 4 – Continued

		Treatment CTs			Control CTs			
Facility	**Year**	**Before**	**After**	**% Change**	**Before**	**After**	**% Change**	% $\Delta_{Treatment}$ - % $\Delta_{Control}$
Sports Authority Field at Mile High	2001	5852	5456	-7	89258	84960	-5	-2
Miller Park	2001	3003	3526	17	26442	28614	8	9
PNC Park	2001	1453	1444	-1	33211	32847	-1	0
Heinz Field (Rooney)	2001	1711	1729	1	32954	32562	-1	2
Gillette Stadium (CMGI)	2002	304	331	9	102800	116024	13	-4
Ford Field	2002	439	717	63	138284	128830	-7	70
Reliant Stadium	2002	2111	2430	15	118168	135830	15	0
AT&T Center (SBC Center)	2002	775	762	-2	36231	38482	6	-8
CenturyLink Field (Qwest Field)	2002	3096	3768	22	89286	105804	19	3
Great American Ballpark	2003	2225	2833	27	41908	49295	18	10
Toyota Center	2003	3184	4649	46	116173	158533	36	10
Lincoln Financial Field	2003	2522	3567	41	110703	137064	24	18
Jobing.com Arena	2003	2640	4439	68	115124	200946	75	-6
FedEx Forum	2004	1128	1896	68	25514	37587	47	21
Citizens Bank Park	2004	3053	5216	71	113301	143791	27	44
Petco Park	2004	3207	5419	69	72247	86988	20	49
TimeWarner Cable (TWC) Arena	2005	2805	4362	56	48198	67565	40	15
University of Phoenix Stadium	2006	4189	2406	-43	201196	137034	-32	-11
Busch Stadium III	2006	1763	1717	-3	72091	58099	-19	17
Prudential Center	2007	8505	3333	-61	404456	217714	-46	-15
Lucas Oil Stadium	2008	2324	569	-76	49530	24251	-51	-24
Nationals Park	2008	6866	3194	-53	264073	109320	-59	5
Average				31.1			19.5	11.7
Standard Deviation				38			27.1	23
Minimum				-76			-59	-46
Maximum				105			75	70

Table 5: Differences in Census Tract Characteristics, Treatment and Control Areas

		2-Mile Radius			3-Mile Radius		
Variable	Statistic	Treatment	Control	Difference	Treatment	Control	Difference
Population Density, $1000/km^2$	mean	4.4	1.8	2.6	4.2	1.7	2.4
	std. dev.	0.5	0.2	0.5	0.4	0.2	0.4
Average Age of Housing Units	mean	46.4	31.7	14.6	47.6	31.2	16.3
	std. dev.	1.7	1.0	1.4	1.5	1.0	1.2
Median Household Income	mean	30.8	51.6	-20.7	33.1	52	-18.9
	std. dev.	1.40	.9	1.5	1.4	0.9	1.4
Median House Value	mean	131.9	152.8	-21	135.7	153.3	-17.6
	std. dev.	11.6	8.1	8.1	12.4	8.0	8.4
% Black	mean	34.7	14.1	20.6	33.9	13.6	20.3
	std. dev.	3.4	1.1	2.7	3.2	1.1	2.5
% Hispanic	mean	17.9	11.8	6.2	17.6	11.6	6.0
	std. dev.	2.7	1.6	1.8	2.6	1.6	1.6
% Below Poverty Line	mean	27.1	10.3	16.7	24.5	10.0	14.5
	std. dev.	1.3	0.3	1.3	1.1	0.3	1.2
% Renter-occupied Housing	mean	63.1	32.6	30.5	57.9	32	25.9
	std. dev.	2.4	0.6	2.4	2.0	0.6	2

Notes: The statistics above are from an un-weighted sample of 56 facilities. Each treatment or control area associated with an individual facility is regarded as a single observation.

Table 6: Regression Results, 2-Mile Radius Treatment Area

	C1	C2	C3	C4	C5
	(1)	(2)	(3)	(4)	(5)
Treatment-2 miles	20.72	18.29	8.88	10.14	9.94
	(4.01)**	(4.13)**	(4.72)	(5.05)*	(4.79)*
Population density, $1000/km^2$		0.59	0.11	0.3	0.31
		(0.15)**	(0.14)	(0.1)**	(0.1)**
Median household income, thousands			-.04	0.02	0.04
			(0.08)	(0.07)	(0.07)
% below poverty line			0.61	0.72	0.58
			(0.16)**	(0.16)**	(0.12)**
Median house value, thousands				-.02	-.02
				(0.02)	(0.02)
% renter occupied units				-.05	-.05
				(0.05)	(0.05)
Average age of housing units, years				-.08	-.11
				(0.09)	(0.09)
% residents black alone					0.1
					(0.07)
% residents Hispanic					-.03
					(0.05)
% unemployed					0.2
					(0.16)
% residents with college degree					-.03
					(0.06)
% residents over 65					0.008
					(0.07)
% share of employment in manufacturing					-.27
					(0.13)*
Obs.	42176	42174	42088	41527	41522
R^2	0.41	0.41	0.43	0.44	0.45

* Significant at the 95% significance level; ** 99% significance level. Notes: 1) All regressions include facility-opening indicator variables, which precludes the inclusion of year and MSA dummies due to perfect collinearity. 2) The reported standard errors are cluster-adjusted at the level of facility-specific treatment and control groups. The sample has 56 facilities, each having one control group and one treatment group. There are thus 112 clusters. 3) The census information is from the 2000 Census, even if the facility involved was opened before 2000. The underlying assumption is that census characteristics are relatively stable over time. The 2000 Census is roughly the midpoint of our sample period of 1992-2010. 4) Census tracts are weighted by resident population.

Table 7: Regression Results, 3-Mile Radius Treatment Area

	C1	C2	C3	C4	C5
	(1)	(2)	(3)	(4)	(5)
Treatment-3 miles	16.68	14.62	6.50	8.00	7.42
	(3.54)**	(3.58)**	(3.91)	(4.25)	(4.14)
Population density, 1000/km^2		0.56	0.11	0.3	0.32
		(0.13)**	(0.14)	(0.09)**	(0.1)**
Median household income, thousands			-.04	0.02	0.04
			(0.08)	(0.07)	(0.07)
% below poverty line			0.6	0.72	0.57
			(0.15)**	(0.15)**	(0.12)**
Median house value, thousands				-.02	-.02
				(0.02)	(0.02)
% renter occupied units				-.06	-.05
				(0.05)	(0.05)
Average age of housing units, years				-.09	-.12
				(0.09)	(0.09)
% residents black alone					0.1
					(0.07)
% residents Hispanic					-.03
					(0.05)
% unemployed					0.19
					(0.16)
% residents with college degree					-.03
					(0.06)
% residents over 65					0.01
					(0.07)
% share of employment in manufacturing					-.26
					(0.13)*
Obs.	42176	42174	42088	41527	41522
R^2	0.41	0.41	0.43	0.44	0.45

* Significant at the 95% significance level; ** 99% significance level. Notes: 1) All regressions include facility-opening indicator variables, which precludes the inclusion of year and MSA dummies due to perfect collinearity. 2) The reported standard errors are cluster-adjusted at the level of facility-specific treatment and control groups. The sample has 56 facilities, each having one control group and one treatment group. There are thus 112 clusters. 3) The census information is from the 2000 Census, even if the facility involved was opened before 2000. The underlying assumption is that census characteristics are relatively stable over time. The 2000 Census is roughly the midpoint of our sample period of 1992-2010. 4) Census tracts are weighted by resident population.

Table 8: Summary Statistics

Variable	**Mean**	**Std. Dev.**	**Min.**	**Max.**	**N**
% change in residential mortgage applications	18.34	56.03	-80	420.84	42176
Treatment-2 miles	0.03	0.17	0	1	43023
Treatment-3 miles	0.06	0.24	0	1	43023
Population density; thousand per km^2	3.06	5.54	0	88.82	43020
Median household income in thousands	50.89	24.28	5	250	42874
Median house value in thousands	175.85	140.98	5	1250	42173
Average age of housing units in years	38.59	14.32	0.9	75	42883
% residents living in poverty	12.57	12.03	0	100	42909
% renter occupied units	37.9	24.87	0	100	42877
% unemployed	6.56	6.36	0	100	42903
% residents with college degree	27.6	19.42	0	100	42963
% residents black alone	17.78	27.35	0	100	42967
% residents Hispanic	13.37	19.38	0	100	42967
% residents over 65	12.26	7.32	0	100	42967
% share of employment in manufacturing	12.2	7.25	0	100	42896

Notes: All census statistics are from the 2000 Census.

Figure 1: Difference in Application Growth with a 2-mile radius

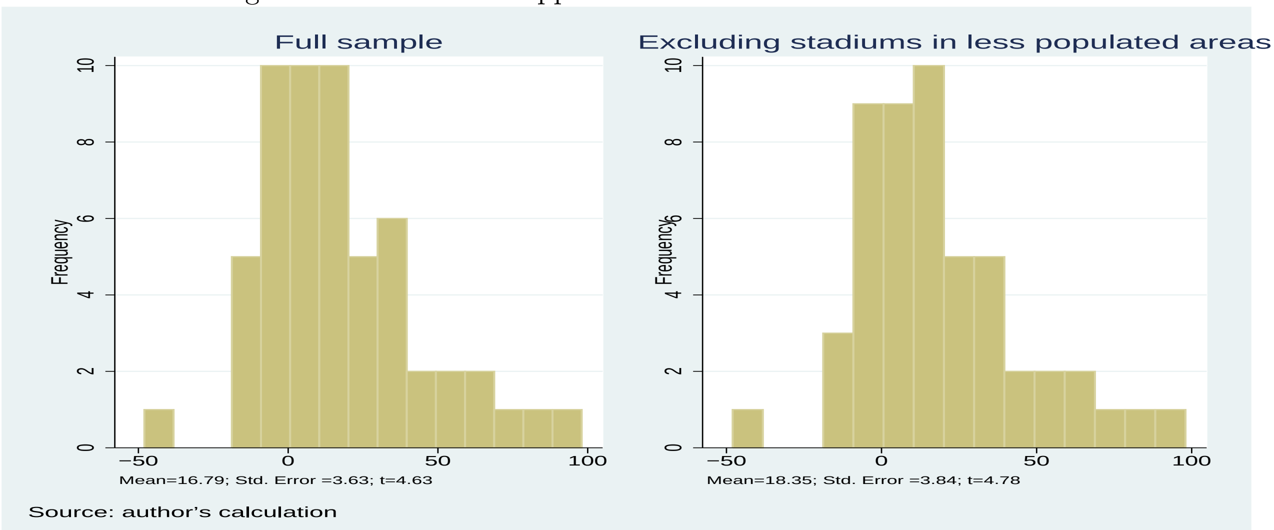
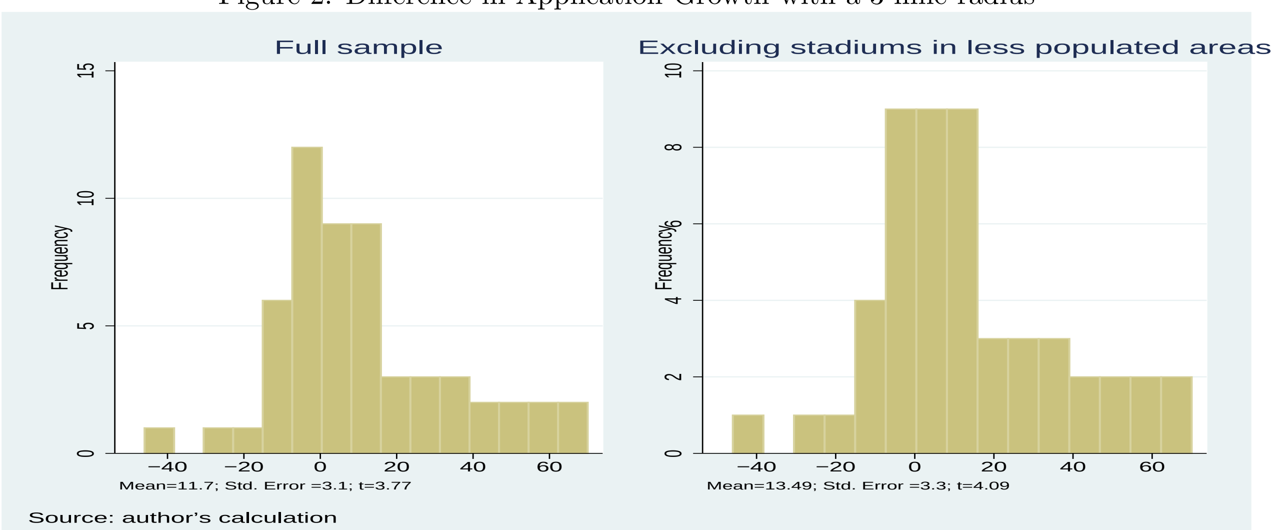


Figure 2: Difference in Application Growth with a 3-mile radius



Appendix - A: The Between-Census Revision in the Area Definition of Census Tracts

The Bureau updates area definitions between censuses to reflect population changes; the revisions "often involve[s] the subdivision of an existing census tract (or census tracts) into two or more new units." These revisions potentially can affect both the location of the population centroid for a census tract and residential mortgage application counts.

First, consider the consequences for population centroids in census tracts. The Census Bureau provides the longitude and latitude of a census tract's centroid based on resident population in the 2000 Census under the Census-2000 definition of census tracts. No equivalent information is available for the 1990 Census (and in any case, the population count will be outdated even if such centroid information is provided). Most of our mortgage application data, however, uses the Census-1990 area definition. The difference in definitions can be reconciled by re-weighting the centroid using the between-Census relationship file from the Census Bureaus. This relationship file comes with information on the distribution of resident population. We define the population-weighted centroid of a census tract under the 1990-definition as the population-weighted average of the longitudes and latitudes of all relevant parts in the relationship file that consists of the census tract; the weights are based on the resident population in the 2000 Census. For example, if a census tract under the 1990-definition was split into multiple descendant tracts, the population weighted centroid of the parent tract is the weighted average of the longitudes and latitudes of all the descendant tracts in the 2000 Census. We use the Census-2000 residents as weights to reflect demographic-allocation patterns in 2000, which is the midpoint of our sample period (1992-2008). If multiple census tracts in 1990 were merged into a single census tract in 2000, all those parental tracts share the same population centroid as the descendant tract. Other types of revisions are handled in a consistent way, using the Census-2000 population as weights. Finally, we assign census tract to MSAs defined in the 2000 Census. This does not play an important role, because few census tract switch metropolitan areas between censuses. The only difference is that in our tables of descriptive statistics, we will see MSA names as they were in the 2000 Census, instead of as they were in the 1990 Census.

Second, consider the consequences for mortgage counts. The HMDA reports incorporated the census updates with a lag, starting with the 1990-Census definition in 1992 before updating to the 2000-Census definition in 2003. A majority of our data (those from 1992 to 2002) are thus under the 1990-definition. The rest (those from 2003 to 2008) are under the 2000-definition. The Census Bureau provides geographic and demographic relationship files between these definitions. Using the relationship file and the information on resident population contained in them that that we use as weights, we allocate the mortgage applications in the 2003-2008 period to the 1990-Census definition of census tracts.

Appendix - B: Before and After the Housing Bust

Table B.1: Regression Analysis with a 2-Mile Radius; Excluding Facilities Opened After 2005 thus the Mortgage Data in the Housing Bust

	C1	C2	C3	C4	C5
	(1)	(2)	(3)	(4)	(5)
Treatment-2 miles	22.76	17.48	9.78	11.34	11.63
	(4.18)**	(4.99)**	(5.22)	(5.59)*	(5.16)*
Population density, $1000/km^2$		1.16	-.40	0.19	0.19
		(0.55)*	(0.48)	(0.46)	(0.43)
Median household income, thousands			-.13	0.05	0.06
			(0.08)	(0.08)	(0.08)
% below poverty line			0.69	0.83	0.51
			(0.17)**	(0.16)**	(0.15)**
Median house value, thousands				-.05	-.04
				(0.01)**	(0.01)**
% renter occupied units				-.02	-.01
				(0.05)	(0.05)
Average age of housing units, years				-.11	-.16
				(0.09)	(0.08)*
% residents black alone					0.18
					(0.07)**
% residents Hispanic					-.005
					(0.05)
% unemployed					0.37
					(0.15)*
% residents with college degree					-.02
					(0.07)
% residents over 65					0.006
					(0.09)
% share of employment in manufacturing					-.23
					(0.15)
Obs.	34621	34619	34547	34265	34260
R^2	0.19	0.19	0.22	0.23	0.24

* Significant at the 95% significance level; ** 99% significance level. Notes: 1) All regressions include facility-opening indicator variables, which precludes the inclusion of year and MSA dummies due to perfect collinearity. 2) The reported standard errors are cluster-adjusted at the level of facility-specific treatment and control groups. 3) The census information is from the 2000 Census, even if the facility involved was opened before 2000. The underlying assumption is that census characteristics are relatively stable over time. The 2000 Census is roughly the midpoint of our sample period of 1992-2010.

Table B.2: Regression Analysis with a 3-Mile Radius; Excluding Facilities Opened After 2005 thus the Mortgage Data in the Housing Bust

	C1	C2	C3	C4	C5
	(1)	(2)	(3)	(4)	(5)
Treatment-3 miles	18.82	14.70	7.93	9.71	9.45
	(3.61)**	(4.16)**	(4.29)	(4.72)*	(4.41)*
Population density, $1000/km^2$		1.03	-.45	0.15	0.16
		(0.54)	(0.48)	(0.45)	(0.42)
Median household income, thousands			-.13	0.05	0.06
			(0.08)	(0.08)	(0.08)
% below poverty line			0.68	0.82	0.5
			(0.16)**	(0.16)**	(0.14)**
Median house value, thousands				-.05	-.04
				(0.01)**	(0.01)**
% renter occupied units				-.02	-.01
				(0.05)	(0.05)
Average age of housing units, years				-.13	-.18
				(0.09)	(0.08)*
% residents black alone					0.18
					(0.06)**
% residents Hispanic					-.006
					(0.05)
% unemployed					0.37
					(0.15)*
% residents with college degree					-.02
					(0.07)
% residents over 65					0.01
					(0.09)
% share of employment in manufacturing					-.22
					(0.15)
Obs.	34621	34619	34547	34265	34260
R^2	0.19	0.19	0.22	0.23	0.24

* Significant at the 95% significance level; ** 99% significance level. Notes: 1) All regressions include facility-opening indicator variables, which precludes the inclusion of year and MSA dummies due to perfect collinearity. 2) The reported standard errors are cluster-adjusted at the level of facility-specific treatment and control groups. 3) The census information is from the 2000 Census, even if the facility involved was opened before 2000. The underlying assumption is that census characteristics are relatively stable over time. The 2000 Census is roughly the midpoint of our sample period of 1992-2010.

Table B.3: Regression Analysis with a 2-Mile Radius; Using Facilities Opened between 2006-08

	C1	C2	C3	C4	C5
	(1)	(2)	(3)	(4)	(5)
Treatment-2 miles	-.26	-.14	1.70	-1.33	0.5
	(5.22)	(4.52)	(4.57)	(6.82)	(6.23)
Population density, $1000/km^2$		0.44	0.52	0.35	0.37
		(0.02)**	(0.06)**	(0.11)**	(0.12)**
Median household income, thousands			0.21	0.06	0.02
			(0.03)**	(0.05)	(0.08)
% below poverty line			0.21	0.06	0.49
			(0.09)*	(0.14)	(0.06)**
Median house value, thousands				0.03	0.01
				(0.004)**	(0.008)
% renter occupied units				-.02	-.01
				(0.01)	(0.04)
Average age of housing units, years				0.006	0.01
				(0.05)	(0.03)
% residents black alone					-.21
					(0.03)**
% residents Hispanic					-.10
					(0.11)
% unemployed					-.26
					(0.1)**
% residents with college degree					0.14
					(0.11)
% residents over 65					0.17
					(0.1)
% share of employment in manufacturing					-.35
					(0.11)**
Obs.	7555	7555	7541	7262	7262
R^2	0.1	0.13	0.15	0.21	0.25

* Significant at the 95% significance level; ** 99% significance level. Notes: 1) All regressions include facility-opening indicator variables, which precludes the inclusion of year and MSA dummies due to perfect collinearity. 2) The reported standard errors are cluster-adjusted at the level of facility-specific treatment and control groups. 3) The census information is from the 2000 Census, even if the facility involved was opened before 2000. The underlying assumption is that census characteristics are relatively stable over time. The 2000 Census is roughly the midpoint of our sample period of 1992-2010.

Table B.4: Regression Analysis with a 3-Mile Radius; Using Facilities Opened between 2006-08

	C1	C2	C3	C4	C5
	(1)	(2)	(3)	(4)	(5)
Treatment-3 miles	-4.41 (5.77)	-4.54 (5.01)	-2.61 (4.94)	-3.00 (5.76)	0.89 (4.80)
Population density, 1000/km^2		0.44 (0.02)**	0.51 (0.06)**	0.34 (0.11)**	0.37 (0.12)**
Median household income, thousands			0.21 (0.03)**	0.06 (0.04)	0.02 (0.08)
% below poverty line			0.22 (0.09)*	0.07 (0.14)	0.49 (0.06)**
Median house value, thousands				0.03 (0.004)**	0.01 (0.008)
% renter occupied units				-.02 (0.01)	-.01 (0.04)
Average age of housing units, years				0.008 (0.05)	0.01 (0.03)
% residents black alone					-.21 (0.03)**
% residents Hispanic					-.10 (0.1)
% unemployed					-.27 (0.1)**
% residents with college degree					0.14 (0.11)
% residents over 65					0.17 (0.1)
% share of employment in manufacturing					-.35 (0.11)**
Obs.	7555	7555	7541	7262	7262
R^2	0.1	0.13	0.15	0.21	0.25

* Significant at the 95% significance level; ** 99% significance level. Notes: 1) All regressions include facility-opening indicator variables, which precludes the inclusion of year and MSA dummies due to perfect collinearity. 2) The reported standard errors are cluster-adjusted at the level of facility-specific treatment and control groups. 3) The census information is from the 2000 Census, even if the facility involved was opened before 2000. The underlying assumption is that census characteristics are relatively stable over time. The 2000 Census is roughly the midpoint of our sample period of 1992-2010.

Department of Economics, University of Alberta
Working Paper Series

http://www.economics.ualberta.ca/en/WorkingPapers.aspx

2012-04: Commercial Revitalization in Low-Income Urban Communities: General Tax Incentives vs Direct Incentives to Developers – **Zhou, L**
2012-03: Native Students and the Gains from Exporting Higher Education: Evidence from Australia - **Zhou**
2012-02: The Overpricing Problem: Moral Hazard and Franchises – **Eckert, H, Hannweber, van Egteren**
2012-01: Institutional Factors, Sport Policy, and Individual Sport Participation: An International Comparison – **Humphreys,** Maresova, **Ruseski**
2011-23: The Supply and Demand Factors Behind the Relative Earnings Increases in Urban China at the Turn of the 21st Century – **Gao, Marchand, Song**
2011-22: Tariff Pass-Through and the Distributional Effects of Trade Liberalization – **Ural Marchand**
2011-21: The Effect of Parental Labor Supply on Child Schooling: Evidence from Trade Liberalization in India – **Ural Marchand**, Rees, Riezman
2011-20: Estimating the Value of Medal Success at the 2010 Winter Olympic Games – **Humphreys,** Johnson, Mason, Whitehead
2011-19: Riding the Yield Curve: A Spanning Analysis – **Galvani, Landon**
2011-18: The Effect of Gambling on Health: Evidence from Canada – **Humphreys,** Nyman, **Ruseski**
2011-17: Lottery Participants and Revenues: An International Survey of Economic Research on Lotteries – Perez, **Humphreys**
2011-16: The Belief in the "Hot Hand" in the NFL: Evidence from Betting Volume Data – Paul, Weinbach, **Humphreys**
2011-15: From Housing Bust to Credit Crunch: Evidence from Small Business Loans – **Huang, Stephens**
2011-14: CEO Turnover: More Evidence on the Role of Performance Expectations – **Humphreys,** Paul, Weinbach
2011-13: External Balance Adjustment: An Intra-National and International Comparison - **Smith**
2011-12: Prize Structure and Performance: Evidence from NASCAR – Frick, **Humphreys**
2011-11: Spatial Efficiency of Genetically Modified and Organic Crops – Ambec, **Langinier**, Marcoul
2011-10: Unit Root Testing with Stationary Covariates and a Structural Break in the Trend Function - **Fossati**
2011-09: CDS as Insurance: Leaky Lifeboats in Stormy Seas – **Stephens,** Thompson
2011-08: Game Attendance and Competitive Balance in the National Hockey League – Coates, **Humphreys**
2011-07: Rationalization in the Canadian Retail Gasoline Industry: The Role of Environmental Regulations – **Eckert, H; Eckert, A**
2011-06: Physical Activity and Health Outcome: Evidence from Canada – **Humphreys,** McLeod, **Ruseski**
2011-05: Dating U.S. Business Cycles with Macro Factors – **Fossati**
2011-04: Covariate Unit Root Tests with Good Size Power – **Fossati**

Please see above working papers link for earlier papers