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# Unpacking the impacts of the Low-Income Housing Tax Credit program on nearby property values

**Ayoung Woo**
Texas A&M University, USA

**Kenneth Joh**
Texas A&M University, USA

**Shannon Van Zandt**
Texas A&M University, USA

**Abstract**
Most existing research on the impacts of the Low-Income Housing Tax Credit (LIHTC) on neighbouring property values is limited in terms of providing causal attribution and uncovering nuances in the role of housing market and neighbourhood composition. This article addresses these shortcomings by investigating the impacts of the LIHTC program in Charlotte, North Carolina and Cleveland, Ohio. Levels and trends in housing prices before and after LIHTC developments in neighbourhoods are examined based on parcel-level housing sales data from 1996 to 2007. The Adjusted Interrupted Time Series-Difference in Differences (AITS-DID) model is used to clarify the causal direction of impacts of LIHTC developments. The results show that LIHTC developments have negative impacts in Charlotte, while having upgrading effects in Cleveland. Also, these impacts vary across neighbourhoods' income heterogeneity. Thus, care should be taken when siting LIHTC developments to minimise negative impacts and enhance its use for community revitalisation across different housing market conditions.

**Keywords**
housing prices, Low-Income Housing Tax Credit, neighbourhood, neighbourhood heterogeneity, planning, spillover effects, subsidised housing

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## Introduction

Policymakers have long faced a dilemma with respect to the implementation of federal housing assistance programs. While the

**Corresponding author:**
Ayoung Woo, Landscape Architecture and Urban Planning, Texas A&M University, MS 3137 TAMU, College Station, TX 77843, USA.
Email: awoo@arch.tamu.edu

least-advantaged populations need affordable housing and suitable living environments, affluent residents frequently oppose the introduction of subsidised housing into their communities. Community opposition has been rooted in a negative perception of subsidised households, which fundamentally stems from attitudes toward tenant characteristics such as race/ethnicity and poverty (Freeman and Botein, 2002). The core issue of 'not in my back yard' (NIMBY) attitudes has been fear of the deterioration of property values due to the influx of 'undesirable' households. These attitudes have resulted in the exclusion of low-income residents from affluent neighbourhoods, and have exacerbated social, racial and housing inequalities in the United States. This is of paramount concern for planners and policymakers, especially in desirable neighbourhoods where affordable housing is scarce.

Prior studies examining the impacts of subsidised housing programs on nearby property values have produced conflicting results. Some researchers have found a negative impact (Cummings and Landis, 1993; Lee et al., 1999), while others have found a positive (Santiago et al., 2001; Schwartz et al., 2006) or even no impact (Castells, 2010; Sedway and Associates, 1983). These inconsistent findings may be due to two reasons: 1) the causal direction of impacts of subsidised housing on nearby property values is not clarified in the analysis, thereby confounding results; and 2) the impact of subsidised housing may vary across local housing market and submarket conditions. We address these gaps by examining how the spatial distribution of subsidised housing developments influences neighbouring property values. This article addresses a simple question: Do Low Income Housing Tax Credit (LIHTC) subsidised housing developments significantly affect nearby property values?

We examine the impacts of LIHTC developments on nearby property values from 1996 to 2007 in two US cities: Charlotte, North Carolina and Cleveland, Ohio. These cities are selected to compare how LIHTC impacts vary across different housing markets. Further, our analysis compares housing submarkets stratified by median family income to determine how impacts differ across low-, middle- and high-income neighbourhoods (Freeman and Botein, 2002). We examine factors associated with LIHTC developments and property values using a methodology that accounts for the levels and trends in housing prices over time. Our research may help policymakers better understand how LIHTC developments affect neighbourhoods and can help promote policies to enhance positive impacts and mitigate negative impacts.

## Literature review

### *How subsidised housing developments may affect nearby property values*

The impact of subsidised housing developments in neighbourhoods can be capitalised into housing prices, reflecting physical and socioeconomic changes (Baum-Snow and Marion, 2009). Literature from the past decade is replete with studies assessing whether subsidised housing has negative impacts on neighbouring housing prices. However, the findings have been inconsistent. Some researchers who found negative spillover effects of subsidised housing programs point to the influx of 'undesirables' as the cause of neighbourhood decline (Cummings and Landis, 1993; Lee et al., 1999), while others suggested that subsidised housing developments lead to neighbourhood revitalisation by eliminating disamenities in communities (Baum-Snow and Marion, 2009; Koschinsky, 2009; Schwartz et al., 2006). A critical review of the literature provides support for both perspectives.

Disparities between residents of subsidised housing and neighbourhood residents may result in dissonance among neighbours (Freeman and Botein, 2002; Nguyen, 2005). Such dissonance may induce a drop in housing prices if white residents flee or potential purchasers begin to view the neighbourhood as undesirable based on tenant characteristics or perceived disamenities (e.g. crime). In contrast, if subsidised households and non-subsidised households share similar socioeconomic characteristics, especially in lower-income neighbourhoods, the impact on neighbouring housing prices may be negligible (Ellen et al., 2005; Freeman and Botein, 2002). This underlines the significance of neighbourhood heterogeneity in assessing impacts of subsidised housing that have been overlooked in many previous studies. This article addresses this gap by classifying neighbourhood heterogeneity based on income level to examine the impacts of subsidised housing.[1]

Subsidised housing developments may also affect surrounding housing prices due to the removal of amenities or disamenities (Ellen et al., 2005; Freedman and Owens, 2011). The loss of historic buildings, parks and open space and other neighbourhood amenities may have a negative effect (Ellen et al., 2005); in contrast, the removal of undesirable land uses such as deteriorated buildings and abandoned lots may result in a positive impact (Castells, 2010; Freedman and Owens, 2011; Schwartz et al., 2006). Traditional US public housing programs have often been criticised for depressing housing prices and increasing crime within neighbourhoods, triggering neighbourhood decline (Lee et al., 1999; McNulty and Holloway, 2000; Roncek et al., 1981). In response to these concerns, the LIHTC program was established in 1986 to subsidise the development of low-income housing through an equity contribution by private developers, considered to be a more effective strategy for creating higher quality housing units and maintaining neighbourhood vitality (Deng, 2009). Additionally, many state agencies have promoted LIHTC developments to improve urban neighbourhoods by removing disamenities (Deng, 2007; National Council of State Housing Agencies, 2002). This may suggest that LIHTC developments, by revitalising distressed neighbourhoods, may have positive impacts on neighbouring property values. However, further investigation is needed to assess LIHTC's impacts on neighbourhoods, which is the aim of this research.

Project-based subsidised housing developments may also yield spillover effects due to new residential investment. Studies on housing investments typically found a positive impact of residential investment in new construction and rehabilitation on nearby property values (DeSalvo, 1974; Ding et al., 2000; Simons et al., 1998). Compared to other project-based subsidised housing programs, the LIHTC program is a market-based approach to providing affordable housing as well as market rate units (Deng, 2007; Van Zandt and Mhatre, 2009). Thus, LIHTC housing investments can reap the benefit of collective action in large-scale investments through partnerships between government and housing developers (Ellen et al., 2005; Schwartz et al., 2006). Further, new LIHTC developments that demonstrate success may attract additional residential investment into an area (Caplin and Leahy, 1998; Schwartz et al., 2006). In this way, LIHTC housing investments may have positive spillover effects on neighbouring housing prices by stimulating local development, which is directly investigated in this article.

### *Methodological limitations undercut previous evidence on the impacts of subsidised housing*

This research builds on previous literature examining spillover effects of subsidised housing developments on neighbouring housing prices. Earlier studies used the test versus control area methodology which compares housing prices in neighbourhoods that contained subsidised housing developments to neighbourhoods without subsidised housing. For instance, MaRous (1996) found no evidence that low-income housing units have a negative impact on market-rate housing units in Chicago. Additionally, the majority of previous studies found that there were positive (Nourse, 1963; Rabiega et al., 1984) or insignificant impacts of subsidised housing developments (Schafer, 1972; Sedway and Associates, 1983). However, a methodological limitation of earlier studies is the difficulty of knowing whether the test neighbourhoods were identical to the control neighbourhoods except for the existence of subsidised housing (Freeman and Botein, 2002). Although previous studies selected comparable neighbourhoods, there might be subtle differences that were not easily captured by the test versus control area approach. Further, this methodology cannot control for other factors such as locational, environmental and neighbourhood characteristics that can affect property values (Nguyen, 2005).

To overcome previous limitations and examine spillover effects of subsidised housing developments, many recent studies have employed a hedonic price methodology. However, these studies have typically used a cross-sectional analysis to examine the impact of subsidised housing on nearby property values, while not accounting for the direction of causality (Cummings and Landis, 1993; Goetz et al., 1996; Lee et al., 1999; Lyons and Loveridge, 1993). Subsidised housing tends to be developed in lower priced neighbourhoods due to NIMBY attitudes (Rohe and Freeman, 2001). Methodologically, this suggests that the causal direction of subsidised housing impacts should be accounted for in the analysis, to determine whether subsidised housing complexes are the cause of property value depreciation, or whether these units are placed only in neighbourhoods with lower prices to avoid controversy. The majority of previous studies do not account for these directions of causality. Additionally, as Galster (2004) notes, these studies are also prone to selection bias since they do not identify the preexisting price levels of neighbourhoods where subsidised housing was developed. However, a few researchers have accounted for causal direction by employing a quasi-experimental research design to consider preexisting price levels and trends (Ellen et al., 2005; Galster et al., 1999b; Koschinsky, 2009; Schwartz et al., 2006). For example, after accounting for causal direction, Schwartz et al. (2006) found that place-based subsidised housing had positive impacts in New York City, and this spillover effect increased with the size of subsidised developments.

Limitations of many previous studies examining the relationship between subsidised housing programs and nearby property values stem from the difficulty in employing a robust analytic methodology at the individual parcel level. This article attempts to overcome some of these limitations by applying the AITS-DID (Adjusted Interrupted Time Series-Difference in Differences) model to parcel-level sales transaction data. This approach helps to better understand the impacts of LIHTC developments on property values because the AITS-DID model identifies the direction of causality based on a difference-in-differences specification on levels and trends in housing prices. In addition to a more robust methodology, our study employs a comparative analysis by expanding the scope of our research area to two cities with contrasting market conditions to determine whether impacts of LIHTC developments vary across housing markets and by income level. The results from this study may help policymakers better understand the differential impacts of LIHTC developments on property values under various market and submarket conditions.

## Study area and data

### Defining proximity to LIHTC developments

We examined impacts on housing prices before and after the introduction of LIHTC subsidised housing using a concentric ring buffer around each property, known as a microneighbourhood (Castells, 2010; Galster et al., 1999b; Koschinsky, 2009; Lee, 2008; Schwartz et al., 2006). The microneighbourhood of each property, based on Euclidean distance rings, may include other properties within its radius. We classified properties based on their proximity to LIHTC developments; when the boundaries of LIHTC developments are contained within the property's microneighbourhood, the property was considered to be within the sphere of influence of LIHTC developments (Galster et al., 1999a). Boundaries of LIHTC complexes rather than the centroid were used, based on the notion that neighbours would be able to identify LIHTC units from the edge of the complexes. While buffer distances vary across research and are somewhat arbitrary, previous studies have used distances of 500 feet (Galster et al., 1999b; Santiago et al., 2001), 1000 feet (Galster et al., 1999b; Koschinsky, 2009; Santiago et al., 2001) or 2000 feet (Castells, 2010; Ellen et al., 2005; Galster et al., 1999b; Santiago et al., 2001; Schwartz et al., 2006).[2] For this study, a buffer distance of 2000 feet (600 meters) was used to define the microneighbourhood of each property. This buffer distance was selected based on a sensitivity test using various distance thresholds, and also to make results comparable to the existing literature.

### Study areas

Charlotte, North Carolina and Cleveland, Ohio were selected as study areas, representing different regions of the U.S. (South and Midwest, respectively). Both cities are notably outside of the urban Northeast, the focus of previous studies given its history of public housing programs (Freeman and Botein, 2002; Nguyen, 2005). Thus, our study extends the existing literature on subsidised housing beyond the Northeast region.

These two cities show contrasting economic and housing market conditions (Table 1). Charlotte exemplifies a growing Southern city (population 542,131 in 2000) and has experienced steady population growth during the past few decades (Delmelle et al., 2013). Despite the recent economic downturn, Charlotte remains one of the fastest growing cities in the U.S. (Rohe et al., 2012). In response to pressures from rapid growth, Charlotte has actively promoted residential revitalisation and investments in both downtown and its suburbs (Delmelle et al., 2014). In contrast, Cleveland has experienced post-industrial decline resulting in severe population loss and neighbourhood destabilisation (Koschinsky, 2009). To offset this substantial decline, Cleveland has focused on neighbourhood revitalisation and new residential investments as the top priority of the city development administrators' agenda (Ding et al., 2000). Despite civic and community efforts, the housing market in Cleveland remains stagnant: vacancy rates are twice as high as Charlotte and annual average number of sales transactions and housing permits are substantially lower than Charlotte during the study period. The annual average sales prices from 1996 to 2007 in Cleveland were around \$52,000, lower than its median housing value, indicating that Cleveland's housing market consists largely of lower price housing transactions. In contrast, the average sales prices in Charlotte (\$313,000) was two times higher than its median housing value, indicating that higher price housing is substantially transacted in Charlotte's housing market.

**Table 1.** City profile for Charlotte and Cleveland.

| City profile | Charlotte | | Cleveland | |
|---|---|---|---|---|
| | Number | Percentage | Number | Percentage |
| Population | 542,131 | - | 478,393 | - |
| Racial Composition | | | | |
| White | 298,501 | 55.06 | 186,368 | 38.96 |
| African-American | 175,563 | 32.38 | 240,362 | 50.24 |
| Hispanic | 40,008 | 7.38 | 34,554 | 7.22 |
| Others | 28,059 | 5.18 | 17,109 | 3.58 |
| Median Family Income ($) | 56,517 | - | 30,286 | - |
| Median Housing Value ($) | 134,300 | - | 72,100 | - |
| Total Housing Units | 230,556 | - | 215,844 | - |
| Vacancy Rate | 14,811 | 6.42 | 25,211 | 11.68 |
| Annual Average Number of Sales Transactions | 44,454 | - | 18,402 | - |
| Annual Average Sales Transaction Prices ($) | 313,306 | - | 52,604 | - |
| Annual Average Number of Housing Permits | 7636 | - | 407 | - |

*Source:* Average sales prices and number of sales transactions (1996–2007) came from historical housing sales data from the Mecklenburg County Assessor's Office and the Northeast Ohio Community and Neighborhood Data for Organizing (NEO CANDO); Average number of housing permits (1996–2007) was obtained from the Mecklenburg County IDS Public Reports and HUD's State of the Cities Data Systems; all the other data were tabulated based on the 2000 census data (U.S. Bureau of the Census 2000).

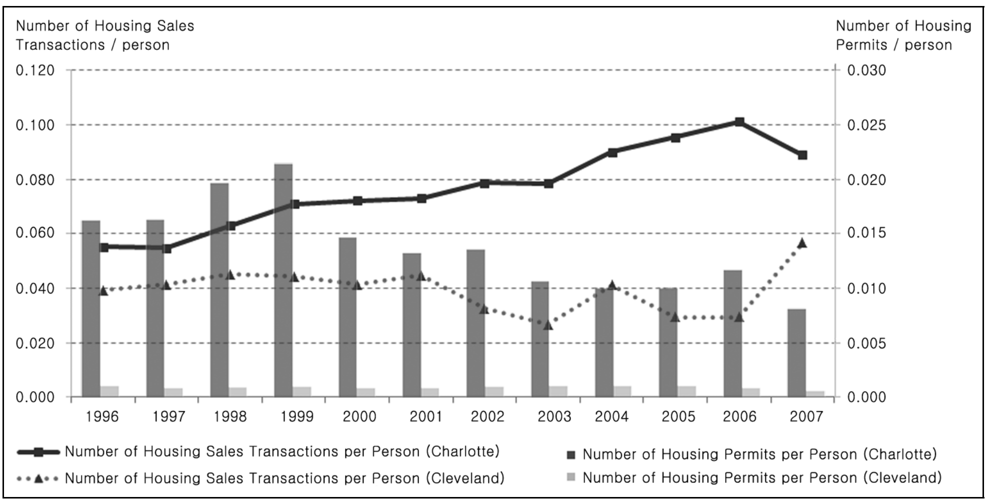


**Figure 1.** Housing market trends in the cities of Charlotte and Cleveland.

Trends in housing sales transactions and housing permits per person in the two cities from 1996 to 2007 are shown in Figure 1. In Charlotte, the number of housing sales transactions per person increased steadily from 0.05 to 0.10. In Cleveland, housing sales transactions were lower than Charlotte, and remained stagnant for most of this period. In terms of annual average number of housing sales transactions per person, Charlotte was twice that of Cleveland (0.8 versus 0.4). Additionally, although the number of housing permits per person in Charlotte gradually decreased since its peak in 1999, Charlotte was substantially higher than Cleveland (0.013 versus 0.001). Hence, there is a clear contrast in housing market conditions between Charlotte and Cleveland; by comparing these two cities, we can examine the varying impacts of subsidised housing developments.

### *Data sources and descriptions*

This study relies primarily on historic housing sales data for Charlotte and Cleveland from 1996 to 2007, obtained with permission from the Mecklenburg County Assessor's Office for Charlotte and from the Northeast Ohio Community and Neighborhood Data for Organizing (NEO CANDO) for Cleveland. The unit of analysis for this study was a single-family housing unit, and all forced sales transactions were excluded. Additionally, only housing sales at the latest transfer date between 1996 and 2007 were considered because structure characteristics data only included attributes at the latest transfer date and not historical records. The top and bottom 1 percent of the sample in sales prices was excluded to remove outliers. Also, census tracts with fewer than 10 property sales were excluded. After these conditions were applied, the final sample consisted of 114,471 housing sales transactions in Charlotte and 27,636 housing sales transactions in Cleveland during the 1996 to 2007 period. The summary statistics of variables included in our analysis are presented in Table 2.

Data obtained from the U.S. Department of Housing and Urban Development's (HUD) *Picture of Subsidised Households* were used to identify characteristics of LIHTC developments such as their size and spatial locations. However, due to incomplete data, the HUD data was supplemented with additional data from the Mecklenburg County Integrated Data Store (IDS) Public Reports, the Mecklenburg County GeoPortal and the Ohio Housing Finance Agency. The locations of LIHTC developments were triangulated using the Mecklenburg County GeoPortal (Charlotte), the Ohio Housing Finance Agency (Cleveland), Google satellite imagery and FindTheData. Project completion dates were obtained from the Mecklenburg County IDS Public Reports and the Ohio Housing Finance Agency. After cleaning the data, we determined the locations of 75 developments (4718 units) in Charlotte and 123 developments (8603 units) in Cleveland (see Figure 2).

Figure 2 shows the spatial distribution of neighbourhoods stratified by median family income for Charlotte and Cleveland.[3] For Charlotte, high-income neighbourhoods fan out from the centre towards the south, while low- and middle-income neighbourhoods are clustered in a crescent shape near the city centre. In Cleveland, low-income neighbourhoods comprise most of the centre while high-income neighbourhoods occupy the outskirts of the city.

The distribution of LIHTC developments in both cities across income submarkets is shown in Table 3. The majority of LIHTC developments are located in low- and middle-income neighbourhoods: 79 percent of LIHTC developments and 73 percent of units were located in low-income neighbourhoods in Charlotte; for Cleveland, 48 percent of LIHTC developments and 59 percent of units were located in low-income neighbourhoods.

Unobserved and time-invariant neighbourhood characteristics were also captured using 2000 census data. A total of 125 census tracts in Charlotte and 192 census tracts

**Table 2.** Citywide descriptive statistics.

| Variable definition and unit | Charlotte | | | | Cleveland | | | |
|---|---|---|---|---|---|---|---|---|
| | Mean | Std. Dev. | Min | Max | Mean | Std. Dev. | Min | Max |
| Dependent Variable | | | | | | | | |
| Sales Price ($1000) | 194.95 | 142.71 | 23.50 | 1039.50 | 73.74 | 37.41 | 3.50 | 239.90 |
| Independent Variables | | | | | | | | |
| *Structural Characteristics* | | | | | | | | |
| Heated Areas (sq ft) | 2055.27 | 904.84 | 414.00 | 13,580.00 | 1268.10 | 344.21 | 390.00 | 8023.00 |
| Property Sizes (sq ft) | - | - | - | - | 5.16 | 2774.76 | 340.00 | 102,000.00 |
| Building Age (years) | 17.29 | 20.59 | 0.00 | 107.00 | 74.64 | 26.03 | 0.00 | 207.00 |
| Number of Bedrooms (#) | 3.31 | 0.67 | 1.00 | 44.00 | 2.97 | 0.78 | 1.00 | 10.00 |
| Number of Full Bathrooms (#) | 2.03 | 0.63 | 1.00 | 8.00 | 1.10 | 0.31 | 1.00 | 4.00 |
| Number of Half Bathrooms (#) | 0.57 | 0.52 | 0.00 | 11.00 | 0.14 | 0.36 | 0.00 | 10.00 |
| Number of Fireplaces (#) | 0.84 | 0.39 | 0.00 | 11.00 | - | - | - | - |
| Binary: 1 = Electric Heating Source | 0.11 | 0.31 | 0.00 | 1.00 | - | - | - | - |
| Binary: 1 = Oil Heating Source | 0.01 | 0.09 | 0.00 | 1.00 | - | - | - | - |
| Binary: 1 = Brick/Stone Exterior | 0.26 | 0.44 | 0.00 | 1.00 | 0.09 | 0.29 | 0.00 | 1.00 |
| Binary: 1 = High-Housing Quality | 0.02 | 0.13 | 0.00 | 1.00 | 0.00 | 0.06 | 0.00 | 1.00 |
| Binary: 1 = Low-Housing Quality | 0.01 | 0.09 | 0.00 | 1.00 | 0.07 | 0.26 | 0.00 | 1.00 |
| Binary: 1 = Bungalow Housing Style | - | - | - | - | 0.07 | 0.25 | 0.00 | 1.00 |
| Binary: 1 = Colonial Housing Style | - | - | - | - | 0.49 | 0.50 | 0.00 | 1.00 |
| *Locational Characteristics* | | | | | | | | |
| Binary: 1 = Parks 250 ft. (75 m) | 0.07 | 0.25 | 0.00 | 1.00 | 0.05 | 0.21 | 0.00 | 1.00 |
| Binary: 1 = Rivers/Lakes 500 ft. (150 m) | - | - | - | - | 0.04 | 0.19 | 0.00 | 1.00 |
| *Year/Quarter Characteristics* | | | | | | | | |
| 1997 (Sales Year) | 0.04 | 0.20 | 0.00 | 1.00 | 0.06 | 0.24 | 0.00 | 1.00 |
| 1998 (Sales Year) | 0.05 | 0.22 | 0.00 | 1.00 | 0.07 | 0.25 | 0.00 | 1.00 |
| 1999 (Sales Year) | 0.06 | 0.24 | 0.00 | 1.00 | 0.07 | 0.26 | 0.00 | 1.00 |
| 2000 (Sales Year) | 0.07 | 0.25 | 0.00 | 1.00 | 0.07 | 0.26 | 0.00 | 1.00 |
| 2001 (Sales Year) | 0.07 | 0.26 | 0.00 | 1.00 | 0.08 | 0.27 | 0.00 | 1.00 |
| 2002 (Sales Year) | 0.08 | 0.27 | 0.00 | 1.00 | 0.06 | 0.24 | 0.00 | 1.00 |
| 2003 (Sales Year) | 0.09 | 0.28 | 0.00 | 1.00 | 0.09 | 0.29 | 0.00 | 1.00 |
| 2004 (Sales Year) | 0.10 | 0.30 | 0.00 | 1.00 | 0.10 | 0.30 | 0.00 | 1.00 |
| 2005 (Sales Year) | 0.12 | 0.32 | 0.00 | 1.00 | 0.13 | 0.33 | 0.00 | 1.00 |
| 2006 (Sales Year) | 0.14 | 0.35 | 0.00 | 1.00 | 0.12 | 0.32 | 0.00 | 1.00 |
| 2007 (Sales Year) | 0.14 | 0.35 | 0.00 | 1.00 | 0.10 | 0.30 | 0.00 | 1.00 |
| April–June (Sales Quarter) | 0.28 | 0.45 | 0.00 | 1.00 | 0.29 | 0.45 | 0.00 | 1.00 |
| July–Sept (Sales Quarter) | 0.28 | 0.45 | 0.00 | 1.00 | 0.27 | 0.45 | 0.00 | 1.00 |
| Oct–Dec (Sales Quarter) | 0.23 | 0.42 | 0.00 | 1.00 | 0.23 | 0.42 | 0.00 | 1.00 |
| *LIHTC Developments* | | | | | | | | |
| Within 2000 ft. (600 m) of LIHTC | 0.07 | 0.26 | 0.00 | 1.00 | 0.29 | 0.45 | 0.00 | 1.00 |
| LIHTC Units (#) | 3.21 | 22.61 | 0.00 | 504.00 | 12.21 | 38.18 | 0.00 | 811.00 |

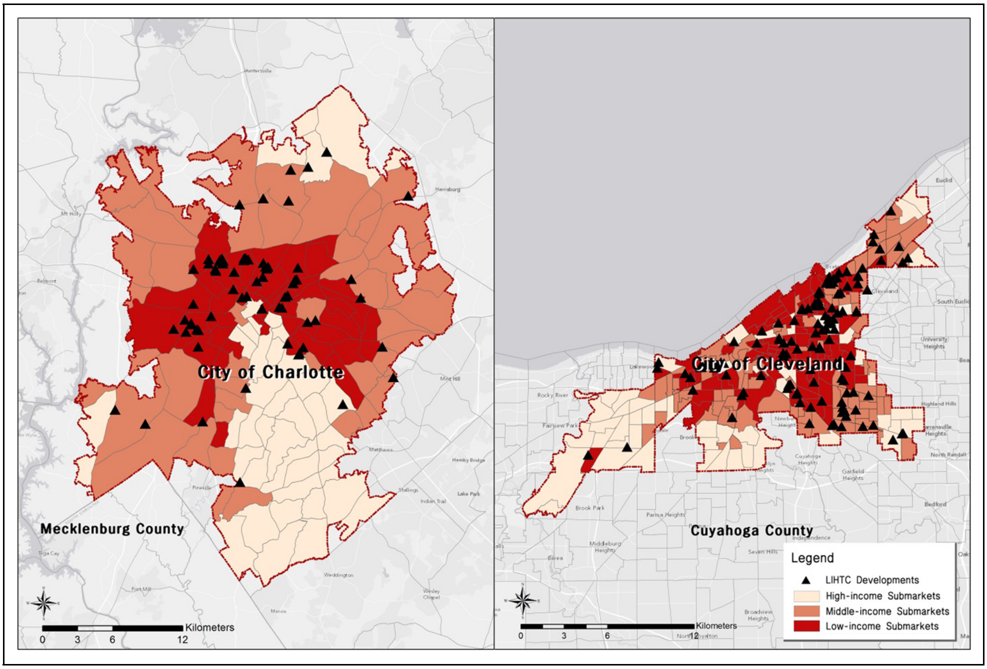


**Figure 2.** Charlotte and Cleveland LIHTC developments by neighbourhood heterogeneity.
*Source*: Cities of Charlotte and Cleveland GIS data sets.

**Table 3.** Distribution of LIHTC developments by submarkets.

| Submarkets (by income) | Charlotte | | Cleveland | |
|---|---|---|---|---|
| | No. of projects (%) | No. of units (%) | No. of projects (%) | No. of units (%) |
| Low-income | 59 (78.67) | 3447 (73.06) | 59 (47.97) | 5105 (59.34) |
| Middle-income | 12 (16.00) | 830 (17.59) | 46 (37.40) | 2645 (30.75) |
| High-income | 4 (5.33) | 441 (9.35) | 18 (14.63) | 853 (9.91) |
| Citywide | 75 (100.00) | 4718 (100.00) | 123 (100.00) | 8603 (100.00) |

in Cleveland were analysed in our sample. Geographic coordinates of each property normalised by the distance to the Central Business District (CBD) were derived from parcel data from both counties, 2000 census data and the Census Transportation Planning Products (CTPP) 2000 Home-to-work Flows data. We also used data obtained from each county's GIS Center data to calculate proximity to parks, rivers and lakes.

## Methodology

We used the AITS-DID model to specify the impact of subsidised housing on nearby property values. This approach compares the levels and trends of housing prices in neighbourhoods with LIHTC housing before and after it was developed with those in nearby neighbourhoods where LIHTC housing was not developed during the study period (Galster, 2004; Koschinsky, 2009).

The fundamental concept of the AITS-DID model is based on the hedonic price model, which postulates that housing goods are traded as a bundle of inherent attributes (Chin and Chau, 2003; Koschinsky, 2009; Rosen, 1974).

The centrepiece of the AITS-DID model is estimating housing prices after taking into account neighbourhood characteristics in terms of LIHTC developments. This model controls for the locational and neighbourhood characteristics of properties by using spatial fixed effects, and clarifies the direction of causality to capture the differentials in levels and trends of pre- and post-housing prices associated with LIHTC housing developments by comparing control and impact sales. Thus, the AITS-DID framework in this study is specified as:

$$\ln P_{int} = \alpha + \beta S_i + \gamma T_{it} + \delta L_i + \zeta N_n + \eta R_{it} + \mu M_{it} + \varepsilon_{int}, \quad (1)$$

where $\ln P_{\text{int}}$ is the log of housing sales price of property $i$ in neighbourhood $n$ at time $t$, that is transformed to a natural logarithmic functional form to reduce skewness and pull in outliers. $S_i$ is a vector of property-related structural characteristics such as heated areas, building age, number of bedrooms, number of bathrooms, number of half bathrooms, number of fireplaces, heating sources, exterior types, housing styles and housing quality.[4] The vector $T_{it}$ is a set of time indicators for each property indicating the year and quarter in which the sale occurred in order to account for seasonal differences. These variables consist of 11 indicators for the year of sale (with 1996 as the reference category) and three indicators for the quarter (with the first quarter as the reference category) in which the sale occurred. The variable $L_i$ includes the indicators of locational characteristics for each property such as proximity to parks (within 250 feet or 75 meters), rivers and lakes (within 500 feet or 150 meters) and the geographic coordinates of each property (normalised by distance to the CBD) to capture most remaining locational attributes (Koschinsky, 2009).[5] $N_n$ is a set of census tract fixed effects capturing the unobserved and time-invariant neighbourhood characteristics, which is census tract dummy variables signifying the year 2000 census tract for each neighbourhood to control for their distinct characteristics. $R_{it}$ is a vector of ring variables that captures housing price differentials and trends before and after LIHTC developments were located within a microneighbourhood, described in more detail in the section describing key variables. $M_{it}$ is a vector of size variables that explores the size effects of newly developed subsidised housing, which is the total number of subsidised housing units within a microneighbourhood after subsidised housing was developed, and $\varepsilon_{it}$ is an error term of the model. The coefficients $\alpha, \beta, \gamma, \delta, \zeta, \eta$ and $\mu$ are estimated employing ordinary least squares (OLS) regression with a robust standard error to correct for heteroskedasticity which might violate the assumption that the variance of the error term is the same across the housing submarket segmentations or space (Koschinsky, 2009; Wooldridge, 2009). Finally, for each city, models were estimated separately for three types of neighbourhoods stratified by family income, to test whether impacts of subsidised housing vary based on income heterogeneity.

## Key variables

The key variables comprise the vector of ring variables ($R_{it}$), which account for the differentials in levels and trends of pre- and post-housing prices related to LIHTC developments by comparing control and impact sales (Galster, 2004; Koschinsky, 2009; Lee, 2008). The underlying concept of these variables could be explained in terms of: 1) control/impact sales; and 2) pre/post differentials in levels and trends of housing prices.

First, all sales can be categorised into two groups: control sales and impact sales. Impact sales are properties where LIHTC housing is located within the property's microneighbourhood. Control sales are defined as properties where LIHTC housing is not within the property's microneighbourhood but located in the same census tract with impact sales (Koschinsky, 2009). Second, the ring variables capture the differentials in the levels and trends of housing prices in microneighbourhoods including LIHTC developments before and after its completion. Impact sales can be further divided into two categories according to the completion dates of LIHTC housing: pre-impact sales and post-impact sales. Pre-impact sales are transactions that took place prior to LIHTC developments while post-impact sales are sales that occurred after LIHTC housing was developed within their microneighbourhoods.

The ring variables include two dummy variables for the microneighbourhood of each property to capture the differences in housing price levels. Pre-impact sales for housing price levels (pre-price level) take on a value of one when there is or will be LIHTC developments within the microneighbourhood of the property (Galster et al., 1999b; Schwartz et al., 2006). This explains the existing average price levels in microneighbourhoods and reflects the inherent neighbourhood price levels before LIHTC housing is developed. Post-impact sales for housing price levels (post-price level) take on a value of one when the property has a completed LIHTC development within the property's microneighbourhood. This measures the housing price levels in microneighbourhoods after LIHTC housing is developed. By specifying these two indicators, we can compare the differentials in housing price levels with control sales before and after LIHTC was developed within microneighbourhoods.

The ring variables also include two more indicators for the microneighbourhood to estimate the break in housing price trends. One variable signifies the distance in days between the date of sale and the beginning of the research period (pre-price trend) (Galster et al., 1999b; Koschinsky, 2009). Another variable measures the distance in days between the date of sale and the completion date of subsidised housing (post-price trend) (Galster et al., 1999b; Koschinsky, 2009; Schwartz et al., 2006). In sum, the vector of ring variables allows us to compare the differentials in levels and trends of housing prices between impact sales and control sales before and after LIHTC housing was developed within microneighbourhoods.

## Results

### Citywide results

Table 4 shows the results for the citywide models for Charlotte and Cleveland. We first present the results for Charlotte.

All variables explain around 76.2 percent of the variance in property values. For sales price, the model showed expected coefficient signs for all structural variables. Thus, for the sake of brevity, we will focus on interpreting key coefficients for LIHTC developments. The main finding in the AITS-DID model for Charlotte was that the completion of LIHTC developments in a microneighbourhood had a significant negative effect on nearby property values (see Table 4 and Panel A in Figure 3). The coefficient of the pre-impact variable is negative, indicating that the housing price level is lower compared to the control area (i.e. outside the impact area but in the same census tract) before the siting of LIHTC housing. The housing price level for impact sales was

**Table 4.** Citywide results.

| Variables | Citywide results, Charlotte | | | | Citywide results, Cleveland | | | |
|---|---|---|---|---|---|---|---|---|
| | Coef. | t-value | Adj.Beta† | Robust Std. Err | Coef. | t-value | Adj.Beta† | Robust Std. Err |
| *LIHTC Developments* | | | | | | | | |
| Pre-price level 2000ft. | –0.055 *** | –5.19 | –5.383 | 0.011 | –0.085 *** | –3.18 | –8.104 | 0.027 |
| Post-price level 2000ft. | –0.068 *** | –5.33 | –6.550 | 0.013 | 0.070 ** | 2.32 | 7.299 | 0.030 |
| Pre-price trend 2000ft. | 0.005 *** | 3.18 | 0.474 | 0.001 | 0.012 *** | 2.71 | 1.174 | 0.004 |
| Post-price trend 2000ft. | 0.008 *** | 5.28 | 0.848 | 0.002 | –0.008 * | –1.75 | –0.785 | 0.005 |
| # of LIHTC Units | –1.08e–04 | –1.50 | –0.011 | 7.20e–05 | –6.41e–05 | –0.33 | –0.006 | 1.92e–04 |
| *Structural Characteristics* | | | | | | | | |
| *Log* Heated Areas | 0.641 *** | 125.43 | 89.806 | 0.005 | 0.380 *** | 19.03 | 46.178 | 0.020 |
| *Log* Property Sizes | - | | - | - | 0.092 *** | 8.13 | 9.636 | 0.011 |
| Building Age | –0.009 *** | –43.99 | –0.917 | 2.09e–04 | –0.013 *** | –19.33 | –1.303 | 0.001 |
| Building Age$^2$ | 1.01e–04*** | 30.39 | 0.010 | 3.33e–06 | 4.57e–05*** | 8.38 | 0.005 | 5.46e–06 |
| *Log* Number of Bedrooms | 0.023 *** | 3.02 | 2.324 | 0.008 | 0.072 *** | 4.28 | 7.423 | 0.017 |
| # of Full Bathrooms | 0.065 *** | 21.95 | 6.765 | 0.003 | 0.017 | 1.32 | 1.759 | 0.013 |
| # of Half Bathrooms | 0.004 | 1.60 | 0.360 | 0.002 | 0.037 *** | 2.79 | 3.751 | 0.013 |
| Number of Fireplaces | 0.048 *** | 15.27 | 4.950 | 0.003 | - | - | - | - |
| Electric Heating Source | 0.009 *** | 3.24 | 0.885 | 0.003 | - | - | - | - |
| Oil Heating Source | 0.011 | 0.75 | 1.075 | 0.014 | - | - | - | - |
| Brick/Stone Exterior Types | 0.108 *** | 36.10 | 11.451 | 0.003 | 0.052 *** | 5.53 | 5.285 | 0.009 |
| High-Housing Quality | 0.211 *** | 17.59 | 23.477 | 0.012 | 0.067 | 1.24 | 6.921 | 0.054 |
| Low-Housing Quality | –0.072 *** | –3.25 | –6.935 | 0.022 | –0.211 *** | –10.16 | –19.002 | 0.021 |
| Bungalow Housing Style | - | - | - | - | 0.059 *** | 3.96 | 6.120 | 0.015 |
| Colonial Housing Style | - | - | - | - | 0.055 *** | 6.69 | 5.631 | 0.008 |
| *Locational Characteristics* | | | | | | | | |
| Parks 250 ft. | –0.016 *** | –4.30 | –1.572 | 0.004 | 0.003 | 0.20 | 0.310 | 0.016 |
| River/Lake 500 ft. | - | - | - | - | 0.001 | 0.05 | 0.089 | 0.017 |
| X, Y Coordinates (CBD) | Included | | | | Included | | | |
| Census Tract Indicators | Included | | | | Included | | | |
| Seasonal Indicators | Included | | | | Included | | | |
| Number of Observations | 114,471 | | | | 27,636 | | | |
| $R^2$ | 0.7623 | | | | 0.3999 | | | |

*Notes:* ***denotes a 1% significance level; **denotes a 5% significance level; *denotes a 10% significance level; † Adjustment = $100(e^{\beta}–1)$, except Log Heated Areas, Log Property Sizes, and Log Number of Bedrooms; The full table including all variables (X-Y coordinates, seasonal indicators, and census tract indicators) is available from the lead author upon request.

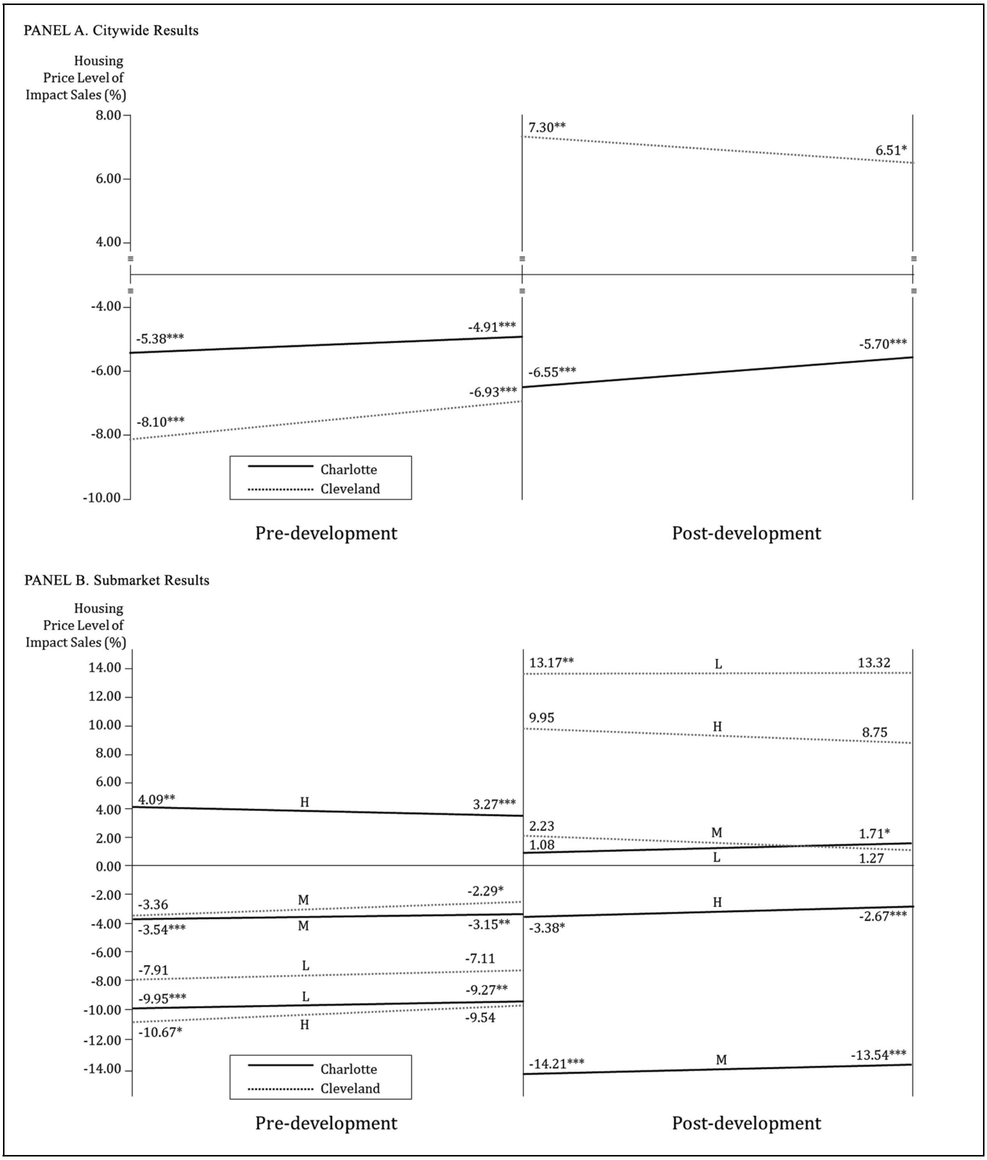


**Figure 3.** Citywide and submarket results: Pre- and post-sales price levels and trends.
*Notes:* ***denotes a 1% significance level; **denotes a 5% significance level; *denotes a 10% significance level; L = Low-income submarkets; M = Middle-income submarkets; H = High-income submarkets; Left-lines indicate the levels and trends of housing prices before LIHTC was developed while right-lines indicate the levels and trends after LIHTC was developed.

5.4 percent lower in the microneighbourhood compared to control properties located outside of the microneighbourhood before LIHTC was developed, *ceteris paribus*. However, the gap in housing price level between impact and control sales increased after the introduction of LIHTC units within a microneighbourhood. After the LIHTC complexes were developed within a microneighbourhood, the housing price level for impact sales was 6.6 percent lower compared to control sales; hence, the gap in housing price levels widened by 1.2 percent. Price trend changes show a 0.5 percent incline on average before LIHTC developments while averaging a 0.8 percent incline after the introduction of LIHTC.

Cleveland's citywide model explained around 40.0 percent of the variance in property values.[6] In contrast to Charlotte, LIHTC developments in a microneighbourhood had a positive impact on surrounding housing prices (see Table 4 and Panel A in Figure 3). The coefficient for the pre-impact variable showed a negative sign similar to Charlotte, and housing price level for impact sales was 8.1 percent lower in the microneighbourhood compared to control sales before LIHTC developments were sited. However, after LIHTC developments were located in a microneighbourhood, the housing price level was 7.3 percent higher than for control sales. The completion of the LIHTC developments significantly increased the housing price level in neighbourhoods, from –8.1 percent to 7.3 percent. Positive pre-price trends, averaging a 1.2 percent incline within a microneighbourhood, contrast with declining post-price trends by around 0.8 percent.

The citywide results for Charlotte showed that the introduction of the LIHTC developments had a negative impact on nearby property values. In contrast, the LIHTC developments for Cleveland positively affected surrounding housing prices.

### *Neighbourhood heterogeneity results*

Next we consider how the impact of LIHTC developments varies across housing submarket heterogeneity, in terms of low-, middle- and high-income neighbourhoods in Charlotte and Cleveland. For brevity, Table 5 reports only the results of key variables for each housing submarket.

Model 1 shows the results for low-income neighbourhoods in Charlotte and Cleveland. The pre-impact variable in Charlotte showed a negative coefficient indicating that the housing price level for impact sales was 10.0 percent lower compared to control sales before LIHTC developments. However, the post-impact variable was not statistically significant. Similar to the citywide models in terms of post-trend variables, post-price trend changes were far less substantial, averaging a 0.7 percent incline before the development of LIHTC, and a 0.6 percent incline after the development. Size effects of LIHTC developments were statistically significant; a one-unit increase in the number of LIHTC units at the time of sale decreased the housing price by 0.03 percent, *ceteris paribus*, in the low-income neighbourhoods of Charlotte.

The results for Cleveland showed that the LIHTC developments in a microneighbourhood had a positive impact on neighbouring housing prices for low-income neighbourhoods (see Panel B in Figure 3). The post-impact variable showed a positive coefficient indicating that the housing price level was higher compared to the control area after the LIHTC developments were sited. However, other variables related to LIHTC developments were not statistically significant.

Model 2 presents the results for middle-income neighbourhoods in both cities. The key finding for middle-income neighbourhoods in Charlotte was that LIHTC developments in a microneighbourhood had a negative impact on neighbouring housing prices (see Panel B in Figure 3). The housing

**Table 5.** Results for low-, middle- and high-income submarkets.

| Model 1 | Low-income submarkets, Charlotte | | | | Low-income submarkets, Cleveland | | | |
|---|---|---|---|---|---|---|---|---|
| | Coef. | t-value | Adj.Beta† | Robust Std. Err | Coef. | t-value | Adj.Beta† | Robust Std. Err |
| Pre-price level 2000ft. | –0.105 *** | –4.49 | –9.954 | 0.023 | –0.082 | –1.32 | –7.914 | 0.063 |
| Post-price level 2000ft. | 0.011 | 0.43 | 1.075 | 0.025 | 0.124 ** | 2.05 | 13.168 | 0.060 |
| Pre-price trend 2000ft. | 0.007 ** | 2.00 | 0.682 | 0.003 | 0.008 | 0.85 | 0.801 | 0.009 |
| Post-price trend 2000ft. | 0.006 * | 1.87 | 0.633 | 0.003 | 0.001 | 0.06 | 0.052 | 0.008 |
| # of LIHTC Units | –2.81e–04 *** | –2.96 | –0.028 | 9.48e–05 | –2.48e–04 | –0.72 | –0.025 | –3.44e–04 |
| Structural Characteristics | Included | | | | Included | | | |
| Locational Characteristics | Included | | | | Included | | | |
| X, Y Coordinates (CBD) | Included | | | | Included | | | |
| Census Tract Indicators | Included | | | | Included | | | |
| Seasonal Indicators | Included | | | | Included | | | |
| Number of Observations | 17,853 | | | | 4549 | | | |
| $R^2$ | 0.5770 | | | | 0.3434 | | | |
| **Model 2** | **Middle-income submarkets, Charlotte** | | | | **Middle-income submarkets, Cleveland** | | | |
| | Coef. | t-value | Adj.Beta† | Robust Std. Err | Coef. | t-value | Adj.Beta† | Robust Std. Err |
| Pre-price level 2000ft. | –0.036 *** | –2.73 | –3.536 | 0.013 | –0.034 | –0.94 | –3.362 | 0.036 |
| Post-price level 2000ft. | –0.153 *** | –7.20 | –14.209 | 0.021 | 0.022 | 0.58 | 2.233 | 0.038 |
| Pre-price trend 2000ft. | 0.004 ** | 1.88 | 0.386 | 0.002 | 0.011 * | 1.73 | 1.075 | 0.006 |
| Post-price trend 2000ft. | 0.007 *** | 2.96 | 0.668 | 0.002 | –0.010 | –1.58 | –0.961 | 0.006 |
| # of LIHTC Units | 0.001 *** | 4.75 | 0.106 | 2.23e–04 | 3.82e–05 | 0.16 | 0.004 | 2.35e–04 |
| Structural Characteristics | Included | | | | Included | | | |
| Locational Characteristics | Included | | | | Included | | | |
| X, Y Coordinates (CBD) | Included | | | | Included | | | |
| Census Tract Indicators | Included | | | | Included | | | |
| Seasonal Indicators | Included | | | | Included | | | |
| Number of Observations | 51,728 | | | | 10,598 | | | |
| $R^2$ | 0.5863 | | | | 0.2870 | | | |

*(continued)*

**Table 5.** (Continued)

| Model 3 | High-income submarkets, Charlotte | | | | High-income submarkets, Cleveland | | | |
|---|---|---|---|---|---|---|---|---|
| | Coef. | t-value | Adj.Beta† | Robust Std. Err | Coef. | t-value | Adj.Beta† | Robust Std. Err |
| Pre-price level 2000ft. | 0.040 ** | 2.44 | 4.094 | 0.016 | –0.113 * | –1.81 | –10.673 | 0.062 |
| Post-price level 2000ft. | –0.034 * | –1.69 | –3.377 | 0.020 | 0.095 | 0.94 | 9.948 | 0.100 |
| Pre-price trend 2000ft. | –0.008 *** | –3.94 | –0.825 | 0.002 | 0.011 | 1.10 | 1.137 | 0.010 |
| Post-price trend 2000ft. | 0.007 *** | 3.26 | 0.704 | 0.002 | –0.012 | –1.07 | –1.199 | 0.011 |
| # of LIHTC Units | –4.81e–04 *** | –3.14 | –0.048 | 1.53e–04 | –2.13e–04 | –0.15 | –0.021 | 0.001 |
| Structural Characteristics | Included | | | | Included | | | |
| Locational Characteristics | Included | | | | Included | | | |
| X, Y Coordinates (CBD) | Included | | | | Included | | | |
| Census Tract Indicators | Included | | | | Included | | | |
| Seasonal Indicators | Included | | | | Included | | | |
| Number of Observations | 44,890 | | | | 12,489 | | | |
| $R^2$ | 0.6988 | | | | 0.4318 | | | |

*Notes:* ***denotes a 1% significance level; **denotes a 5% significance level; *denotes a 10% significance level; † Adjustment = $100(e^{\beta}–1)$; The full table including all variables (structural and locational characteristics, X-Y coordinates, seasonal indicators and census tract indicators) is available from the lead author upon request.

price level for impact sales was 3.5 percent lower than control sales before LIHTC was developed, and 14.2 percent lower after LIHTC was introduced. Post-price trend change was statistically significant, averaging a 0.4 percent incline before the LIHTC development, and a 0.7 percent incline after the development. Interestingly, building more units in LIHTC developments appears to mitigate the negative effects of LIHTC developments; a one-unit increase in the number of LIHTC units at the time of sale increased housing price by 0.1 percent, *ceteris paribus*.

For Cleveland, the $R^2$ for the middle-income neighbourhoods was lower than that for other models such as models for low- and high-income neighbourhoods; the model accounted for around 28.7 percent of the variance in the property values. Compared to other models, small numbers of structural variables were only statistically significant. Furthermore, the pre- and post-impact variables were not statistically significant, although the coefficients maintained the same signs as other submarket models.[7]

For high-income neighbourhoods in Charlotte, the pre-price level variable showed a positive coefficient (see Model 3). The pre-existing housing price level of impact areas prior to LIHTC developments was 4.1 percent higher compared to control areas. The pre-price level in high-income submarkets contrasts with that in other submarkets such as low- and middle-income neighbourhoods in Charlotte. The post-impact variable for high-income neighbourhoods showed a negative sign indicating that the housing price level for impact sales was lower compared to control sales after the LIHTC units were developed, although statistically significant only at the 10 percent level.[8] Negative pre-price trends, averaging a 0.8 percent decline within a microneighbourhood, contrast with inclining post-price trends around 0.7 percent. The development size effect was also statistically significant; a one-unit increase in the number of LIHTC units at the time of sale decreased housing price by 0.05 percent, *ceteris paribus*.

For Cleveland, the post-price level, pre- and post-trend variables were not statistically significant, although the coefficients maintained the same signs as other models.

## Conclusion

Our citywide results suggest that LIHTC developments have a differential impact across local housing markets. LIHTC developments had a negative impact on surrounding housing prices in Charlotte, while having a positive impact in Cleveland.

Charlotte experienced active residential development, mirroring its rapid population growth. Furthermore, transactions of higher priced housing were more prevalent in the Charlotte housing market than in Cleveland. Given the relatively higher property values of non-subsidised housing compared to subsidised housing, LIHTC developments appear to have been perceived as undesirable development, rather than an instrument for stimulating residential investment. In contrast, Cleveland's housing market has experienced stagnation shown by the lack of new housing construction and fewer sales transactions, juxtaposed with severe population loss and neighbourhood destabilisation. In an already stagnant housing market, any residential investment (including LIHTC development) may have a stimulating effect. Indeed, many state agencies have utilised LIHTC developments to revitalise distressed communities, and the positive impacts of such developments may be related to the removal of disamenities such as dilapidated and abandoned buildings that damage residential property values and promote crime (Schwartz et al., 2006). Therefore, subsidised housing developments in stagnant housing markets may serve as tools for new residential investment and community revitalisation rather than a locally undesirable land use.

Our findings also showed that the impacts of LIHTC developments varied across different housing submarkets. It is notable that spillover effects in low-income neighbourhoods were not statistically significant in Charlotte. This finding might be interpreted in several ways. First, differences in tenant characteristics between LIHTC housing and neighbours in low-income neighbourhoods of Charlotte may not be as pronounced compared to middle- or high-income neighbourhoods. Thus, the response to the introduction of new low-income households might not be as sensitive in low-income neighbourhoods. Second, low-income submarkets in higher density (i.e. multifamily) residential areas may be less sensitive to new subsidised housing developments than middle- or high-income neighbourhoods dominated by low density single family housing. Third, realtors may not want to exert the same level of effort to provide this information to low-income clients compared to those of higher income due to lower commission (Galster, 1987; Kobie and Lee, 2011). In contrast, LIHTC developments in low-income neighbourhoods of Cleveland had positive impacts on neighbouring housing prices. These upgrading effects imply that LIHTC developments might be deemed as the tool for new residential investment and community revitalisation by neighbours in deteriorated neighbourhoods in cities with depressed housing market conditions like Cleveland.

Our results for middle-income submarkets showed that the influx of LIHTC subsidised households negatively affects surrounding housing prices in Charlotte. Interestingly, the size effects of LIHTC developments were positive for middle-income neighbourhoods in Charlotte. This finding suggests that larger developments might mitigate the negative effects of LIHTC units. The influx of subsidised households into neighbourhoods contributes to housing price decreases, but larger developments may alleviate housing price decreases. However, the impacts of LIHTC developments in middle and high-income neighbourhoods were not statistically significant in Cleveland (although the coefficient maintained the same positive sign as the Cleveland citywide results). Thus, LIHTC developments used as a tool for residential investment and revitalisation may have a minimal impact on housing prices for middle- and high-income neighbourhoods in a depressed housing market. The results for high-income submarkets in Charlotte suggested that LIHTC developments had negative impacts on neighbouring property values. Size effects of LIHTC developments were also significant indicating that a larger number of LIHTC units for high-income neighbourhoods had larger spillover effects on neighbouring property values in Charlotte.

Our results suggest that the common perception that subsidised housing developments negatively affect neighbourhoods needs to be viewed in a more nuanced way. Subsidised housing developments in depressed housing market conditions may generate positive externalities by enhancing neighbourhood housing prices. Low-income neighbourhoods in depressed housing markets such as Cleveland may benefit from increased property values as LIHTC developments contribute to community revitalisation and residential investment, stimulating stagnant market conditions. Further, even in more robust market conditions, subsidised housing developments may have a positive impact, as shown by the impact of larger developments in middle-income neighbourhoods in Charlotte. Hence, housing market and submarket conditions should be considered when siting LIHTC developments. Cities with stagnant market conditions may be able to use LIHTC investments to provide affordable housing for low-income families by stimulating neighbours' perception of the demonstration effect of residential investments and community revitalisation for communities. Furthermore, policymakers may encounter less community opposition to LIHTC developments in these markets and neighbourhoods.

However, our findings should not be interpreted as implying that subsidised housing units should not be placed in affluent neighbourhoods and robust markets. LIHTC developments in high-income submarkets and stimulated market conditions may not necessarily lead to housing price decreases in the long run because trends in housing prices increased after LIHTC developments in the citywide and high-income submarket results. The mixing of income groups via the integration of subsidised housing developments in affluent neighbourhoods is a worthy aim and should be facilitated to achieve poverty deconcentration and more equitable access to socioeconomic opportunities for subsidised households (Van Zandt and Mhatre, 2009). The neighbourhoods where subsidised households live largely affect their socioeconomic opportunities for improved life outcomes and upward mobility (Crowley, 2003; Ellen and Turner, 1997; Massey and Denton, 1993).

Our intent here is to help identify the conditions under which undesirable outcomes of LIHTC developments are more or less likely. Developers of affordable housing in 'hot' or rapidly appreciating markets face a special kind of challenge, as is evident by the dearth of affordable units in the upper end of the market. At the very least, our findings suggest that policymakers should be prepared to defuse strong community opposition to LIHTC developments to achieve poverty deconcentration and income mixing in affluent neighbourhoods. They are not intended to suggest that affordable housing developers should avoid these areas, but rather highlight the difficulties they may face in placing affordable housing in burgeoning or affluent markets.

However, creative design approaches may help affordable housing units blend in with existing buildings in the community. For instance, the visibility of physical and design structure in LIHTC developments may be improved to enhance the tool for community revitalisation and mitigate community opposition because physical design of new developments may affect nearby property values. Schill et al. (2002) have suggested that the design of developments may matter to the extent that the physical design is consistent with the neighbourhood's visual character. HUD's partnership with the American Institute for Architects (AIA) in developing the Affordable Housing Design Advisor (www.designadvisor.org) also offers recommendations for maintaining massing, setback and other land development regulations to ensure consistency.

Further, statewide Qualified Allocation Plans (QAPs), which guide requirements for LIHTC development within each state, including guidelines for the siting of developments, may also address income mixing in LIHTC developments. While the LIHTC program was conceived of as a mixed-income approach, it has largely been implemented with very high proportions of low-income units (HUD, 2005). Our results suggest that in higher-income neighbourhoods in rapidly appreciating markets, such as Charlotte's, LIHTC guidelines might limit the proportion of low-income units, and offset the loss of volume of units available for low-income households by encouraging developments with higher numbers of units.

## Limitations

We examined the impacts of subsidised housing in Charlotte and Cleveland, choosing these study areas to provide contrasting market conditions; these cities may not, however, represent housing market conditions in other cities by reason of the uniqueness of each city. Further, we were unable to control for all alternative explanations for the observed differences, given data limitations. For instance, the differential impacts of LIHTC developments might reflect differences in racial and ethnic composition between the two cities, with Charlotte being majority white and Cleveland being majority African-American. If LIHTC residents are people of a race/ethnicity different than surrounding residents, the influx of these residents may have been more strongly opposed by more affluent and white residents in Charlotte. While this suggests a racial and ethnic bias that might account for differences in the impacts of LIHTC development, we are unable to determine the magnitude or extent of this bias due to the unavailability of tenant level data on race and ethnicity for LIHTC residents. We suggest that future studies extend the scope of impacts of LIHTC developments across other cities and other housing market conditions with tenant level data about LIHTC units.

Additionally, although many state agencies aim to utilise LIHTC developments to revitalise deteriorated communities, there is a lack of empirical evidence as to whether increases in housing prices are due to the effort of community revitalisation. Thus, additional future studies examining the change of land use due to subsidised housing developments (i.e. the replacement of a desirable or undesirable use) may empirically look beyond the current role of LIHTC developments as the tools for community revitalisation.

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## Notes

1. Neighbourhood heterogeneity could be defined by ethnicity and income level. However, we focused on the income levels of neighbourhoods to stratify the neighbourhood's heterogeneity. Because LIHTC subsidized units are occupied by households with income below 50 or 60 percent of the Area Median Income (AMI), the discrepancies in income levels of tenant characteristics between subsidized households and neighbours would play a key role in allowing different impacts across neighborhoods (Freeman, 2004; McClure, 2006).
2. In some studies, buffer distances are classified as three distance bands: 500, 1000, and 2000 feet (Galster et al., 1999b; Santiago et al., 2001).
3. Neighbourhoods in both cities were stratified into three categories based on median family income in 2000 at the census tract level: low-income (less than 80 percent of the city's median family income), middle-income (80 to 120 percent) and high-income (greater than 120 percent).
4. After checking the normality of each variable using tests for kurtosis and skewness, two variables (heated areas and number of bedrooms) for Charlotte and three variables (property sizes, heated areas and number of bedrooms) for Cleveland were transformed using a natural log transformation. Also, the independent variable 'age of a structure' consists of quadratic functions to capture the marginal effect.
5. Incorporating the geographic coordinates of each property in the empirical model explains or reduces spatial heterogeneity and spatial correlation (Koschinsky, 2009). Additionally, a CBD was defined as the centroid of the census tract including the highest job density in the city. Job density was calculated as the number of jobs per square metre of land use in each census tract.
6. Due to the different sources of data for structural characteristics, the models for Charlotte and Cleveland are not identical. There are certain structural variables included in the model for Charlotte (e.g. number of fireplaces and heating sources) that are not included in the model for Cleveland, and vice versa.

7. Cleveland consists mostly of poorer neighborhoods compared to its suburbs. If the Cleveland submarkets were not classified by the city's median family income but by Cuyahoga County's median family income, Cleveland would have a higher proportion of low-income submarkets (86.9 percent) compared to the suburbs. The greater homogeneity of neighbourhood characteristics in terms of poorer housing and neighbourhood conditions in Cleveland may explain the insignificance of many independent variables in the results (Kobie and Lee, 2011). Lack of variation in the explanatory variables may not account for the effects of LIHTC developments, especially in middle-income neighbourhoods of Cleveland.
8. For the analysis of high-income neighborhoods, the small variation of impact sales might be an issue. In Charlotte high-income submarkets, out of 44,890 sales, 2.9 percent (1290 sales) are within 2000 feet of LIHTC developments. In Cleveland high-income submarkets, out of 12,489 sales, 10.7 percent (1334 sales) are within 2000 feet of LIHTC projects.

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