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Effects of concentrated LIHTC development on surrounding house prices

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ABSTRACT

The Low-Income Housing Tax Credit is the largest supply-side housing subsidy in the United States, with more than $8 billion worth of credits allocated per year. For a variety of reasons, LIHTC properties tend to be geographically concentrated in low-income urban communities. While numerous studies have examined the spillover effects of these properties on local property values, they have not accounted for the cumulative effects of clustering multiple LIHTC properties within an area. This paper examines the effects of introducing additional LIHTC developments in urban neighborhoods to determine whether the concentration of these affordable housing properties negatively affects local home values. We combine an interrupted time series model with a difference-in-difference approach to estimate the price effects in Chicago and surrounding Cook County, Illinois. We find some evidence that both stand-alone and clustered LIHTC developments generate positive price spillover effects on the surrounding neighborhoods; subsequent LIHTC projects do not affect prices negatively. The benefits are strongest within one quarter mile of the development, but smaller impacts prevail for up to a half mile from the LIHTC property. The positive impacts remain strong for at least 10 years after the initial development. The cumulative price effect is positive in both lower and higher-income areas and more significant in lower-income areas.

1. Introduction

Since its creation as part of the Tax Reform Act of 1986, the federal Low-Income Housing Tax Credit (LIHTC) has been the primary public subsidy for affordable housing in the United States. The credit provides an incentive for taxable entities to invest equity in rental properties in which most of the units are reserved for households making 60% or less of the area median income (AMI). Over the past 30+ years, LIHTC-related equity has facilitated the development, rehabilitation, and/or preservation of approximately three million units of affordable housing throughout the country. Many developers view the LIHTC program not only as a solution to the ongoing affordable housing shortage, but also as a critical tool in helping stabilize and revitalize distressed urban neighborhoods.

Over the past 15+ years, researchers have devoted considerable attention to the spillover effects of LIHTC properties on surrounding communities. Most analyses (e.g., Ellen et al 2007; Baum-Snow & Marion 2009; Diamond & McQuade 2019) focus on the properties' effects on local home values. The studies generally find neutral to positive impacts, with some variation across different types of communities.

Unfortunately, these analyses generally have not addressed the cumulative effects of LIHTC properties over time. This longer-term assessment is important because of the propensity of developers to locate subsequent LIHTC properties in relatively close proximity to existing LIHTC developments. Several researchers have documented that LIHTC properties tend to be far more clustered than other affordable housing properties and even other residential units (e.g., Oakley 2008; Van Zandt & Mhatre 2009; Dawkins 2013). In Chicago, for instance, more than 90% of LIHTC properties designed for non-elderly tenants and placed in service between 1987 and 2016 are located within one-half

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mile of at least one other LIHTC property. It is reasonable to assume that the spillover effects of earlier properties both influence and are influenced by the presence of subsequent LIHTC properties within the same area.

With a median tenant household earning only $17,943 in 2017 dollars (Office of Policy Development and Research 2019), LIHTC developments effectively concentrate low- and very low-income households within both individual properties and neighborhoods. Given the widely accepted axiom that concentrated poverty contributes to neighborhood economic distress and decline, it is important to understand the spillover ramifications of LIHTC clustering. Does the addition of subsequent LIHTC properties within a community worsen local conditions? Does it actually increase investment in the surrounding area? Or does it have little impact on local home prices? The answer has direct implications for developers and policymakers concerned about stabilizing and revitalizing urban neighborhoods, building wealth among local homeowners, and incorporating equity-seeking objectives into the LIHTC allocation process.

Our study offers an initial response to these questions. We examine the extent to which the development of subsequent LIHTC properties in Chicago-area neighborhoods affects the price of surrounding single-family homes. We document the generally positive effect that an initial LIHTC development has on surrounding property values and then analyze whether the addition of a second or third LIHTC property in close proximity augments or counteracts those effects. We assess whether the clustering effects vary across different types of communities.

We find that the development of subsequent LIHTC properties within a community does not lower surrounding values. In short, more development is not worse and often may be better – at least for local property values. The average positive spillover impacts are greatest in the region's lowest-income neighborhoods but are present in more affluent areas as well. Similarly, impacts are consistently positive in communities with both higher and lower percentages of Black residents. These findings help alleviate concerns about bringing more affordable housing into low-income communities of color and suggest that continued investment in LIHTC properties can and does play a critical and beneficial role in neighborhood revitalization strategies.

2. Context

2.1. Clustering of LIHTC properties

LIHTC properties tend to be located in a relatively small subset of urban neighborhoods. More than 55% are in census tracts with a poverty rate of at least 20%. The average LIHTC unit sits in a tract whose poverty rate is six percentage points higher than the average rate for tracts with only unsubsidized rental units (Ellen, Horn, & Kuai 2018). LIHTC developments are noticeably more concentrated than other multi-family residential units in the nation's 10 largest metropolitan areas (Dawkins 2013).

This geographic concentration stems in large part from the scoring criteria used in LIHTC allocation decisions. Allocating authorities typically prioritize properties located in Qualified Census Tracts (QCTs), those with high levels of economic distress. In Illinois, for instance, a QCT is one in which at least 25% of residents live in poverty and/or half or more of resident households earn 60% or less of AMI. Baum-Snow and Marion (2009) found that developers are more likely than not to concentrate LIHTC-financed units in QCTs, and that LIHTC properties in QCTs contain an average of six more units than properties in tracts just below the QCT threshold. Oakley (2008) found the strongest predictors of a LIHTC property's location to be the presence of QCTs, the presence of existing LIHTC developments in the area, and the proximity of other LIHTC developments.

Of course, there is considerable variation among QCTs and other low-income communities. Some have very distressed (and potentially weakening) real estate markets, while others have recently experienced property value appreciation or appear to be on the verge of noticeable improvements. A LIHTC developer may have an incentive to invest in a comparatively stronger micro-market where real estate values are trending upward, since those are likely to be areas with a declining supply of affordable housing for low-income residents. At the same time, Oakley's research suggests a predilection among developers toward locating new LIHTC properties in communities where LIHTC developments already exist. The success of an existing LIHTC property – measured in terms of occupancy and public acceptance, among other indicators – presumably serves as a good indicator of an area's ability to absorb another such development.

These realities complicate efforts to tease out the spillover effects of LIHTC developments. In theory, some of the initial LIHTC developments could have helped catalyze subsequent investment; part of the price appreciation could result from the LIHTC intervention. In certain Chicago communities, for instance, early LIHTC projects represented some of the only investment that had occurred in their communities for several years (Bostic et al 2020). On the other hand, if LIHTC developers deliberately have chosen to build or rehabilitate properties in already improving neighborhoods, then it is harder to attribute subsequent price appreciation to the LIHTC intervention. Any observed LIHTC spillover effects may be skewed high due to selection bias.

Moreover, in areas with multiple LIHTC properties, the effects of the later developments likely will be influenced by the effects of the prior ones. In such areas, observed increases in local land values subsequent to the introduction of another LIHTC property could be a result of pre-existing price trends and other conditions possibly due to the previously developed LIHTC(s), not the LIHTC property itself.

It is not clear to what extent recent market dynamics factor into developers' locational decisions. The LIHTC program limits the amount of rent a developer can charge. To obtain an allocation of LIHTCs, developers must commit to making a majority of their units affordable to households at or below 60% of AMI and maintaining that affordability for at least 15 years. This effectively constrains the developer's economic return on the property during the mandated affordability period, decoupling rent trends from local real estate price trends and limiting a LIHTC property's near-term appreciation potential. For all but the most patient (and speculative) developers, 15 years would seem to be an unrealistically long time to justify a location decision. There is no guarantee that today's improving neighborhood will be equally or more desirable in the future, as local dynamics and unforeseen external shocks can have marked effects on a community's fortunes.

Because of the affordability and rent restrictions for LIHTC-subsidized units, a developer's profitability depends largely on its ability to minimize up-front and ongoing project costs and to maintain high residential occupancy rates. Consequently, the developer has a strong economic incentive to invest in markets with large numbers of income-qualifying households, a shortage of quality affordable rental housing opportunities, and relatively low land values. Locating in such areas ensures strong demand for the residential units and minimizes up-front acquisition costs and ongoing property tax expenses. Poor but appreciating markets could be more appealing than stagnant or declining areas because of the potential loss of naturally affordable units, but less appealing due to their relatively higher land acquisition and tax costs.

Other, non-economic factors may play into developers' calculations as well. Nonprofit organizations – acting either independently or in joint ventures – historically have comprised at least 20% of LIHTC developers. Many of these mission-driven entities have no intention of selling the property once the LIHTC affordability restrictions expire, but rather hope to maintain the property in perpetuity as affordable housing. It is unlikely that their project development decisions would be driven mainly by local market dynamics. In fact, they may deliberately focus their LIHTC efforts on comparatively distressed and declining areas to maximize the number of units they can develop, to eliminate a major source of local problems (a noted drug house, for instance), and/or to help bring scarce investment dollars into the area.

Finally, LIHTC properties tend to have relatively longer development timelines than unsubsidized projects, partly due to the complexities of assembling multiple funding sources. Developers often have multiple potential LIHTC projects in their pipeline at any given time and tend to select the one(s) most likely to be funded in any given LIHTC allocation round. The relative readiness of a project or its particular unit composition therefore could result in the prioritization of projects in comparatively weaker QCTs.

2.2. Properties' spillover effects on their communities

Several studies have assessed the extent of LIHTC spillover impact over the past few decades. Most have found that the developments have an overall neutral to positive effect on their surrounding areas. Multiple studies documented non-adverse effects of LIHTC properties on surrounding property values and physical conditions (Green, Malpezzi, & Seah 2002; Young 2016; Edmiston 2018). In Cleveland, Dallas, New York City, Portland (OR), and Seattle, LIHTC developments have brought about notable price increases in surrounding single-family homes and other properties (Johnson & Bednarz 2002; Schwartz et al 2006; Furman Center 2006; Ellen & Voicu 2007; Ellen et al 2007; Ezzet-Lofstrom & Murdock 2007; Woo, Joh, & Van Zandt 2016).

Both the extent and the types of spillover effects vary across communities. For example, a national analysis of price trends of homes within one kilometer of LIHTC developments placed in service from 1987 through 2005 found notably higher increases in poor neighborhoods than in stable and gentrifying communities (Baum-Snow & Marion 2009). A more recent analysis (Diamond & McQuade 2019) of price trends in 129 counties across 15 states found that property values within 1/10 mile of newly constructed or rehabilitated LIHTC developments in low-income neighborhoods increased by 6.5% over 10 years, while values of homes within the same distance band of LITHC developments in moderate and upper-income, majority-white communities fell by 2.5%.

Even while acknowledging the tendency of LIHTC developments to be geographically concentrated, the previous analyses of the projects' spillover impacts have treated the impacts of individual LIHTC properties independently. Several studies have factored the number of units within a property into their assessments. In many cases, "bigger is better" with respect to neighborhood revitalization – larger properties have more pronounced spillover effects – although large developments can have negative effects in particular areas (Dillman, Horn, & Verrilli 2017). Multiple researchers have raised concerns about potentially negative price effects associated with the over-concentration of subsidized housing in certain communities, particularly those in the suburbs (Deng 2010; Scally & Koenig 2012; Dillman, Horn, & Verilli 2017). None of these studies addressed the marginal impacts of additional developments, however. On the flip side, there is some evidence, at least in one city (Denver), that higher numbers of small, scattered-site public housing developments within a neighborhood contributed to increased surrounding home values (Santiago et al 2001).

To the best of our knowledge, there have not been any analyses focusing specifically on the sequential or additive effects of clustering LIHTC developments, and whether that concentration of low-income properties has a different effect in different types of neighborhoods. There also has not been any formal examination of the extent to which observed spillover effects are driven by locational selection bias. Baum-Snow and Marion (2009) documented some of the endogenous factors contributing to site selection – QCT eligibility and the relative gentrification of the surrounding community, for instance – but ultimately focused mainly on the different levels of spillover impact across different micro-markets.

3. Our approach

We are ultimately concerned with the interactive effects of multiple LIHTC properties in a community. Specifically, how do subsequent developments influence the spillover price effects of already existing developments? To address that question, we include specific variables noting the presence and number of other LIHTC developments in each community. We impose the restriction that pre-development and post-development impacts are equal across project areas.[1] We track the development of projects over time and assume the impacts of initial developments within a given distance band are similar. We then assume the impacts of a second development are the same across all areas with two developments, and so forth. Our model focuses on average differences in prices across distance bands, both prior and subsequent to the introduction of a LIHTC property.

Our model employs a combination of an interrupted time series (ITS) and a difference-in-difference (DID) approach. The ITS approach compares pre-development real estate price trends with post-development prices and trends while controlling for overall market-wide movements in real estate prices. The DID approach identifies price changes over time and through spatial variation. We expect price impacts to decline as the distance from the development in question increases.

We compare average home prices in the areas surrounding LIHTC properties ("LIHTC neighborhoods") with the expected values of such properties in areas without any nearby LIHTC developments ("non-LIHTC neighborhoods"). Our primary "control group," therefore, consists of properties in areas that are not within the specified distance bands of any LIHTC project. We also examine the extent to which observed price trends in LIHTC neighborhoods differ depending on the number of LIHTC projects in the neighborhood. In other words, how does the price trend in a neighborhood with multiple developments compare to the trend in a neighborhood with just one LIHTC property? Are trends in neighborhoods with three or more LIHTC properties different from those with only two developments?

The effects of a LIHTC development may be comparatively short-lived, may extend for multiple years, and/or may fluctuate over time. Determining the additive effects of a subsequent project requires an understanding of the duration of the previous project's effects. Whereas most analyses to date have tracked surrounding property values for only about three years after the LIHTC development was placed in service, we track the spillover effects for up to 15 years.

Because we cannot account for all the variation across the different neighborhoods where LIHTC properties are located, we include census tract fixed effects and market-wide temporal fixed effects in our model. The latter enables us to capture common shocks in the overall residential real estate market, particularly the sharp downturn from mid-2007 through 2010. Instead of incorporating neighborhood income and racial differences into our model, we apply the model separately to distinct types of neighborhoods. We compare LIHTC price effects in lower- versus higher-income neighborhoods, using the bottom third and the top two thirds of Cook County census tracts, respectively, based on their 2012-2016 median income levels.[2] We also apply the model separately to neighborhoods in the top tercile of Black residents and

[1] This is necessary because the number of parameters in an unrestricted framework becomes hopelessly large. Even with a dataset encompassing all property transactions over multiple decades, only a small proportion of LIHTC properties are in areas with a sufficient number of home sale transactions to allow for statistically significant impact measurements in each time period. As a result, we estimate an average treatment effect across project areas, recognizing that there will likely be heterogeneity in responses (which we investigate across race and income later in the paper).

[2] As discussed below, these results are robust to income classifications from different years. Here, we focus on a more recent classification, as more LIHTC investment occurs later in the sample period.

those where the share of Black residents falls in the bottom two terciles. In addition to helping control for potentially important sources of variation in price changes, the stratifications by income and race allow us to test our initial assumption that the average pre and post effects are the same across project locations.

We acknowledge the potential endogeneity issues affecting our analysis. Yet without more detailed developer- and property-specific information, it is impossible to determine which factors drove the developers' LIHTC site selection calculus and how developers weighted those factors in their decision. Similarly, we are unable to determine what particular aspects of the LIHTC developments bring about the observed changes in surrounding property values. We leave both these issues for future analysis.

3.1. Focus on Chicago

Like many of the previous LIHTC analyses, we focus our study on a single geographic area. We examine the properties' spillover price effects in Chicago and surrounding Cook County, Illinois. Chicago has several features that lend itself to this type of study. Chicago is the nation's third largest city and has a long and rich history of community-based activism and development. It also has considerable racial, ethnic, and socio-economic variation, which allows for an examination of price trends across different types of neighborhoods.

Focusing solely on Cook County enables us to control for broader political and economic trends as well as state differences in LIHTC allocation processes and procedures. It provides us with a sufficiently large sample size while allowing us to manage the complexity associated with calculating overlapping distance bands and limited resources. Although our more localized approach potentially limits the generalizability of the findings, it has the crucial virtue of ensuring the results' internal validity. We do not have to control for the often significant political, economic, and other differences that exist across regions. Perhaps most importantly, we view our analysis as an initial study of the possible accretive effects of affordable housing concentration. We hope that this pilot can and will be replicated elsewhere.

3.2. Model specification

Our model identifies pre- and post-development price effects over time and distance for each LIHTC property.[3] We focus on home prices within 1/4 mile of the LIHTC development and within 1/4 to 1/2 mile.[4] We map the distance from each sold home to every LIHTC development each year. We create pre-development and post-development variables to measure price changes within the different distance bands before and after each LIHTC development was placed in service.

Our full ITS/DID model allows for variation on multiple key measures: (1) distance bands from a LIHTC property; (2) number of LIHTC developments within a given distance band; and (3) period of time a transaction occurred before or after the initial LIHTC project was placed in service. To demonstrate the usefulness of this approach, we build the model in three steps, demonstrating each of these contributions in turn.

First, we present a simple "LIHTC Existence" DID model that is commonly used in the literature to estimate the difference between geographic units in the observed changes between pre- and post-treatment coefficients. In this exercise, we examine price changes in communities that have one or more LIHTC properties compared to changes in communities that have no LIHTC developments.[5] Equation 1 specifies this model:

$$\ln(P_{itk}) = \sum_{d\in D}\alpha_{0d}Pre_{idt} + \sum_{d\in D}\alpha_{1d}Post1_{idt} + \beta X_{it} + \varepsilon_k + \tau_t + \mu_{itk} \quad (1)$$

where:

- $\ln(P_{itk})$ is the natural log of the price of house i at time t in Census tract k;
- D is a set of distance bands d, where D = {0-1/4 miles, 1/4-1/2 miles}
- Pre_{idt} is a dummy variable equal to 1 if the transaction of house i in distance band d at time t is prior to the construction of a LIHTC project;
- $Post1_{idt}$ is a dummy variable equal to 1 if the transaction of house i in distance band d at time t is after the construction of the first LIHTC project;
- X_{it} is a vector of property traits of house i at time t;[6]
- ε_k is a vector of k tract-specific fixed effects;
- τ_t is a vector of t year-specific fixed effects; and
- μ_{itk} is a random error variable.

The "average treatment effect" in this type of DID model is the average difference between the coefficients for the Pre and Post1 variables within a given distance band across LIHTC projects. Note how this approach differs from the most basic DID approach, where the Pre variable is omitted from the regression. In that approach, the Post1 variable can measure the treatment effect by itself because it is estimated relative to the omitted Pre years. By explicitly including the Pre variable, we add an extra calculation: We must manually calculate the difference between Pre and Post1. This extra step will become useful later when we want to investigate how these trends evolve over time.

Next, we expand the model to distinguish between multiple developments that create overlapping distance bands, such that house i might be "treated" by more than one development as it falls in this intersection. To capture these overlapping treatments, we include variables indicating the number of LIHTC properties within the different distance bands. Equation 2 specifies this "concentration" model:

$$\ln(P_{itk}) = \sum_{d\in D}\alpha_{0d}Pre_{idt} + \sum_{d\in D}\alpha_{1d}Post1_{idt} + \sum_{d\in D}\alpha_{2d}Post2_{ijdt} + \sum_{d\in D}\alpha_{3d}Post3_{idt} + \beta X_{it} + \varepsilon_k + \tau_t + \mu_{itk} \quad (2)$$

where:

- $Post1_{idt}$ is a dummy variable equal to 1 if the transaction of house i in distance band d at time t is after the construction of at least one LIHTC project;
- $Post2_{idt}$ is a dummy variable equal to 1 if the transaction of house i in

[3] Our model therefore incorporates elements of both the ITS and DID models.

[4] Smaller bands reduce the sample size—and significantly decrease the power of the regression. Nevertheless, we investigated other distance bands and found that alternative specifications did not change our basic conclusions.

[5] We considered examining price trends in communities with one LIHTC development and no other LIHTC properties within one half mile for the entire sample period. Unfortunately, there are too few of these neighborhoods for analysis (only 40 of the 430 non-elderly LIHTC projects (9.3%) developed since 1987). Moreover, of those 40 projects, only 33 were developed during the period encompassed by our transaction dataset (1997-2016), and merely 20 have both pre and post observations in all distance bands.

[6] These property traits include total square footage, living area square footage, lot size square footage, floor-area ratio (FAR), age at sale, air conditioning (dummy), fireplace (dummy), number of stories, building structure, and seasonal dummies (spring, summer, fall).

$$\ln(P_{itk}) = \sum_{d=1}^{D}\sum_{s=\theta}^{0}\alpha_{ods}Pre_{ids} + \sum_{d=1}^{D}\sum_{u=0}^{U}\alpha_{1du}Post1_{idu} + \sum_{d=1}^{D}\sum_{v=0}^{V}\alpha_{2dv}Post2_{idv} + \sum_{d=1}^{D}\sum_{w=0}^{W}\alpha_{3dw}Post3_{idw} + \beta X_{it} + \varepsilon_k + \tau_t + \mu_{itk} \tag{3}$$

distance band d at time t is after the construction of at least two LIHTC projects; and

$Post3_{idt}$ is a dummy variable equal to 1 if the transaction of house i in distance band d at time t is after the construction of at least three LIHTC projects.

Again, the average treatment effects are differences: Treatment1 is the difference between Pre and Post1, Treatment2 is the difference between Pre and (Post1 + Post2), and Treatment3 is the difference between Pre and (Post1 + Post2 + Post3). This approach captures the *cumulative* effect of clustering multiple projects in a particular neighborhood. In contrast, each Post variable individually isolates the marginal contribution of each new LIHTC development, as it adds incrementally to the preceding price trends.[7]

Finally, we incorporate the ITS approach into this DID model by allowing the treatment effects to vary over time.[8] We add variables to reflect the years between subsequent home sales and subsequent LIHTC developments – i.e., a separate variable for the number of years that a transaction occurred after the second / third project. We include these as a series of year dummy variables representing the potentially non-linear impact of time before and after a given LIHTC development. Equation 3 specifies this "time-varying concentration" model:

Table 1
Key Characteristics of Sampled LIHTC Developments & Their Census Tracts

	Tracts with Any LIHTC Properties	Tracts with Only 1 LIHTC Property	Tracts with 2+ LIHTC Properties	Tracts with No LIHTC Properties
Total Census Tracts	242	144	98	1,077
Tract Median HH income	$33,679	$40,412	$27,019	$56,440
Tract Median Vacancy Rate	12.4%	11.5%	15.4%	8.6%
Tract Median Poverty Rate	29.5%	23.1%	33.9%	12.7%
Tract Median % African-American	58.0%	21.5%	89.2%	4.4%
Tract Median Contract Rent	$803	$835	$758	$886
Tract Median Home Value	$129,400	$156,900	$115,600	$224,200
Average Number of Units within LIHTC Properties	94	144	89	N/A

Note: Census tract data are based on American Community Survey 2012-2016 5-year estimates.

In this third model, s, u, v, and w denote the number of years the transaction occurred before the initial LIHTC project was developed, after the initial LIHTC project was developed, after the second LIHTC project was developed, and after the third LIHTC project was developed, respectively, within distance band d. In the year that a project is placed into service, $s = u = v = w = 0$. In the pre-period, $s = [\theta,0]$, with a maximal value of $\theta = -17$ years per the data. In the post-period, $u = [0, U]$, $v = [0,V]$, and $w = [0,W]$, with maximal values of $U = 15$ years, $V = 10$ years, and $W = 10$ years, respectively. We cluster standard errors based on the 77 community areas in Chicago, recognizing that the residuals may potentially be correlated by geography.[9]

This "time-varying concentration" model enables us to capture the longitudinal price trend before and after the initial LIHTC development, as well as the additional price impact from any subsequent development (s). It allows us to tease out separate average impacts associated with the first, second, and third (or more) LIHTC developments within a neighborhood. When we apply the model to data segmented by community income level, we can assess how spillover impacts differ across neighborhoods.

4. Data

We obtained data from HUD on each of the 508 LIHTC properties placed in service in Cook County between 1987 and 2014.[10] In building our database, we included the property's street address, the year it was placed in service, and its total number of units. We excluded properties designed exclusively for senior citizens, since most are not clustered with other LIHTC developments. After also excluding properties for which data were incomplete, we had a sample of 430 LIHTC developments – 390 of which are located within ½ mile of at least one other LIHTC property. While this subsample may undercount the number of nearby LIHTC properties for some transactions in our dataset, we have no reason to believe that the omitted developments have a systematically biased effect on property values upward or downward. Table 1 provides a basic overview of the characteristics of these properties and their neighborhoods, distinguishing between areas with only one LIHTC property and those with multiple developments.

The areas with multiple LIHTC properties tend to be within the city of Chicago, in neighborhoods with comparatively high poverty rates, high proportions of Black residents, and low household incomes. Only 8% of the overlapping LIHTC properties are in census tracts whose median incomes are in the upper third of all Cook County tracts. Figure 1 maps the location of all 430 properties, with green dots marking the non-overlapping properties and orange dots indicating the overlapping ones.

We obtained data on all Cook County single-family residential property sales from 1997 to 2016 from DataQuick Information Systems and CoreLogic.[11] There were 602,498 arm's length sales (those with independent buyers and sellers) with complete data during that period. Table 2 shows how the number of transactions and the mean and median sales price increased from 1997 to 2007, declined sharply during the

[7] Note that the model could be respecified so that Post1, Post2, and Post3 represent the effects of *exactly 1, 2, or 3 or more* LIHTC developments. The coefficients shown in (3) above can be calculated from this alternative specification to yield numerically identical results.

[8] This is similar to the new DID approach that is becoming standard in the literature pioneered by Goodman-Bacon (2021) and Callaway and Sant'Anna (2021).

[9] We treat suburban Cook County as a single additional community area for clustering purposes.

[10] Because the program was created in 1986, there are no projects built before 1987.

[11] These transactions include both attached and detached single-family properties.

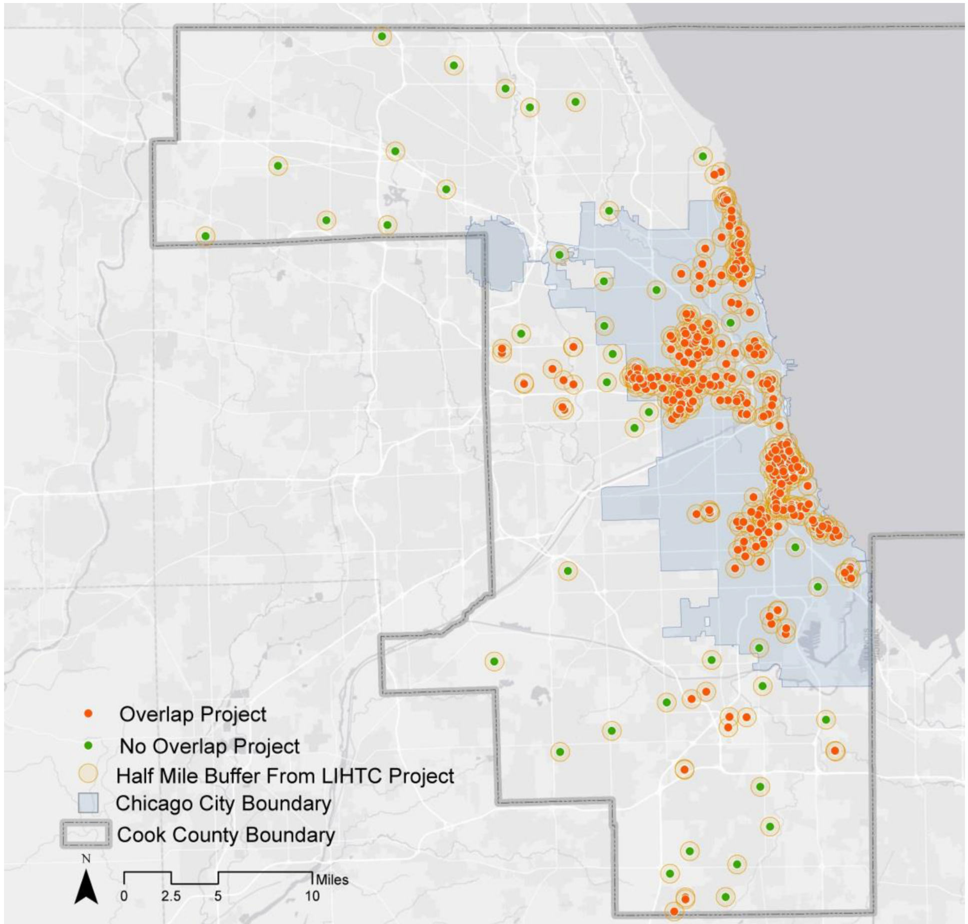


Fig. 1. Map of Sampled LIHTC Properties and Surrounding 1/2 Mile Radius
Notes: Dots represent Low-Income Housing Tax Credit properties in Cook County, IL, from 1997 to 2016 with half-mile circles representing the catchment areas for our model estimating the effect on surrounding housing prices.

Table 2
Single-Family Residential Property Transactions in Cook County, 1997-2016

Year	Observations	Mean Price ($)	Median Price ($)
1997	12,986	169,714	141,500
1998	35,058	189,765	155,000
1999	39,446	201,900	162,500
2000	36,476	222,312	176,000
2001	36,318	243,878	195,000
2002	36,975	258,851	211,000
2003	38,602	296,335	240,000
2004	46,255	312,204	255,000
2005	50,486	343,833	280,000
2006	32,987	374,531	300,000
2007	26,554	410,097	317,500
2008	17,704	403,092	301,000
2009	16,298	332,394	250,000
2010	17.927	317,491	230,000
2011	16,919	316,694	218,000
2012	20,165	310,906	220,000
2013	25,920	335,864	242,000
2014	27,833	346,446	250,000
2015	32,919	348,179	255,000
2016	34,670	342,595	255,000
Total	**602,498**	**228,000**	**228,000**

Notes: Data obtained from DataQuick Information Systems and CoreLogic.

Great Recession, and then began recovering after a few years. Overall, nominal values of single-family residential properties roughly doubled over the 19 years. These fluctuations underscore the importance of using a difference-in-differences approach to avoid mistaking countywide trends for local effects of LIHTC development.

We geo-coded the location of each transaction to calculate the distance between the sold home and nearby LIHTC developments. About 11% of all property sales took place within 1/2 mile of a non-overlapping LIHTC development, whereas 7% occurred within 1/2 mile of overlapping developments. Many LIHTC developments were placed in service subsequent to a given home sale, so that the sold home may initially have fallen within the 1/2-mile ring of only one LIHTC development but ultimately ended up within the rings of multiple LIHTC projects.

Comparing these transactions—those that are not near LIHTC developments, and those near 1, 2, or 3 or more LIHTC developments—is at the heart of our empirical strategy. Thus, it is important to understand the differences between these groups. In Table 3, we break down the mean and median property prices based on the transaction sales time relative to the construction of LIHTC properties: pre vs post LIHTC project construction. Over the 20-year period, there were more than 30,509 transactions within 1/4 mile of a LIHTC property and 66,184 transactions within the 1/4-to-1/2-mile band. First, we see that properties are about 9% less valuable, on average, within 1/4 mile of a LIHTC development than prices of housing within the 1/4 - 1/2 mile band. This is consistent with previous evidence suggesting that LITHC properties are more likely to be built in lower-income neighborhoods. Our hybrid ITS/DID model controls for this difference, and Census tract fixed effects further isolate the treatment effects from many of the factors that differentiate neighborhoods. We separately apply the model to low-

Table 3
Residential Prices Near LIHTC Properties, Pre vs. Post Development

Distance Band	LIHTCs Near	Number of Transactions	Mean Price ($)	Standard Deviation ($)	Median Price ($)
1/4 Mile	Prior to LIHTC	9,390	292,627	257,073	220,000
	1 LIHTC Near	14,648	323,873	311,849	227,000
	2 LIHTCs Near	4,120	259,258	232,006	199,000
	3+ LIHTCs Near	2,341	270,209	234,680	224,000
1/2 Mile	Prior to LIHTC	18,851	321,262	287,920	245,000
	1 LIHTC Near	27,511	351,245	371,460	237,000
	2 LIHTCs Near	9,320	295,169	275,793	210,000
	3+ LIHTCs Near	10,502	289,933	263,916	220,000

Notes: Observations are single-family residential property sales from 1997 to 2016 within 1/4 mile of and within the 1/4-to-1/2-mile distance from a Low-Income Housing Tax Credit (LIHTC) development in Cook County, IL. "LIHTC Near" indicates transactions within the distance band before or after 1, 2, or 3+ LIHTC developments are placed in service. Data obtained from DataQuick and CoreLogic.

income and high-income neighborhoods to test the income variation directly. Second, relative to prices prior to the completion of the initial LIHTC property, home values appear to increase after the first LIHTC property is placed in service, decline after completion of the second LIHTC development, and increase again after the third LIHTC project is completed. Our model investigates whether these differences truly reflect changes that occur within a given neighborhood after the LIHTC property is placed in service.

Finally, it is useful to consider how prices are changing within these different neighborhoods from year to year. Figure 2 compares the annual mean price growth rates of transactions within 1/2 mile of LIHTC projects to the annual mean price growth rates of transactions outside of this 1/2-mile distance band. There is a lot of variation, but in the majority of years, there appears to be higher appreciation within the distance band. This is consistent with previous evidence showing that, particularly in the 1990s and the first half of the 2000s, LIHTC properties tended to be placed into service in low-income, but appreciating markets. Freeman (2004) found that LIHTC properties throughout the country were in neighborhoods with considerably higher poverty rates, lower median incomes, and lower median home values than the typical urban neighborhood. Yet while the median home value increased by 35.3% from 1990-2000 in all metropolitan neighborhoods, it increased by 44.3% in LIHTC neighborhoods during that period. In Chicago, home values in low-income neighborhoods – those with proportionally greater concentrations of LIHTC developments – rose by as much as 190% from 2000 through mid-2007 (Institute for Housing Studies 2015).

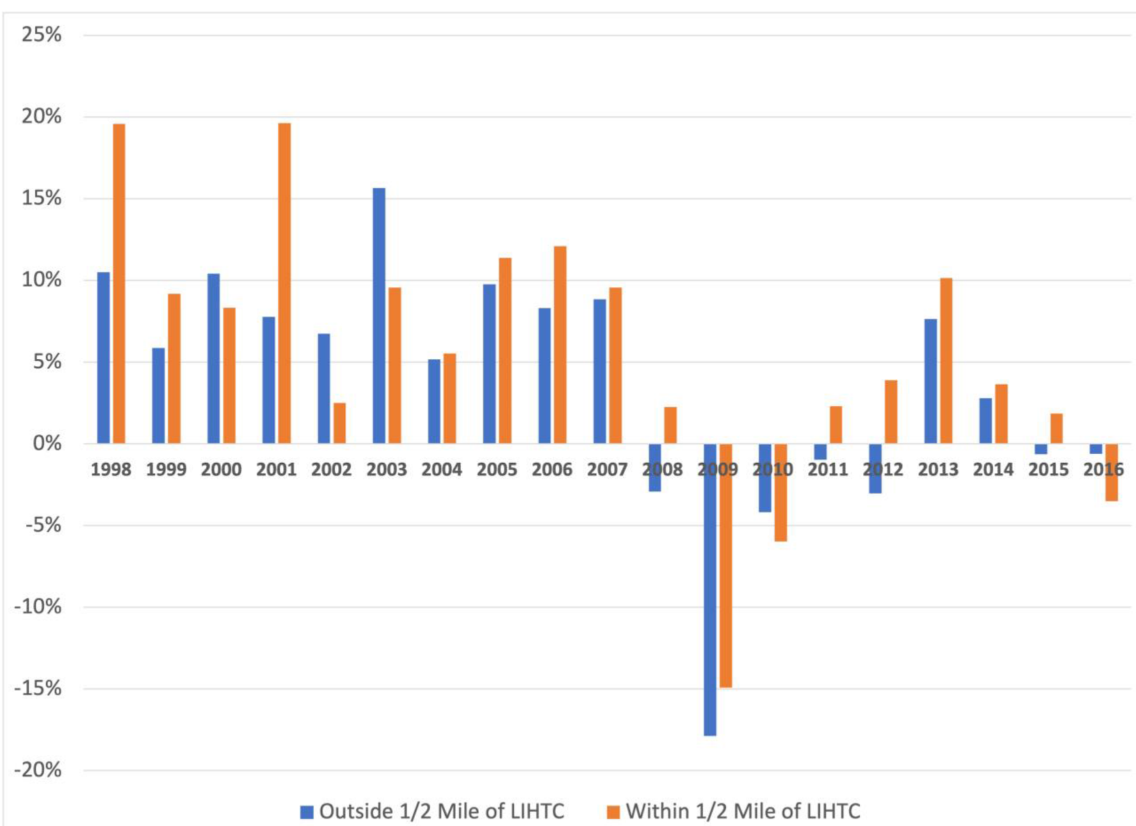


Fig. 2. Annual Price Growth Rates for Single-Family Residential Transactions within or not within ½ Mile of LIHTC Projects, 1997-2016
Notes: Means are calculated using single-family residential property sales from 1997 to 2016, including both attached and detached houses. Data obtained from DataQuick and CoreLogic.

Table 4
LIHTC Pricing Model Without Time Varying Impacts

Measures	Distance from LIHTC Property	Model 1 Coefficient	T Stat	Model 2 Coefficient	T Stat
Pre	0 - 1/4 Mile	-0.084***	-4.42	-0.085***	-4.44
Post1		0.020	1.30	0.015	0.97
Post2				-0.012	-0.46
Post3				0.042+	1.81
Treatment1		**0.103*****	-5.44	**0.100*****	**5.29**
Treatment2				**0.089****	**3.18**
Treatment3				**0.131*****	**4.87**
Pre	1/4 Mile - 1/2 Mile	-0.025	-1.22	-0.025	-0.22
Post1		0.000	0.02	-0.007	-0.40
Post2				0.015	0.71
Post3				0.022	1.40
Treatment1		**0.025**	**-1.31**	**0.018**	**0.77**
Treatment2				**0.033**	**1.10**
Treatment3				**0.055+**	**1.69**
Constant		11.620	0.40	11.550	0.40
Number of Observations		602,498		602,498	
R Bar2		0.738		0.738	

Note: Regressions control for Census tract fixed effects, year fixed effects, and the following property traits: total square footage, living area square footage, lot size square footage, floor-area ratio (FAR), age at sale, air conditioning (dummy), fireplace (dummy), number of stories, building structure, and seasonal dummies (spring, summer, fall). Treatment1, Treatment2, and Treatment3 are calculated manually from the differences in the regression coefficients, as described in the Model Specification section. +p<0.1, *p<0.05, **p<0.01, ***p<0.001

neighborhood and property-level characteristics, we find that home values in LIHTC neighborhoods were lower than the values in comparable non-LIHTC neighborhoods prior to the development of the initial LIHTC property. Values for homes within 1/4 mile of a LIHTC site were 8.1% lower than the control groups, as indicated by the Pre coefficient in column 3, while values within the 1/4-to-1/2-mile band around a site were 2.5% lower, though only the shorter distance band is statistically significant from zero.[12]

Once the initial LIHTC developments were placed into service, surrounding prices jumped. Relative to non-LIHTC neighborhoods, the average sale prices of homes in the 1/4-mile band were 2.0% *higher*, as indicated by the Post1 coefficient, and the average sale prices in the 1/4-to-1/2-mile band had pulled even with the non-LIHTC neighborhoods. By subtracting the Pre from the Post1 coefficient, we can conclude that the introduction of the initial LIHTC property boosted surrounding home values by approximately 10.8 and 2.5 percentage points in these two bands, respectively, relative to expectations. (See the Treatment1 line in Table 4.) Again, the change in values is statistically significant within the ¼ mile band. These positive impacts echo those of other analyses highlighted earlier, and as expected, they dissipate with distance.[13]

5.2. *Model 2: hybrid difference-in-difference with concentration of LIHTC projects*

We then tease out the price impacts of subsequent LIHTC developments within the different distance bands, incorporating Post2 and

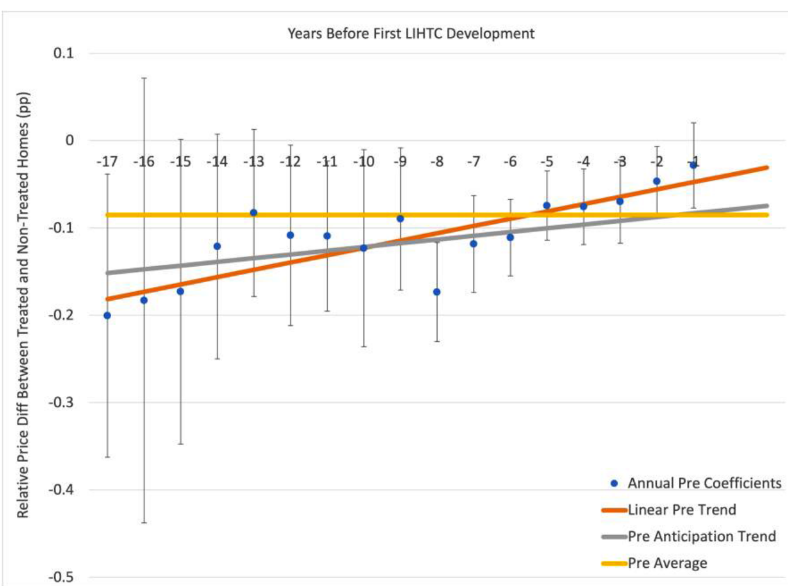


Fig. 3. Pre-LIHTC Temporal Patterns Within ¼-Mile Band
Notes: Graphic representation of time-varying Pre coefficients from Equation 3, indicating the path of difference in housing prices near LIHTC projects before the first project is built. The bars associated with each point estimate indicate 95% confidence intervals for each yearly impact. The full set of coefficients is reported in Appendix A.

5. Findings

5.1. *Model 1: difference-in-difference of LIHTC existence*

To identify a baseline effect, we initially apply our regression model using only Pre and Post1 variables for each of the two distance bands. In this way, we determine the aggregate impact of all LIHTC projects on houses within the different surrounding distance bands, regardless of when the projects were placed in service. In this formulation, Post1 is an indicator of whether any LIHTC projects are in close proximity to the sold homes.

As Table 4 shows, Cook County's LIHTC properties have had a positive effect on surrounding home values. Controlling for various

Post3 variables into our initial model. We show the results in the "Model 2" columns of Table 4. We find no evidence that the aggregate property value effects decreased when additional LIHTC properties were introduced within the distance band. For example, the introduction of a

[12] Throughout the paper, we translate the coefficients from the model by converting from natural logarithms back to percentages, i.e. $e^{-0.084} - 1 = 8.1\%$. There consequently may be some minor differences between the percentages reported in the text and the coefficients reported in the tables.

[13] As we discussed on pages 8-10, these findings could be skewed high due to endogeneity bias (i.e. the selection of project sites partly because of positive existing price trends). Such a critique would apply to most LIHTC studies, however.

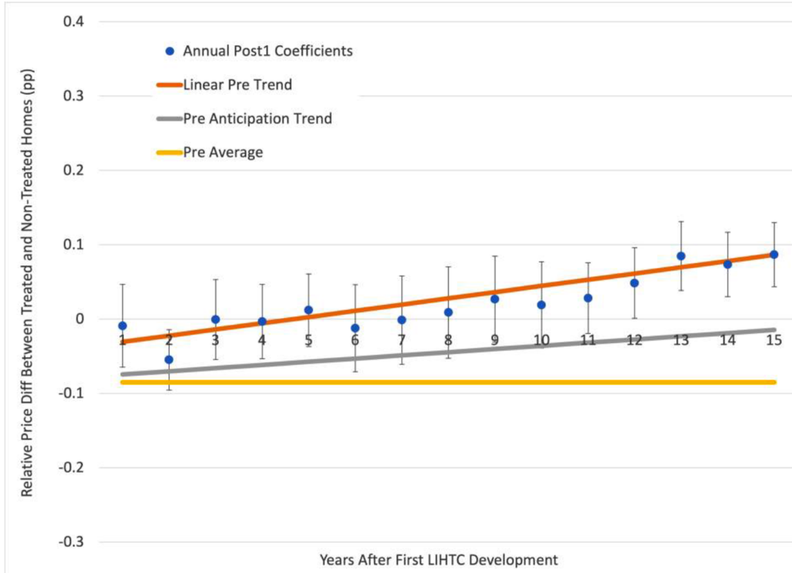


Fig. 4. Temporal Patterns Within ¼-Mile Band After 1st LIHTC Development
Notes: Graphic representation of time-varying Post1 coefficients from Equation 3, indicating the path of difference in housing prices near LIHTC projects after the first project is built. The full set of coefficients is reported in Appendix A.

second and then a third or more subsequent LIHTC properties increased home prices by an aggregate 3.1 percentage points relative to the first property's effect within 1/4 mile of that development and by an additional 3.8 percentage points within 1/2 mile, though most of these impacts are not statistically different from zero.[14] Again, these increases are relative to the expected price trends without those additional properties.

Subtracting the Pre coefficient from the sum of the respective Post coefficients, as described earlier, reveals the total treatment effect. Collectively, homes located within 1/4 mile of three or more LIHTC properties experienced an aggregate 14.0 percentage point appreciation in value relative to expectations, and homes in the 1/4-to-1/2-mile band experienced a total 5.7 percentage point appreciation.

Note that while the individual Post variables are not statistically significant, the differences between the Post and Pre variables are. We therefore can be confident in the finding that the introduction of one or more LIHTC developments has a positive effect on local prices, but we cannot be wholly confident in the specific additive benefits of a second or third LIHTC property. As a result, we conservatively interpret the results as indicating only that subsequent developments did *not lower* property values.

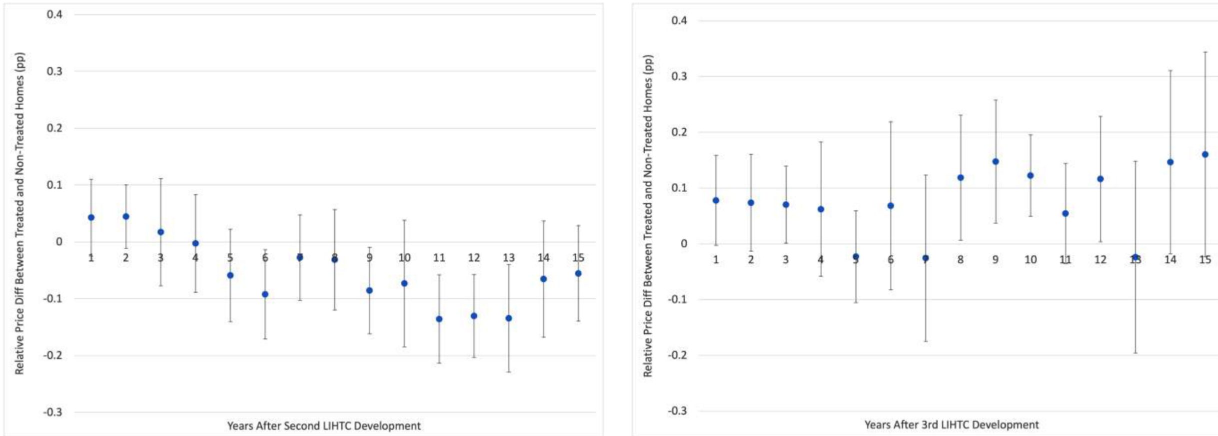
5.3. Model 3: hybrid DID/ITS model with time-varying impacts

Finally, our most flexible model decomposes these average pre- and post-effects by year, showing how they change over time. Since the ¼-mile distance band is the most significant in Model 2, we focus on those results in the graphs below. Before the first LIHTC development is completed, Figure 3 shows the Pre coefficients as blue dots. The yellow line shows the average of these coefficients, which is the –0.085 Pre coefficient reported in Model 2. This is one potential baseline we use in visualizing the treatment effect. However, to a casual observer, prices generally appear to have been trending upward in the eight years prior to the time the first LIHTC property is placed in service. Therefore, following standard difference-in-differences protocol, we test for the existence of a pre-trend by interacting the Pre variable with a linear time trend.[15] We do this in two ways. First, following previous literature and anecdotal evidence from the industry, we assume that the LIHTC development is not a surprise to the market at $t = 0$. Rather, as planning, permits, and construction occur, the market anticipates the new property, and therefore the final four Pre coefficients are indicating an anticipation effect. We therefore indicate the pre-trend *before* this anticipation effect with the shallow, upward-sloping gray line. Some readers may not believe that markets are efficient enough to anticipate new development in this way. To address this concern, our second approach assumes that there is no anticipation effect and therefore uses all 17 pre-LIHTC years to construct the pre-trend, reflected in the steeper, upward-sloping orange line. In both cases, the model indicates that there is no statistically significant pre-trend in the 1/4-mile distance band.[16] However, since there is no standard practice to deal with these annual fluctuations, reasonable econometricians can disagree.

[14] This comes from adding the Post2 and Post3 coefficients.

[15] We provide the full table of coefficients in Appendix B, both for the simple Pre/Post model and for the model testing all three levels of LIHTC concentration.

[16] Part of the upward price trend in the years preceding the introduction of the first LIHTC development may be associated with an anticipation effect. Each of our models uses the *completion* date of the project as the beginning of the post-period because we do not have data on the date at which the project's development was *announced*. There is a significant theoretical and empirical literature demonstrating the forward-looking nature of real estate markets. For example, Chen, Wilkoff, and Yoshida (2021) show that housing prices reflect positive news, such as a new office headquarters bringing valuable jobs into a neighborhood, long before the headquarters is built. Therefore, it is possible for prices to begin reacting to the new LIHTC property once news of that planned development becomes widely known. In California, it typically takes 22.8 months from the start of a LIHTC property's construction to its completion (State of California 2014). Based on our conversations with officials at the National Council of State Housing Agencies, the California's timing is generally representative of other markets throughout the country. And since it typically takes at least 16 months to obtain the permits and package the financing necessary to begin construction (Millar, Oliner, & Sichel 2016), it is possible that the anticipation period could extend three to four years. If one allows for an anticipation effect, there is even less evidence of a pre-trend in the 1/4th mile band.



(a) Post 2 (b) Post 3 Plus

Fig. 5. Temporal Patterns Within ¼-Mile Band After 2nd and 3rd LIHTC Developments
Notes: Graphic representation of time-varying Post2 and Post3 coefficients from Equation 3, indicating the path of difference in housing prices near LIHTC projects after the second and third projects are built. The full set of coefficients is reported in Appendix A.

Table 5
Difference in Observed Housing Price Trends: Higher vs. Lower Black Share & Income

Measures	Distance from LIHTC Property	Higher Black Percentage		Lower Black Percentage		Higher Income		Lower Income	
		Coefficient	T Stat	Coefficient	T Stat	Coefficient	T Stat	Coefficient	T Stat
Pre	0 - 1/4 Mile	-0.057*	-2.15	-0.116***	-4.76	-0.055+	-1.99	-0.068**	-3.008
Post1		0.021	1.33	-0.019	-0.943	0.029*	2.168	0.017	0.860
Post2		-0.020	-1.04	-0.038	-0.805	-0.070**	-2.83	-0.003	-0.113
Post3		0.010	0.38	0.018	0.316	0.057	0.55	0.027	1.175
Treatment1		**0.077***	**2.36**	**0.097*****	**4.25**	**0.084***	**2.56**	**0.085*****	**3.56**
Treatment2		**0.057***	**2.63**	**0.060**	**1.36**	**0.014**	**0.50**	**0.082***	**2.41**
Treatment3		**0.067+**	**1.79**	**0.077****	**2.91**	**0.071**	**0.64**	**0.109*****	**3.72**
Pre	1/4 Mile - 1/2 Mile	0.003	0.21	-0.056*	-2.28	0.000	-0.003	-0.028	1.16
Post1		0.006	0.61	-0.038	-1.60	0.015	1.29	-0.015	0.65
Post2		-0.001	-0.09	0.007	0.23	-0.019	-0.841	0.031	1.28
Post3		0.010	0.38	-0.001	-0.04	0.024	0.661	0.012	0.718
Treatment1		**0.004**	**0.29**	**0.017**	**0.63**	**0.015**	**0.79**	**0.013**	**0.44**
Treatment2		**0.002**	**0.09**	**0.024**	**0.64**	**-0.003**	**-0.10**	**0.044**	**1.23**
Treatment3		**0.024**	**0.70**	**0.024**	**0.70**	**0.021**	**0.42**	**0.056**	**1.44**
Constant		11.934***	250.33	12.899***	278.82	11.776	182.362	11.361	1.51
Number of Observations		131,053		471,445		509,388		93,110	
R Bar2		0.551		0.732		0.751		0.709	

Note: Regressions control for Census tract fixed effects, year fixed effects, and the following property traits: total square footage, living area square footage, lot size square footage, floor-area ratio (FAR), age at sale, air conditioning (dummy), fireplace (dummy), number of stories, building structure, and seasonal dummies (spring, summer, fall). Treatment1, Treatment2, and Treatment3 are calculated manually from the differences in the regression coefficients, as described in the Model Specification section. +p<0.1, *p<0.05, **p<0.01, ***p<0.001

Therefore, we will consider all three cases when we visualize our treatment effects. In the foregoing analysis, we will focus on *marginal* treatment effects, i.e. the incremental impact of each additional project, not the *total* treatment effects, which would require unrealistically strict assumptions about *when* each project is completed in order to sum the marginal effects at an annual frequency.

After the first LIHTC development is completed, the Post1 coefficients in Equation 3 indicate the price performance of the treated houses, relative to the non-treated houses. In order to determine a time-varying treatment effect, we must compare this post-LIHTC performance to a pre-LIHTC baseline. In Figure 4, we show the Post1 coefficients, again as blue dots, compared to all three baselines that we constructed in Figure 3. The yellow line extends the Pre average as a constant; this is the standard DID approach. The distance between the blue dots and the yellow line indicate the treatment effect using this baseline. They are positive and increasing over time, and the confidence intervals of the coefficients are generally above the baseline. The gray line is a more conservative approach, extending the pre-anticipation trend (despite the fact that it is statistically insignificant in the pre-LIHTC period). Again, the treatment effects—the distance between the blue dots and gray line—are positive and increasing over time, and the confidence intervals are generally above the extrapolated baseline. Finally, the most conservative approach extends the full (insignificant) pre-trend, which we show with the orange line. The blue dots fluctuate around this line closely, ending the 15-year Post1 period nearly identical to the pre-trend projection. Under this approach, there is no statistically significant treatment effect, either positive or negative. Considering all of these approaches, we can conclude that the potential time-varying effects of the first LIHTC development range between zero and significantly positive. There is no evidence of negative effects over the long run.

For the second and third LIHTC project completed within a ¼ mile of the treated houses, we focus on the marginal effect of each project *in addition to* the first LIHTC effect graphed above. We cannot add them together without making an assumption about *when* the second and third projects are completed, i.e. during which of the above Post1 years. Therefore, we do not calculate total treatment effects from this cumulative concentration, and we do not extend the baselines from the Post1 graph. Instead, Figure 5a shows the Post2 coefficients as blue dots that

Table A1
Time-varying treatment effects after LIHTC developments for housing prices within varying distance bands

		1/4 Mile Post1			1/2 Mile Post1	
Year	Post1	Post 2	Post3_plus	Post1	Post 2	Post3_plus
1	0.081*	0.153***	0.138**	0.002	0.036	0.053*
2	0.036	0.155***	0.134**	0.022	0.035	0.021
3	0.090**	0.127*	0.130**	0.043	0.045	-0.020
4	0.088**	0.107*	0.122+	0.023	0.058+	0.041
5	0.103**	0.051	0.037	-0.020	0.009	0.020
6	0.078*	0.018	0.129+	0.003	0.003	0.018
7	0.090**	0.083+	0.035	-0.009	-0.001	-0.004
8	0.100**	0.079+	0.179*	-0.004	-0.015	0.008
9	0.117***	0.024	0.208***	-0.004	0.015	0.041
10	0.110**	0.036	0.183***	-0.001	0.003	0.056+
11	0.119***	-0.026	0.115	0.014	0.021+	0.118***
12	0.139***	-0.020	0.177**	0.040	-0.005	0.086***
13	0.176***	-0.024	0.037	0.046+	-0.019	0.101**
14	0.164***	0.044*	0.207**	0.059+	-0.002	0.074*
15	0.177***	0.055**	0.221+	0.061+	-0.015	0.181**

Note: Regressions control for Census tract fixed effects, year fixed effects, and the following property traits: total square footage, living area square footage, lot size square footage, floor-area ratio (FAR), age at sale, air conditioning (dummy), fireplace (dummy), number of stories, building structure, and seasonal dummies (spring, summer, fall). +p<0.1, *p<0.05, **p<0.01, ***p<0.001

Table A2
Time-varying pre and post trend after LIHTC developments for housing prices within varying distance bands

	Pre		Post1		Post2		Post3_plus	
Year	1/4 Mile	1/2 Mile	1/4 Mile	1/2 Mile	1/4 Mile	1/2 Mile	1/4 Mile	1/2 Mile
-17	-0.200*	-0.0487						
-16	-0.183	-0.0516						
-15	-0.173	-0.0966**						
-14	-0.121	-0.108**						
-13	-0.0828	-0.0626						
-12	-0.109*	-0.0672*						
-11	-0.109*	-0.0531						
-10	-0.123*	-0.0429						
-9	-0.0898*	-0.0513*						
-8	-0.173***	-0.0600*						
-7	-0.119***	-0.0459						
-6	-0.111***	-0.0246						
-5	-0.0745***	-0.0193						
-4	-0.0757***	-0.00419						
-3	-0.0698**	0.000312						
-2	-0.0465*	-0.00335						
-1	-0.0284	-0.000897						
0	0	0	0	0	0	0	0	0
1			-0.00967	-0.023	0.0428	0.0175	0.0775	0.0413*
2			-0.0553**	-0.00357	0.0451	0.0166	0.073	0.00976
3			-0.000742	0.0178	0.0167	0.0265	0.0691	-0.0318
4			-0.00273	-0.00185	-0.00329	0.0395	0.0613	0.0295
5			0.0121	-0.0454	-0.059	-0.00976	-0.0234	0.00842
6			-0.0128	-0.0224	-0.0922*	-0.0158	0.0684	0.0059
7			-0.0011	-0.034	-0.0273	-0.0195	-0.0259	-0.0156
8			0.00877	-0.0291	-0.031	-0.0338	0.119*	-0.00326
9			0.0258	-0.0295	-0.0859*	-0.00355	0.147*	0.0296
10			0.019	-0.0266	-0.0736	-0.0156	0.122**	0.0442
11			0.0281	-0.0117	-0.136***	0.00201	0.0543	0.106***
12			0.048	0.0147	-0.131***	-0.024	0.116*	0.0747*
13			0.0848***	0.0208	-0.134**	-0.0381	-0.0241	0.0890*
14			0.0733**	0.0341	-0.0657	-0.0211	0.146	0.0625
15			0.0863***	0.0359	-0.0556	-0.0333	0.16	0.170***

Note: Regressions control for Census tract fixed effects, year fixed effects, and the following property traits: total square footage, living area square footage, lot size square footage, floor-area ratio (FAR), age at sale, air conditioning (dummy), fireplace (dummy), number of stories, building structure, and seasonal dummies (spring, summer, fall). +p<0.1, *p<0.05, **p<0.01, ***p<0.001

signify its *incremental* effect relative to Post1, not relative to any cumulative baseline. Although these marginal effects begin positive, we cannot reject the null hypothesis, and they trend downward until $t = 13$ and then rebound afterward. These negative effects are only significant in years t = 6, 11, 12, and 13. Therefore, the potential time-varying treatment effects of the second LIHTC project are mixed, ranging from insignificantly positive to significantly negative.

To determine whether this is a signal about the effects of LIHTC concentration or merely a noisy fluctuation, we add a third LIHTC development in Figure 5b. The effects are mostly positive and increasing, despite a few noisy fluctuations. These positive effects are significant in years t = 3, 8, 9, 10, and 12. Thus, considering Post1, Post2, and Post3 together as the full effects of LIHTC concentration, we find little evidence for sustained negative long-term effects. As we found after the first LIHTC project, most of the total treatment effects of concentrated development range from zero to very positive.

Table A3
Time-Varying Pre and Post Trend After LIHTC Developments For Housing Prices Within Varying Distance Bands – Lower Income Community

	Pre		Post1		Post2		Post3_plus	
Year	1/4 Mile	1/2 Mile	1/4 Mile	1/2 Mile	1/4 Mile	1/2 Mile	1/4 Mile	1/2 Mile
-17	-0.129	0.174						
-16	-0.325	0.00473						
-15	-0.211	-0.0638						
-14	-0.128	-0.127						
-13	-0.0834	-0.117*						
-12	-0.157*	-0.056						
-11	-0.0926	-0.0756						
-10	-0.174	-0.0501						
-9	-0.0641	-0.0549						
-8	-0.167***	-0.0706						
-7	-0.103**	-0.0676						
-6	-0.0948**	-0.0451						
-5	-0.054	-0.0361						
-4	-0.0368	0.00863						
-3	-0.0609	-0.0119						
-2	-0.0351	-0.0163						
-1	0.00435	0.00158						
0	0	0	0	0	0	0	0	0
1			0.0103	-0.00665	0.0616	0.0237	0.0696	0.0255
2			-0.0616	0.0179	0.0571	0.0521	0.0776	0.0264
3			0.0276	0.0384	0.0471	0.0522	0.0729	-0.0326
4			0.0113	-0.00511	0.0334	0.0771*	0.0623	0.0477*
5			0.0174	-0.0711*	-0.029	0.0137	-0.0315	0.0219
6			-0.0253	-0.0425	-0.0654	0.0208	0.0653	0.0218
7			0.00678	-0.0347	0.00593	0.00623	-0.0243	-0.00941
8			0.0189	-0.0338	-0.0119	-0.00718	0.105	-0.00935
9			0.0108	-0.0294	-0.054	0.0283	0.161*	0.0408
10			0.00314	-0.0361	-0.0575	0.0231	0.138**	0.0302
11			0.0165	-0.0187	-0.131**	0.0347	0.0513	0.0966**
12			0.0233	-0.00313	-0.130**	0.0219	0.115	0.053
13			0.0713*	-0.0245	-0.132*	-0.0217	-0.0129	0.0514
14			0.0623*	-0.00893	-0.0726	0.0105	0.12	0.0408
15			0.0603*	-0.019	-0.0457	-0.0116	0.0972	0.134**

Note: Regressions control for Census tract fixed effects, year fixed effects, and the following property traits: total square footage, living area square footage, lot size square footage, floor-area ratio (FAR), age at sale, air conditioning (dummy), fireplace (dummy), number of stories, building structure, and seasonal dummies (spring, summer, fall). +p<0.1, *p<0.05, **p<0.01, ***p<0.001

5.4. Higher v. lower income communities

As we noted in our review of the literature, most previous LIHTC research has identified variations in the extent of LIHTC spillovers in different types of neighborhoods. The effects tend to be greater in lower-income communities than higher-income ones. In several cases, researchers have identified negative price effects of LIHTC properties in more affluent areas.

Unlike studies such as that of Diamond and McQuade (2019), we found positive and significant LIHTC price effects price effects within ¼ mile of the development in both lower- and higher-income communities. [17] As illustrated in the four rightmost columns in Table 5, the net price effect of one development is essentially the same (see Treatment 1) in the two types of neighborhoods within both the ¼ mile and ½ mile bands.

The neighborhood variation becomes much more pronounced when LIHTC developments are clustered. The effect of having multiple developments in proximity is substantially more positive in lower-income neighborhoods than in higher-income ones. Adding a second and then a third or more LIHTC developments to the initial property (so there are now at least three properties in the area) increases values within ¼ mile by another 2.4 percentage points in lower-income areas. This result is statistically significant. In contrast, that same activity in higher-income areas results in a relative 1.3 percentage point decline in values, though the result is statistically insignificant. Put differently, clustering three or more LIHTC properties within 1/4 mile generates an aggregate 11.5 percentage point increase in home values in lower-income areas but only a 7.4 percentage point boost in higher-income communities—and this latter impact is not statistically significant. (Again, this increase is relative to similar communities with no LIHTC developments.)[18] The time-varying coefficients for Model 3 are reported in Tables A3 and A4. Though they fluctuate over time, it is clear that the lower-income communities tend to have lower pre coefficients and similar post coefficients, generating the average treatment effects in Table 5.

5.5. Predominantly black communities

The Chicago area historically has been one of the most racially segregated metropolitan areas in the country (Sampson 2012). There are very few neighborhoods in the city that have substantial proportions of more than one racial group. In many census tracts on Chicago's south and west sides, the population is 99% or more Black. Given the extent to which race influences Chicago neighborhood dynamics, we stratified

[17] We ranked all census tracts in Cook County by their median income, as reported in the 2012-2016 ACS. We define "higher-income" areas as tracts in the top two thirds, and "lower-income" as the bottom third. This classification creates a large enough sample size for the "higher-income," as there are few LIHTC properties in the top third alone. The results are robust to different years of income classification. We use 2012-2016 because most LIHTC investment is concentrated near the end of the sample period. If we use earlier data for this classification, we risk mistakenly assigning communities to a category that they no longer occupy *when the LIHTC project is actually built*—and therefore, they will bias any estimates about how LIHTC projects affect that category of communities.

[18] Not surprisingly, the puzzling decline in relative values associated with the introduction of a second LIHTC development persists in both markets, particularly within ¼ mile.

Table A4
Time-Varying Pre and Post Trend After LIHTC Developments For Housing Prices Within Varying Distance Bands – Higher Income Community

	Pre		Post1		Post2		Post3_plus	
Year	1/4 Mile	1/2 Mile	1/4 Mile	1/2 Mile	1/4 Mile	1/2 Mile	1/4 Mile	1/2 Mile
-17	-0.176	-0.0804						
-16	-0.0452	-0.024						
-15	-0.0633	-0.0643*						
-14	-0.0282	-0.0574*						
-13	-0.0199	-0.00905						
-12	-0.00626	-0.0306						
-11	-0.0601	0.00384						
-10	-0.00711	0.00406						
-9	-0.0601	-0.0272						
-8	-0.122**	-0.0361						
-7	-0.082	0.00129						
-6	-0.0718*	0.0136						
-5	-0.0497	0.0113						
-4	-0.0729*	-0.00297						
-3	-0.0354	0.0229						
-2	-0.0399	0.0237						
-1	-0.062	0.0109						
0	0	0	0	0	0	0	0	0
1			-0.0152	-0.0228	-0.00382	0.0082	-0.0327	0.0783
2			-0.00526	0.00295	0.0348	-0.0142	0.132	-0.0634
3			0.0000126	0.0158	-0.102	0.00513	-0.0495	0.0351
4			0.0306	0.0203	-0.202*	0.00685	0.263	-0.0442
5			0.044	0.01	-0.129	-0.00285	0.0109	-0.0466
6			0.0581	0.0349	-0.118**	-0.0556	0.131	-0.0594
7			0.0407	0.00771	-0.181***	-0.0382	0.00321	-0.0218
8			0.0278	0.0172	-0.00554	-0.0678	0.178	0.0243
9			0.0864*	0.013	-0.126	-0.0591	-0.0318	-0.023
10			0.0840*	0.0176	-0.154	-0.0853	-0.252	0.104
11			0.0488	0.0029	0.0368	-0.0349	0.226*	0.145**
12			0.0759	0.0117	-0.0505	-0.0997**	0.274*	0.165**
13			0.0475	0.0489	-0.11	-0.0222	-0.203	0.206***
14			0.0323	0.0585*	0.155	-0.0677	0.484***	0.103
15			0.0135	0.0634	-0.280*	-0.0917	0.277*	0.246***

Note: Regressions control for Census tract fixed effects, year fixed effects, and the following property traits: total square footage, living area square footage, lot size square footage, floor-area ratio (FAR), age at sale, air conditioning (dummy), fireplace (dummy), number of stories, building structure, and seasonal dummies (spring, summer, fall). +p<0.1, *p<0.05, **p<0.01, ***p<0.001

our sample by the proportion of Blacks living in the community. Following our income methodology above, we stratified communities into terciles, with the higher Black share designated by the top tercile and the lower Black percentage designated by the bottom two terciles.[19]

As shown in Table 5, LIHTC price effects are consistently positive across all levels of LIHTC concentration, both distance bands, and both predominantly Black and less Black neighborhoods. Consistent with our previous findings, the price effects are larger and more statistically significant nearest the LIHTC development. The affordable housing properties have generally similar effects across the two types of neighborhoods, but those effects are slightly larger in communities where Blacks comprise a smaller share of the population.[20] This finding indicates that both the presence and concentration of LIHTC properties benefit neighborhoods regardless of their racial composition. The time-varying coefficients from Model 3 are reported in Tables A5 and A6, which again indicate fluctuation from year to year. We do not detect noticeably different trends, though, between the two types of neighborhoods, confirming the results from Model 2.

Discussion and conclusion

We find evidence that LIHTC developments in Cook County, IL, have had positive impacts on surrounding house prices. Those impacts have been greater in areas where LIHTC properties are concentrated, though the differences between subsequent developments is not statistically significant; thus, we can conclude that concentration of multiple properties did not lower property values overall. Though there is some evidence that property values decline after the second LIHTC project is completed, this impact is not statistically different from the pre-LIHTC baseline, and it is not large enough to outweigh the positive impacts of the first and third project. Given the inherent clustering patterns of LIHTC developments in Chicago and other urban areas throughout the country, it is important to tease out and quantify the cumulative impacts of these properties. Our work builds on previous studies that have documented the program's clustering patterns in low-income, low-opportunity neighborhoods in metropolitan areas (see Diamond & McQuade 2019; Ellen, Horn, & Kuai 2018; Van Zandt & Mhatre 2009; and Koschinsky 2009, among others).

While nobody appears to have specifically analyzed the additive effects of LIHTC clustering, several scholars have assumed that such concentration, particularly in certain neighborhoods, could have negative spillover effects on crime and surrounding property values (e.g., Deng 2010; Nguyen 2005; Van Zandt & Mhatre 2009). With considerable research having documented the effects of neighborhood conditions on resident wellbeing (e.g., Chetty et al. 2016, and Chetty & Hendren 2016), some researchers and policy-makers have argued that concentrating additional subsidized housing properties in comparatively high-poverty neighborhoods will negatively affect short-and long-term economic and other outcomes for local residents.

Our study refutes the first set of assumptions by documenting the positive spillover price effects that LIHTC projects have brought to neighborhoods throughout the Chicago area at all levels of neighborhood concentration. The addition of a second LIHTC development has a

[19] Due to the strong relationship between income and racial segregation, this categorization is similar to the lower-income and higher-income communities, respectively, in our previous income breakdown.

[20] Again, we note the presence of a relative decline in price trends in communities with just two LIHTC properties.

Table A5
Time-Varying Pre and Post Trend After LIHTC Developments For Housing Prices Within Varying Distance Bands – Lower Black Population Percentage Community

	Pre		Post1		Post2		Post3_plus	
Year	1/4 Mile	1/2 Mile	1/4 Mile	1/2 Mile	1/4 Mile	1/2 Mile	1/4 Mile	1/2 Mile
-17	-0.193	-0.0637						
-16	-0.228	-0.0558						
-15	-0.203	-0.117**						
-14	-0.158*	-0.134***						
-13	-0.0753	-0.0852*						
-12	-0.088	-0.0895**						
-11	-0.138*	-0.0598						
-10	-0.155*	-0.0605						
-9	-0.146**	-0.0578*						
-8	-0.209***	-0.0667*						
-7	-0.128***	-0.0622						
-6	-0.117***	-0.0542						
-5	-0.0816***	-0.0329						
-4	-0.0952**	-0.0502*						
-3	-0.107***	-0.048						
-2	-0.0704***	-0.0433						
-1	-0.0644*	-0.0477						
0	0	0	0	0	0	0	0	0
1			-0.0142	-0.0607**	-0.000704	0.0196	-0.0681	0.0780**
2			-0.0592**	-0.0346	0.0329	-0.00907	0.0299	0.0017
3			-0.0218	-0.0153	0.0307	0.0256	-0.0341	0.00993
4			-0.0219	-0.0243	-0.0269	0.0108	-0.0893	0.0383
5			-0.0101	-0.0597	-0.0637	-0.0133	-0.197*	0.00646
6			-0.0173	-0.0599	-0.198***	-0.0753	0.127	-0.046
7			-0.0521	-0.0679	-0.123	-0.0850*	0.126	-0.0424
8			-0.0393	-0.0606	-0.102	-0.0802**	0.232	-0.0549
9			-0.0432	-0.0655	-0.162***	-0.0936**	0.199*	-0.0684
10			-0.0243	-0.0609	-0.106	-0.0667*	0.113	-0.001
11			-0.0132	-0.0327	-0.0912	-0.03	0.0546	0.0421
12			0.0223	0.00701	-0.0826	-0.0475	-0.00168	0.0431
13			0.0469	0.0145	-0.172*	0.00118	0.0809	0.0438
14			0.0147	-0.0116	-0.0414	-0.0354	0.311	0.0186
15			0.0318	-0.0198	0.0839	0.0058	0.509***	0.140***

Note: Regressions control for Census tract fixed effects, year fixed effects, and the following property traits: total square footage, living area square footage, lot size square footage, floor-area ratio (FAR), age at sale, air conditioning (dummy), fireplace (dummy), number of stories, building structure, and seasonal dummies (spring, summer, fall). $+p<0.1$, $*p<0.05$, $**p<0.01$, $***p<0.001$

slightly negative effect within 1/4 mile, but that effect is only statistically significant by using the more conservative baselines that we generated by extrapolating an increasing linear trend from the pre-LITHC period. Regardless of the baseline we choose, however, this negative marginal effect does not change the positive overall treatment effect of the LIHTC properties. Furthermore, that negative effect disappears and becomes even more positive with the addition of a third development. And while we found spillover benefits throughout the county, in both lower-income and relatively higher-income areas, the largest and most consistent impacts were in lower-income neighborhoods. The impacts were also positive and significant in communities with different proportions of Black residents. These findings support community developers' contention that LIHTC properties simultaneously can help alleviate the shortage of affordable housing and help stabilize and ultimately improve economically distressed neighborhoods.

While our findings are potentially significant for researchers, practitioners, and policy-makers, they come with three caveats. First, we have focused only on Chicago and surrounding Cook County. The area has substantial variations in income and demographic characteristics, and it contains well-defined neighborhoods and a long history of community development and activism. These and other factors may limit the generalizability of the findings; after all, studies in different markets have found negative spillover effects from LIHTC properties, particularly in more affluent neighborhoods. It will be important to conduct similar analyses in other markets to understand whether the clustering of LIHTC developments has consistently positive effects, or whether locality-specific factors shape the type and extent of the spillover outcomes. Such knowledge would help policymakers and practitioners determine where best to leverage LIHTC resources for maximum neighborhood development benefits.

Second, our analysis focuses solely on LIHTC properties' effects on surrounding housing prices. We assume that changes in values reflect various improvements within a community, but it is not clear what those specific improvements are and how they result in greater demand for property in the area. Understanding that process and the underlying relationships and dynamics driving it likely will require a more mixed-method approach that combines quantitative analysis with interviews of local developers, property managers, residents, investors, and other key actors knowledgeable about the local dynamics.

Third, as with most LIHTC studies, there remains the possibility of endogeneity for which we could not control with our current data. With richer data or a different methodology, it might be possible to test this possibility further and make the results more robust for the purposes of causal inference. This is an important avenue for future research to explore.

Given these limitations, we found little evidence that the concentrated development of LIHTC properties has had negative housing price impacts in higher-income Chicago and Cook County neighborhoods. This underscores the importance of a balanced approach to funding affordable housing investments across a wide variety of communities. Further development of such properties in higher-opportunity neighborhoods has the potential to help lower-income households reap the benefits of living in more affluent areas.

Author statement

All authors participated in all stages of the research project.

Table A6
Time-Varying Pre and Post Trend After LIHTC Developments For Housing Prices Within Varying Distance Bands – Higher Black Population Percentage Community

	Pre		Post1		Post2		Post3_plus	
Year	1/4 Mile	1/2 Mile	1/4 Mile	1/2 Mile	1/4 Mile	1/2 Mile	1/4 Mile	1/2 Mile
-17	-0.224	0.0736						
-16	-0.0589	-0.0496						
-15	-0.14	-0.0582						
-14	-0.101	-0.028						
-13	-0.137	-0.0431						
-12	-0.185*	-0.042						
-11	-0.071	-0.0684						
-10	-0.064	-0.017						
-9	0.0167	-0.0695*						
-8	-0.134**	-0.0784*						
-7	-0.109*	-0.043						
-6	-0.120*	0.00382						
-5	-0.0821	-0.0186						
-4	-0.0682	0.0428						
-3	-0.0317	0.0469*						
-2	-0.032	0.0111						
-1	0.00194	0.0352						
0	0	0	0	0	0	0	0	0
1			-0.0453	0.00224	0.00957	-0.0193	0.0554	-0.000442
2			-0.0945**	0.00932	-0.0197	-0.018	0.0102	-0.00476
3			-0.0231	0.0354	-0.0599	-0.0182	0.0271	-0.0813*
4			-0.0125	-0.00307	-0.0222	0.0173	0.0367	0.00806
5			-0.000626	-0.0623*	-0.0816	-0.0385	-0.0555	-0.0076
6			-0.0448	-0.00144	-0.0931**	0.000248	-0.0131	-0.0000599
7			0.00162	-0.015	-0.028	0.0104	-0.114	-0.0388
8			0.0268	-0.00928	-0.035	-0.0187	0.0288	-0.00377
9			0.0697**	-0.0107	-0.0934*	0.00211	0.0741	0.029
10			0.0432	0.00182	-0.0727	-0.017	0.0636	0.0275
11			0.0507	0.00158	-0.164***	0.00853	0.0204	0.0789**
12			0.0491*	0.01	-0.150**	-0.0126	0.0587	0.0309
13			0.101***	0.0133	-0.121**	-0.0402	-0.108	0.0705
14			0.0997**	0.0640*	-0.0566	-0.00188	0.0794	0.0236
15			0.101**	0.0705**	-0.111**	-0.0255	0.0912	0.136*

Note: Regressions control for Census tract fixed effects, year fixed effects, and the following property traits: total square footage, living area square footage, lot size square footage, floor-area ratio (FAR), age at sale, air conditioning (dummy), fireplace (dummy), number of stories, building structure, and seasonal dummies (spring, summer, fall). +p<0.1, *p<0.05, **p<0.01, ***p<0.001

Table B1
Hybrid ITS/DID Model with Pre-Trend Interaction Variables

Measures	Distance from LIHTC Property	Simple Model Coefficient	T Stat	Concentration Model Coefficient	T Stat
Pre	0 - 1/4 Mile	-0.058**	-3.04	-0.055**	-3.12
Pre-Trend		**0.011**	**1.42**	**0.011**	**1.43**
Post1		0.021	1.44	0.021	1.64
Post1-Trend		0.001	0.95	0.002	1.19
Post2				-0.011	-0.45
Post2-Trend				0.004	1.61
Post3				0.044	1.96
Post3-Trend				0.004	1.42
Pre	1/4 Mile - 1/2 Mile	-0.002	-0.08	0.001	0.07
Pre-Trend		**0.009****	**3.19**	**0.009****	**3.31**
Post1		0.000	0.03	-0.005	-0.27
Post1-Trend		0.001	0.83	0.002	1.02
Post2				0.017	0.81
Post2-Trend				0.002	0.97
Post3				0.023	1.37
Post3-Trend				0.003	1.35
Constant		11.537	0.76	11.537	
Number of Observations		602,498		602,498	
R Bar2		0.738		0.738	

Note: Regressions control for Census tract fixed effects, year fixed effects, and the following property traits: total square footage, living area square footage, lot size square footage, floor-area ratio (FAR), age at sale, air conditioning (dummy), fireplace (dummy), number of stories, building structure, and seasonal dummies (spring, summer, fall). +p<0.1, *p<0.05, **p<0.01, ***p<0.001

Appendix A. Complete model results

Our Model 3 estimates the difference in housing prices between the treatment and control groups, year by year, for up to 17 years preceding a new LIHTC development and 15 years afterward. The full set of coefficients is too cumbersome to report in the main text, but we have provided it below for those who are interested (Table A2-A6). These results are particularly useful in calculating treatment effects by year (Table A1, Table A2, Table A3, TAble A4, Table A5, Table A6), which is visualized as Figure 3. This is an important confirmation of the robustness of our difference-in-difference methodology.

Appendix B. Pre-trend tests

Our most complete specification, Model 3, gives some indication of increasing coefficients during the Pre period, as shown in Figure 2 and numerically listed in Appendix A. Here, we present standard tests for a pre-trend, as the difference-in-differences literature typically requires. In both specifications below, the average Pre coefficients are interacted with a linear time trend to create the Pre-Trend variables. Regardless of whether we include one Post variable or different Post variables for each incremental LIHTC development in a given neighborhood, we find that there is a statistically significant positive trend in the 1/2-mile band but not in the 1/4-mile band. We discuss these findings in the Model 3 subsection of the Findings section in the main text of the paper. Tab B1

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