HOW DO LOW-INCOME HOUSING TAX CREDIT PROJECTS TRIGGER REVITALIZATION IN SHRINKING CITIES? A CASE OF ST. LOUIS, MO

BY

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THESIS

Submitted in partial fulfillment of the requirements
for the degree of Master of Urban Planning in Urban Planning
in the Graduate College of the
University of Illinois at Urbana-Champaign, 2015

Urbana, Illinois

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Abstract

The Low-Income Housing Tax Credit (LIHTC) program plays a significant role in providing affordable housing to low-income households by promoting affordable housing development through tax credits to private investors. In shrinking cities like Detroit and St. Louis, especially, where continuous population loss has created disinvestment and abandonment, LIHTC often represents a rare opportunity to channel resources into distressed neighborhoods. Many scholars have noticed that the LIHTC program has a significant effect on revitalization in shrinking cities by eliminating disamenities and increasing neighborhood vitality. Given this view, this study employs a quasi-experimental design to examine the impact of LIHTC developments in the St. Louis region on the neighborhoods in which they are located, compared to other neighborhoods without LIHTC units. In particular, I consider job accessibility as one of the key indicators of the analysis in order to address how the LIHTC developments provide employment opportunities in a job-housing mismatch context that is obvious in shrinking cities.

This study, first, established and measured job accessibility index of every census block group. By mapping the locational distribution of the LIHTC developments, I examined the relation between the LIHTC units and job accessibility. This study then clustered all LIHTC neighborhoods into five groups with similar socio-economic characteristics. The clustering is based on the index of job accessibility. Finally, the study examined the neighborhood changes of LIHTC-communities in each cluster, where LIHTC development is present, to compare them with non-LIHTC communities.

Findings suggest that the LIHTC developments in the St. Louis region have been located more in relatively high job-accessible neighborhoods. This indicates that LIHTC development has high co-relation with job opportunity and neighborhoods' economic conditions, since it attracts private sector developers. In addition, the LIHTC developments in the neighborhoods with higher employment opportunity and more distressed conditions produce more positive changes. This means that LIHTC development plays a significant role in the revitalization of distressed neighborhoods in shrinking cities, although we see some negative effects in high-income communities.

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Chapter 1. Introduction

The Low-Income Housing Tax Credit (LIHTC) program, enacted in 1986, has grown as the largest place-based affordable housing subsidy program in the United States. The Department of Housing and Urban Development (HUD) announced that, nationwide, the program subsidized more than 40,502 housing development projects and 2.6 million households between 1987 and 2013 (U.S. Department of Housing and Urban Development). Many researchers have asserted that the program played a significant role in providing affordable housing to low-income households through both public and private sectors in terms of equity and social justice. However, opposition to the housing program has emerged, stemming fundamentally stems from attitudes toward tenant characteristics such as race, ethnicity, and poverty (Freeman and Botein, 2002). NIMBYism (Not In My Back Yard) attitudes view the influx of the new households as "undesirables." Prior studies examining the impacts of subsidized housing programs on nearby neighborhoods have produced conflicting results. Some studies have found a negative impact whereas others have found a positive or even no impact (Cummings and Landis, 1993; Lee et al., 1999; Schwartz et al., 2006). The findings from the previous literature have indicated that the impact of subsidized housing may vary across the local housing market, submarket conditions, and local housing needs.

However, a different perspective of the impact of subsidized housing developments on neighborhoods has been identified. Some planners noticed the significant role of the LIHTC program on the revitalization of distressed neighborhoods in shrinking cities, where continuous population loss created disinvestment and abandonment (Schill and Wachter, 2001). They argued that building the LIHTC program

offered a rare opportunity to channel resources into these neighborhoods. In addition, some scholars have shown that LIHTC programs bring revitalization into shrinking neighborhoods by eliminating disamenities and abandoned lots (Baum-Snow and Marion, 2009; Koschinsky, 2009; Schwartz et al., 2006). They have also pointed out that affordable housing development may bring more investment to surrounding neighborhoods. However, one challenge of subsidized housing program is the need to address the shrinking cities, which require a different approach to implement the housing policy in the declining environment from existing planning tools used in growing communities.

In this study, I suggest a different approach to the LIHTC development in shrinking cities that considers providing economic opportunities to low-income households as a key factor. Shrinking cities have experienced severe economic reconstitution and reformation due to the losses of economic bases and populations. To figure out the new approach, this study aims to examine how the LIHTC projects in the St. Louis region have been implemented in a shrinking environment to address its unique housing needs. I focus on the locational distribution of the LIHTC projects in relation to economic opportunities. I then examine the spillover effect of LIHTC projects on surrounding neighborhoods.

Chapter 2. Background and Literature Review

2.1. The Low-Income Housing Tax Credit Program

Enacted as part of the Tax Reform Act of 1986, the Low-Income Housing Tax Credit (LIHTC) program provides financial incentives to low-income rental housing owners and benefits affordable rental housing developments targeted at low-income households. The LIHTC represents a partnership among a variety of public and private sector actors. The basic promise of the LIHTC is to offer federal tax credits to private investors in return for their providing equity for the development of affordable rental housing (Schwartz, 2014). Today, the LIHTC program is the largest resource for creating affordable housing in the United States. The LIHTC has supported 40,502 housing development projects and 2.6 million housing units placed in service between 1987 and 2013, which now accommodates more households than public housing (U.S. Department of Housing and Urban Development; Schwartz, 2014).

In general, credits are allocated annually to state housing authorities by the U.S. Department of the Treasury based on state population. Then state housing authorities distribute the credits to private developers through a competitive process. State housing authorities who set goals for the program review projects proposed by for-profit and non-profit developers, monitor the reasonableness of project costs, and take responsibility for ensuring that projects stay in compliance and that approved projects receive only the tax credits necessary to make the project work. The amount of the credit depends on the location and the cost of the housing development and the proportion of units occupied by low-income households. These non-refundable credits can be used to offset the developer's tax liability or, as is most often the case, sold to generate capital. LIHTC

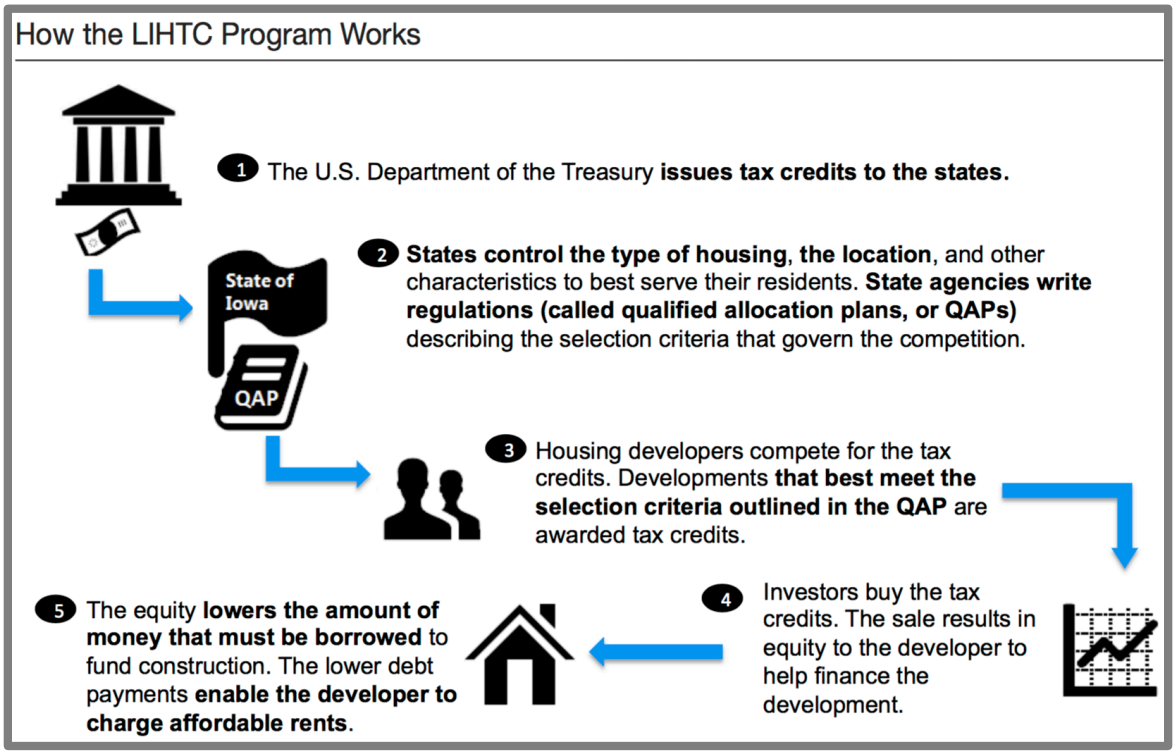

Figure 1. How the LIHTC program works
(Source: Nedwick and Burnett, 2015)

owners can claim a dollar-for dollar reduction in tax liability over 10 years. The reduction enables the developers to charge affordable rents to low-income households (Schwartz, 2010; Cummings and DiPasquale, 1999, Nedwick and Burnett, 2015). Figure 1 shows how the LIHTC program works.

The LIHTC program is a very flexible housing subsidy. State housing authorities could tailor the program to their individual needs and priorities, which allows to decide the types of housing that should receive them. Some give preference to housing for the elderly and other populations with special needs and some favor distressed inner city locations; others promote developments sponsored by nonprofit organizations. The tax credit is also used to preserve other federally subsidized project. For example, the program is frequently used in conjunction with the federal HOPE VI program for the

revitalization of distressed public housing. Nearly half of LIHTC properties have at least one resident receiving tenant-based rental subsidies through the Housing Choice Voucher Program (Climaco et al. 2009).

In terms of locational characteristics, LIHTC housing is more likely to be placed in low-income and minority neighborhoods than is other rental housing. According to Climaco et al., 21% of all LIHTC units put in service from 1995 through 2006 are in census tracts where over 30% of the residents are below the poverty line, while 12% of all rental units are in the tracts. This pattern is more obvious in central cities, where 35% of all LIHTC units are located in high-poverty tracts, compared to 21% of all rental units. Similarly, 44% of all tax credit units are in tracts with over 50% minority population, compared to 32% for all rental housing (Climaco et al. 2009).

The locational concentration of the LIHTC units in minority and low-income neighborhoods perpetuating existing conditions of racial and economic segregation has been criticized. However, although tax-credit housing is more concentrated within minority and low-income neighborhoods than is other rental housing, it is much less concentrated in these neighborhoods than is public housing and other project-based federal housing subsidies (Freeman, 2004). Furthermore, according to Kirk McClure in 2006, LIHTC units may be more effective than rental vouchers in enabling low-income households to move to middle-income suburban neighborhoods (McClure, 2006). It is also obvious that since residents of tax-credit housing tend to have income that are well-above the poverty line, the presence of a tax-credit development within a high-poverty neighborhood may have the counterintuitive effect of reducing the concentration of poverty.

LIHTC Developments in Shrinking Cities

According to Vey (2007), shrinking cities are a special subset of older industrial cities with significant and sustained population loss (25% or greater over the past 40 years) and increasing levels of vacant and abandoned properties, including blighted residential, commercial, and industrial buildings. On the other hand, the Shrinking Cities International Research Network (SCIRN) defines shrinking city as a densely populated urban area with a minimum population of 10,000 that has faced population losses in large parts for more than two years and is undergoing economic transformations with some symptoms of a structural crisis (Wiechmann 2008; Hollander *et al*., 2009). Table 1 shows the list of top twenty shrinking cities in the United States based on population decline

Table 1. Industrial cities in the U.S. that experienced the highest population decline

	Population in 1950	Population in 2010	Population Decline	Pop Decline %
St. Louis, MO	856,796	319,294	537,502	62.7
Detroit, MI	1,849,568	713,777	1,135,791	61.4
Youngstown, OH	168,330	66,982	101,348	60.2
Cleveland, OH	914,808	396,815	517,993	56.6
Buffalo, NY	580,132	261,310	318,822	54.9
Pittsburgh, PA	676,806	305,704	371,102	54.8
Dayton, OH	243,872	141,527	102,345	41.9
Cincinnati, OH	503,998	296,945	207,053	41.0
Scranton, PA	125,536	76,089	49,447	39.3
Utica, NY	100,489	62,235	38,254	38.0
Canton, OH	116,912	73,007	43,905	37.5
Flint, MI	163,413	102,434	60,979	37.3
Newark, NJ	438,776	277,140	161,636	36.8
Rochester, NY	332,488	210,565	121,923	36.6
Baltimore, MD	949,708	620,961	328,747	34.6
Syracuse, NY	220,583	145,170	75,413	34.1
Total	8,242,215	4,069,955	4,172,260	50.6

Sources: Population data from U.S. Census Bureau 1950 and 2010

between 1950 and 2010 with a minimum population of 100,000 residents. St. Louis city is the most critical shrinking city, which has severe population decline by 62.7% over the last 60 years, followed by Detroit (61.4%), Youngstown (60.2%), and Cleveland (56.6%). Most of the cities in the list are located in the rust belt region that has experienced industrial decline and restructuring.

In the shrinking cities, continuous population decline causes demographic changes, which usually changed to the communities with relatively higher rates of poverty, unemployment, and crime. These changes have led different patterns of government housing policies compared to other cities. Table 2 shows the number of subsidized households in four largest shrinking cities, Detroit, St. Louis, Cleveland, and Pittsburgh in 2013. The percentages of households in the shrinking cities that are subsidized by housing subsidy programs are much higher than the US average. For

Table 2. Subsidized households of four largest shrinking cities in 2013

	Total households	Public Housing Households (% in total)	Housing Voucher Households (% in total)	LIHTC households (% in total)	All subsidized households (% in total)
Detroit, MI	256,599	4,248 (1.7%)	10,779 (4.2%)	10,905 (4.3%)	31,598 (12.3%)
St. Louis, MO	140,652	2,790 (2.0%)	4,964 (3.5%)	8,072 (5.7%)	15,656 (11.1%)
Cleveland, OH	166,847	8,907 (5.3%)	7,432 (4.5%)	9,845 (5.9%)	24,254 (14.5%)
Pittsburgh, PA	133,005	4,262 (3.2%)	7,017 (5.3%)	2,478 (1.9%)	17,559 (13.2%)
US Total	115,610,216	1,150,867 (1.0%)	2,386,237 (2.1%)	1,974,163 (1.7%)	5,255,760 (4.6%)

Source: Household data from the U.S. Census 2013 ACS 5-years and housing program data from the U.S. Department of Housing and Urban Development's Picture of Subsidized Households database

example, percentage of all subsidized households in St. Louis is 11.1%, while the national percentage is 4.6%. This result indicates that there are more needs for housing assistant due to the urban shrinkage and economic declines.

Table 3 shows the contribution of LIHTC developments to citywide new housing construction in the four largest shrinking cities, comparing to the four largest cities in the U.S. Clearly, LIHTC developments are most dominant in the shrinking cities. The shares of new housing construction in shrinking cities range between 17% and 33.3%, while other cities have much small share of LIHTC new construction. The significance of LIHTC developments in shrinking cities is not surprising considering the severe population decline the city has experienced in the last several decades. The urban shrinkage and economic decline discourage investments to housing development in the shrinking cities. In this sense, LIHTC played a significant role in attracting investment in new housing construction. Without public subsidies like the LIHTC, private developers did not have much interest in carrying out new development in the shrinking cities (Deng, 2009).

Focusing on new construction projects alone understates the importance of LIHTC development to the shrinking cities, given that most of the LIHTC funding has supported acquisition and rehabilitation activities. According to table 3, the share of LIHTC units provided by acquisition and rehabilitation activities is much larger in shrinking cities. This it due to the fact that shrinking cities has much more vacant housing units and lots that can be used for LIHTC developments.

Overall, since LIHTC developments have played a significant role for housing development in shrinking cities in terms of not only provision of affordable housing, but also attracting private investment, how they are sited could have significant impacts on the city's neighborhoods.

Table 3. Comparison of shares of LIHTC housing development in four largest cities and four largest shrinking cities, 1990-2009

	New Housing Construction 1990-2009			Low Income Housing Tax Credit 1990-2009				Share of LIHTC NC Units in Total Citywide NC Units
	No. of NC Housing Units	Share of NC in total	Margin of Error	No. of Projects	No. of Housing Units	No. of NC Projects	No. of NC Units	
Detroit, MI	15,554	3.8%	1,063 (7%)	233	12,166	79	5,185	33.3%
St. Louis, MO	13,270	6.8%	991 (7%)	228	10,571	82	2,878	21.7%
Cleveland, OH	13,292	5.9%	958 (7%)	123	10,157	36	2,264	17.0%
Pittsburgh, PA	10,197	6.0%	958 (9%)	51	2,544	26	1,868	18.3%
New York, NY	321,717	10.8%	5,413 (2%)	533	38,688	108	20,538	6.4%
Los Angeles, CA	168,267	12.9%	3,443 (2%)	343	22,193	209	12,225	7.3%
Chicago, IL	151,108	13.3%	3,589 (2%)	285	28,517	101	9,680	6.4%
Houston, TX	220,689	30.4%	4,492 (2%)	124	24,897	83	15,698	7.1%

Source: New housing construction data from 1990 to 2009 from 2013 American Community Survey from the U.S. Bureau of Census and LIHTC data from the U.S. Department of Housing and Urban Development
Note: 1. NC means new housing built citywide between 1990 and 2009
2. The four largest shrinking cities are identified based on the total population and the rate of population decline between 1950 and 2010
3. The four largest cities are identified based on the population in 2010
4. Types of LIHTC include new construction, acquisition, 및 rehab, and this study focuses on new construction housing units.
5. When I calculate the share of LIHTC NC housing units in total NC, the margin of error was ignored.

LIHTC in the St. Louis Region

While the region overall is relatively stable, there are areas that face significant levels of population decline and poverty. Like most metropolitan areas, the highest rates of poverty are found in parts of the city of St. Louis and the industrial suburb of East St. Louis, although the past decade has seen a considerable shift of poverty to suburban areas (Theising, 2003; Kneebone and Garr, 2010). Housing in the city of St. Louis is aging, with 66.5 percent of units built prior to 1950. At 54.8 percent, the city has a far higher rate of renter-occupied units than the national average. The rental vacancy rate is also significantly higher; they are likely inflated due to the high number of abandoned properties in the area, the result of decades of population decline (Cummings, 2004). Abandoned properties have been linked to lower rates of homeownership in surrounding neighborhoods, possibly contributing to the city's high rate of rental housing. However, this does not imply the city of St. Louis has enough affordable housing stocks. On the contrary, there is still a great need for safe, quality affordable rental units in the city. Many of vacant units are unsafe and uninhabitable. Therefore, they cannot be included in the available supply of rental housing the area (Cohen, 2001).

The state of Missouri recognizes the need for affordable housing for its residents. According to the latest five-year consolidated plan from the Missouri Department of Economic Development (MDED) in 2008, the state identified the creation of new housing units and the preservation of existing units as its top five housing priorities. Recognizing that there are too many families that are paying more than 30 percent of their gross income for housing cost, the Missouri Housing Development Commission (MHDC) planned to produce 600 new affordable units each year from 2008 to 2012 using

Home funds, state programs and LIHTC development projects (MDED, 2008). MHDC also planned to finance the rehabilitation of 400 existing low-income rental units over the same period using the same funding sources.

According to HUD's LIHTC database, the credit program has funded the creation of more than 52,000 affordable housing units in the state of Missouri from 1987 to 2012. The program has been successful in generating economic benefits for the state and the St. Louis region (Cook et al., 2007). A 2007 cost-benefit analysis for MHDC found that, for each dollar of state tax credit awarded, $9.60 in economic activity was generated and $5.45 in gross state product was added (Cook et al., 2007). For the St. Louis MSA, each LIHTC dollar led to an estimated $10.79 in economic activity and $6.32 in gross regional product (Cook et al., 2007). Another MHDC report conducted by Watts (2010) on the state LIHTC program found similar benefits. Watts predicted that each Missouri LIHTC dollar led to $2.99 in personal income, $4.17 in new value-added gross state product, and $5.85 in new economic output.

Other studies on the LIHTC program in Missouri also have found that it generates various economic impact to regional economies. Mitchell and McKenzie (2009) found that the state LIHTC program between 2000 and 2005 generated a total value-add of roughly $2.44 billion in Missouri and $1.25 billion in the St. Louis region, with approximately 10 full-time jobs created for every 100 LIHTC units built in St. Louis. Cook et al. (2007) also found that LIHTC project brought $6.5 billion in economic impact for the state and the creation of 41,800 full-time jobs during the same period, 19,242 of which were in the St. Louis MSA, while creating 21,250 affordable housing units in the state, with 8,499 of those situated in the St. Louis MSA (Cook et al., 2007).

However, Mitchell & McKenzie (2009) addressed some loss of tax revenue for states, although the program generate significant economic and employment benefits. The losses are found significantly more when projects are developed in rural areas. Losses in rural areas were estimated to be around 85 cents per dollar, compared to 45 cent in urban areas (Mitchell & McKenzie, 2009). When the overall costs and benefits of the state LIHTC program are considered, however, the program still appears to be an important tool for generating economic benefits, employment and housing opportunities in low-income neighborhoods where it may not otherwise be feasible to develop (Cook et al., 2007).

Furthermore, Cook et al. (2007) and Sweaney et al. (2006) identified the social benefits generated by the LIHTC program in Missouri although it is hard to quantify in traditional cost-benefit analyses (Cook et al., 2007; Sweaney et al., 2006). The benefits they found are:

- a decline in the risk of homelessness;
- safer, less crowded neighborhoods;
- improved school performance and reduced drop-out rates among children;
- improved mental health;
- increased prosocial behavior and motivation among children; and
- better overall health of residents

Overall, the studies above consider the LIHTC projects in Missouri successful in achieving its goals as it appears that the benefits of the programs outweigh the costs for Missouri and the St. Louis region (Cook et al., 2007).

2.2. Neighborhood Effect of LIHTC Developments

Many literatures from the past decade studies assessing whether subsidized housing has negative impacts on neighboring units. There are two different perspectives on the effect of LIHTC units. Some researchers who found negative spillover effects of housing assistance programs point to the influx of 'undesirables' as the cause of neighborhood decline (cummings and Landis, 1993; Lee et al., 1999), while others addressed that housing subsidy programs bring revitalization to neighborhoods through eliminating disamenities in communities (Baum,-Snow and Marion, 2009; Koschinsky, 2009; Schwartz et al., 2006). Disparities between subsidized residents and other residents in a neighborhood may result in dissonance among them, which may induce a drop in the average of neighborhoods if previous residents flee or potential purchasers begin to view the neighborhood as undesirable because of the new residents who get housing subsidies (Nguyen, 2005). In contrast, if subsidized households and non-subsidized households share similar socioeconomic characteristics, especially in lower-income neighborhoods, the impact on neighboring housing units may be negligible (Freeman and Botein, 2002). This underlines the significance of neighborhood heterogeneity in assessing impacts of subsidized housing that have been overlooked in many previous studies.

Subsidized housing development also affects surrounding neighborhoods due to the removal of amenities or disamenities (Ellen et al., 2005; Freedman and Owens, 2011). For instance, parks, historic buildings, and open space may be removed due to housing development, which may have a negative effect; in contrast, the removal of abandoned buildings and lots may result in a positive impact (Ellen et al., 2005; Freedman and Owens, 2011; Schwartz et al., 2006). Although public housing programs has been

criticized for depressing surrounding neighborhoods, the LIHTC programs are considered to be more effective housing policy for creating higher quality housing units and maintaining neighborhood vitality (Deng, 2009). In addition, since the LIHTC program can improve quality of surrounding neighborhoods by removing disamenities, LIHTC developments can be effective housing policy for revitalization of distressed neighborhoods and shrinking cities (Deng 2007).

LIHTC developments may also yield spillover effects due to new investment. Many studies found a positive impact of residential investment in new construction and rehabilitation on nearby property value (Desalvo, 1974; Ding et al., 2000; Simons et al., 1998). The LIHTC development is based on market approach to providing affordable housing as well as market rate units (Deng, 2007). 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 the area.

Freeman's work in 2014 shows whole picture of characteristics of neighborhoods where LIHTC units were built. (Freeman, 2004). He examined database of the nationwide LIHTC projects to address their locational characteristics, racial and ethnic makeup, and economic profile, comparing to neighborhoods with other types of federally assisted housing. First, he found that approximately 42 percent of all LIHTC housing units are located in the suburbs, compared to only 24 percent of other project-based federally assisted housing units. However, a majority of LIHTC units (58%) are placed in central cities although a minority (38%) of all metropolitan residents reside there. At the

same time, other types of federally assisted housing developments concentrate in central cities to an even greater degree than LIHTC units. This implies that the LIHTC projects has been more successful in dispersing units into the suburbs than other federal project-based housing assistance programs. Freeman brings up several reasons why the LIHTC's relative success in penetrating the suburbs. Earlier assisted housing developments were for the most part built at a time when the nation was much less suburban than it is today. Additionally, affordable housing developers who apply for LIHTC allocations may face fewer political constraints because suburban politicians choose to avoid NIMBY debates.

Freeman's second finding is that LIHTC neighborhoods contain disproportionate shares of black residents. Blacks represent about one in four residents of LIHTC neighborhoods, although all metropolitan neighborhoods show about one in seven residents with blacks. This implies that LIHTC neighborhoods become more racially and ethnically diverse during the 1990s, thanks largely to a significant increase in their Hispanic and foreign-born populations. Other finding of Freeman indicates that compared to other neighborhoods, LIHTC neighborhoods experienced larger declines in poverty and similar increases in home value during the 1990s, compared to other metropolitan neighborhoods. However, LIHTC neighborhoods still have considerably higher poverty rates, lower median incomes, and lower median home values than typical metropolitan neighborhoods. This is because LIHTC units were built in poorer neighborhoods, which have more likely to contain concentrated levels of poverty and lower income. The last finding from the Freeman's work is that, suburban LIHTC neighborhoods are predominantly white and show higher median incomes, lower levels of poverty, and higher home values and homeownership rates than LIHTC neighborhoods in central

cities. However, the large socioeconomic gaps that separate central city and suburban LIHTC neighborhoods narrowed during the 1990s. For instance although median household income in central city LIHTC neighborhoods trails that in suburban LIHTC neighborhoods by $13,000, incomes grew more than twice as fast in city as suburban LIHTC neighborhoods over the decade.

Freeman conducted a comparison research on LIHTC neighborhoods and other metropolitan neighborhoods in the 1990s. However, this study has a significant limitation in methodology. Although its approach can show the overview of the characteristics of LIHTC neighborhoods in a time of 1990s, it is hard to exhibit actual socioeconomic changes of the neighborhoods caused by LIHTC developments. To figure out this limitation, comparing LIHTC neighborhoods with other ones that has similar socioeconomic characteristics at the same period. In addition, measuring the changes of neighborhoods during certain time can shows the impact of LIHTC neighborhoods more effectively. For instance, neighborhoods with higher black population and lower income level can be compared by the changes between 1990 and 2000.

A research of Woo et al. (2015) examines the impacts of LIHTC developments on nearby property values from 1996 to 2007 in two US cities: Charlotte, North Carolina and Cleveland, Ohio. The research examines levels and trends in housing prices before and after LIHTC developments in neighborhoods based on parcel-level housing sale data between 1996 and 2007. The study applies the Adjusted Interrupted Time Series-Difference in Differences (AITS-DID) model to parcel-level sales transaction data in order to clarify the causal direction of LIHTC development impacts on surrounding neighborhoods.

According to the citywide result of the research, LIHTC developments have a different impact across local housing markets. LIHTC developments have negative impacts on housing prices in Charlotte, while having positive effects in Cleveland. This is due to the fact that Charlotte experienced rapid population growth, causing active residential development investments in the city. This tends to affect to increase housing prices. Given the relatively higher property values of non-subsidized housing compared to subsidized housing, LIHTC developments appear to have been perceived as undesirable development, which results in disinvestment in residential developments. In contrast, Cleveland's housing market has experienced stagnation shown by the lack of new construction and fewer sales transactions due to severe population decline and urban shrinkage. The state have utilized LIHTC developments to revitalize distressed communities, and the positive impacts of such developments may be related to the removal of disamenities such as abandoned buildings that decreases value of neighborhoods (Schwartz et al., 2006). This implies that LIHTC developments can serve as public tools for new community investment and revitalization.

Woo et al.'s research examines different impacts of LIHTC developments in growing and declining cities by choosing Charlotte and Cleveland using housing prices as a value of community. However, housing prices cannot alter a value of community perfectly. Housing prices are very sensitive value, affected by various internal and external factors, including economic and housing market trends or specific new development investment in a specific area. In addition, the study did not account for racial and ethnic composition between the two cities, with Charlotte being majority white and Cleveland being majority African-American.

Deng's study in 2011 examines the socioeconomic changes in neighborhoods including the LIHTC units in Miami-Dade County between 1990 and 2000 using census data (Deng, 2011). The study aims to address how LIHTC developments affect neighborhoods changes in terms of socioeconomic conditions. The study applies a cluster analysis to identify comparison groups to compare changes in LIHTC neighborhoods to the median changes in similar neighborhoods without the LIHTC units using eight socioeconomic characteristics. The study sorts all census block groups into different neighborhood cluster. It then compares changes each LIHTC neighborhood experienced with the median changes in no-LIHTC neighborhoods in the same cluster. Then, the study identifies four types of LIHTC neighborhoods: the most positive, the more positive, the more negative, and the most negative changes. Finally, the study conducted case studies on neighborhoods experiencing the most dramatic changes.

The study's results indicate that over half of the LIHTC neighborhoods in Miami-Dade County have experienced more positive changes, compared to their control groups. However, the changes have varied by neighborhoods' socioeconomic context. Black high-poverty neighborhoods receiving the LIHTC investment are the most likely to experience positive improvement, while middle-class neighborhoods hosting the LIHTC projects are the least likely to do so. Changes in working-class neighborhoods, however, are more mixed. Some have outperformed their control groups, while others have lagged behind.

The case studies also show that LIHTC developments promoted neighborhood revitalization when it is concentrated and cumulative strategically. The study observed from the case studies in Miami City and Miami Beach, where the large-scale LIHTC

development, by targeting working families, indicates that they have contributed to the revitalization of the impoverished neighborhoods. On the other hand, the studies also show that the over-concentration of LIHTC units in vulnerable suburban neighborhoods can show very different changes in middle-class suburban neighborhoods, where the discrepancy between assisted housing and existing housing may become visible and disturbing. Although the study only examines the neighborhood impacts of LIHTC project in the 1990s, which cannot represent current housing market, it suggests basic methodology for comparison analysis between LIHTC neighborhoods and non-LIHTC neighborhoods.

2.3. Employment Opportunities and LIHTC Developments

The literatures concerning the location patterns and neighborhood effects of LIHTC development focus on measuring socioeconomic quality and its changes by sorting LIHTC neighborhoods into different groups with similar conditions. However, an issue that has not been studied is the location of LIHTC developments with respect to employment and job growth (Lens, 2014). Recently, this is a vitally important consideration since the HUD and local housing policymakers focused on allowing subsidized households access to greater opportunity. In shrinking cities, especially, like Detroit and St. Louis which have experienced drastic demographic and economic changes and suburbanization with shrinking cores, the problem of job-housing mismatch is emerging. At the regional scale, city cores that used to be employment centers decline, while jobs moving to suburbs. Low-income households that receive housing subsidy are more frequently moving to lower-income suburbs (Covington et al. 2011), where job

opportunities may be scarce, which cause spatial mismatch. In these suburbs, housing policymakers and advocates need to help subsidized households avoid the worst of both worlds: disadvantaged suburban areas with dispersed employment, low employment growth, and concentration of low-skilled unemployment individuals competing for the few employment opportunities that exist (Lens, 2014).

In this section, at first, I review theories and literatures concerning job-housing balance and job opportunities of subsidized housing units. This study aims to examine the spatial distribution of LIHTC projects in relation to job accessibility. A research by Shen (1998) provides a methodological basis of this study, given its focus on low-income and subsidized households. Shen constructs neighborhood-based measures of employment accessibility for the populations. A methodological strength of his work is the explicit treatment of the competition for jobs-that is, the low skilled unemployed-in determining the employment accessibility of low-income households. He also calculates measures separately for those relying on different types of transportation. In his work published in 1998, he uses data from the Boston metropolitan area to determine the employment accessibility of low-wage workers and finds that inner-city residents have much greater accessibility to employment than those outside the city. He also finds that while the majority of transit; in fact, residents were likely to be better off living in the suburbs and traveling by car rather than living in the job-rich inner city and traveling by public transit (Shen, 1998).

In a 2001 paper, Shen choose to analyze job opening data rather than static employment numbers to improve upon his previous measures. Shen's methodology estimates job openings through two components: job growth and job turnover. Again

using data from the Boston Metropolitan Area, the results are consistent with his 1998 paper: Central-city locations offer greater employment accessibility than the suburbs do (Shen, 2001).

Based on the Shen's methodology to measure employment accessibility, Lens' study in 2014 developed weighted job-accessibility indices for the various types of housing subsidy recipients including public housing, LIHTC, Section 8 New Construction, and housing voucher households. The indices, measuring the extent of spatial mismatch between these households and employment, use census tract level data from the U.S. Department of Housing and Urban Development on housing subsidy locations and employment data from the U.S. Census Bureau (Lens, 2014). He used a distance-decay function to estimate job accessibility indices for census tracts in 300

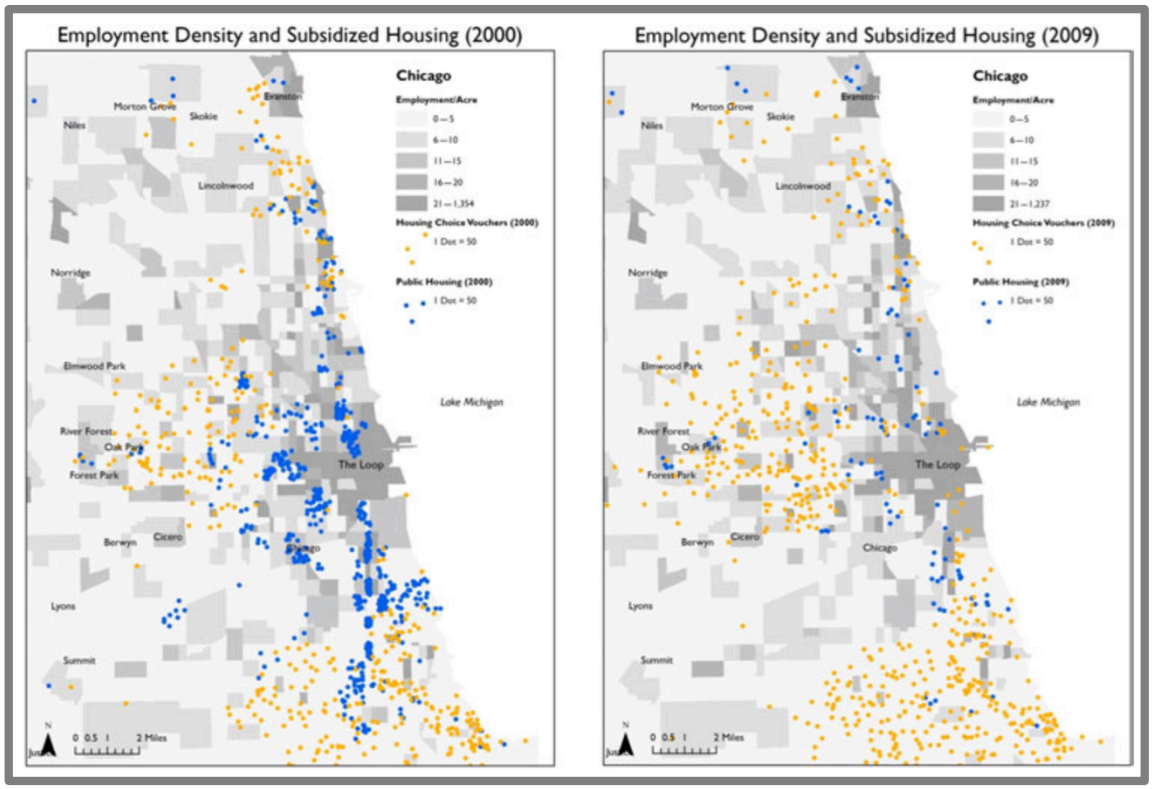

Figure 2. Employment density and job accessibility of public housing and housing voucher households in 2000 and 2009
(Source: Lens, 2014)

metropolitan statistical areas with 100,000 people or more. He found that public housing households live in census tracts with the greatest proximity to low-skilled jobs. However, they also live among the greatest concentration of individuals who compete for those jobs, namely, the low-skilled unemployed.

Although his research suggests the measurement of job accessibility of various types of housing subsidy programs, it uses census tract level data, which decrease the accuracy of location of housing units and the spatial relationship between households and employment. This means census tract cannot accurately represent the location of subsidized households.

2.4. Research Questions

In response to the findings from the literature review and in light of the purpose of the research, this study sought to answer the following questions:

1. **What is the spatial pattern of LIHTC projects in relation to job opportunity in the St. Louis region as one of the shrinking cities?**
2. **What is the impact of LIHTC developments in the neighborhoods in which they are located, compared to other neighborhoods without LIHTC developments?**

As the literature review pointed out, particularly in cities experiencing extensive population decline and suburbanization, where many neighborhoods have long suffered from disinvestment and abandonment, building subsidized affordable housing often represents a rare opportunity to channel resources into the shrinking cities. Given this view, the LIHTC program plays a significant role in promoting neighborhood

revitalization by attracting developers' residential investment in distressed neighborhoods. Most of the previous studies have focused on locational characteristics in relation to demographic attributes, such as median income and racial composition. However, for sustainable revitalization of distressed neighborhoods, the LIHTC development should focus on promoting people's accessibility to greater opportunities, including education, transportation, and employment. This study intends to address whether the LIHTC projects are allocated to promote people's employment opportunities in the St. Louis region. In addition, in relation to employment accessibility, this study aims to examine the neighborhood effect of the LIHTC development on surrounding neighborhoods.

Chapter 3. Data and Methodology

This study employs various statistical analyses using existing datasets of employment, LIHTC projects, and socioeconomic information of the St. Louis MO–IL urbanized area. The reason why I choose the urbanized area scale is that economic and employment studies must consider the limitation of geographic boundaries of place. People's employment and economic activities are not limited to a certain geographic place. It contains the city itself and the surrounding areas. The concept of an urbanized area captures people's commuting patterns, employment transitions, and transportation systems, which are significant elements impacting the local economy and people's economic behavior. This study focuses on employment opportunity in the city of St. Louis, one of the largest shrinking cities in the U.S. It is reasonable to include the surrounding region of the city of St. Louis as the employment changes occur on the regional scale. The St. Louis MO–IL urbanized area includes the city of St. Louis and the surrounding counties in both Missouri and Illinois, including St. Louis County, Jefferson County, and St. Charles County in Missouri and Madison County, Monroe County, and St. Clair County in Illinois.

The research methodology includes three steps to seek the answers to the research questions: (1) measuring job accessibility of all block groups in the study area, (2) mapping spatial distribution of LIHTC units, and (3) identifying neighborhood changes. In the first measurement, the study employed a statistical estimate using the employment information of all census block groups in the St. Louis MO–IL urbanized area based on Shen's methodology, which is commonly used to measure job accessibility. This measurement includes neighborhoods both with and without LIHTC units. Second, this

study maps the location of LIHTC units and job centers in the urbanized area to understand the relationship between employment opportunities and the locations of LIHTC units. Then the study clusters all LIHTC units that have similar job accessibility and socio-economic conditions into several groups. Finally, in order to assess economic changes of LIHTC neighborhoods, the study selects eight indicators to compare the selected LIHTC neighborhoods with comparable groups.

3.1 Measuring Job Accessibility

This study aims to address the spatial relationships between job accessibility and LIHTC populations to get a comprehensive understanding of how LIHTC projects have been implemented to provide more job opportunity to low-income populations in shrinking cities. To figure out the relationship, first, this study needs to address job accessibility of LIHTC neighborhoods in St. Louis MO-IL urbanized area. This study uses Lens (2014)' methodology to measure employment accessibility, which is based on Shen (2001)'s and Parks (2004)' measurements. Lens' measurement collects job opening data and creates distance-weighted job accessibility indices for every census tract. A difference of this study is to use block group level data to increase accuracy of the measurement.

The block group level employment data are from the U.S. Census Longitudinal Employer-Household Dynamics (LEHD) database (U.S. Department of the Census). The database provides the LEHD Origin-Destination Employment Statistics (LODES) datasets, including nationwide annual employment data at census block level from 2002 to 2012 in three categories: origin-destination, residence area characteristics, and

workplace area characteristics. The datasets include the number of jobs, North American Industry Classification System (NAICS) codes, and wage levels by three income categories. To measure recent employment opportunities of block groups in the St. Louis MO-IL urbanized area, this study uses data between 2009 and 2011. This is because I target the period after the Great Depression.

First, this research estimated the number of job opening of each block group in the area between 2009 and 2011. According to Shen's study (2001), job openings consist of opportunities created by employment growth and turnover. This study follows Shen's estimation and the equation for job openings is as follows:

$$O_{it} = O_{it}^{growth} + O_{it}^{turnover} \quad (1)$$

where O_{it} is the number of total job openings; O_{it}^{growth} is the number of job openings that come from net employment growth; and $O_{it}^{turnover}$ is the number of jobs created by turnover, all measured in tract i and year t.

Under normal macroeconomic conditions, average vacancy duration in the U.S. is roughly 0.5 month, or 15 days (Shen, 2001). This study assumes that the employment level increases or decreases by a constant amount every month during a given time period. Therefore, job openings due to employment growth (O_{it}^{growth}) can be estimated as follows:

$$O_{it}^{growth} = \frac{E_{i,t} - E_{i,t'}}{(t - t') \times 12\ months} \times 0.5\ months \quad (2)$$

where t is the ending point (year) of the time period; t' is the starting point (year) of the time period; and $E_{i,t}$ is employment level in block group i in the time period t. The monthly rate of ${O_{it}}^{growth}$ between 2009 and 2011 is divided by 24 months and multiplied by 0.5 months.

Due to the lack of systematically collected data on turnover, estimating the number of job opening created by turnover directly is more challenging. However, there are sound alternatives to measure the data. The U.S. Bureau of Labor Statistics (BLS) conducted annual surveys on turnover in the manufacturing sector and the data indicated that the average monthly turnover rate by quits, discharges, and layoffs was roughly 4%. However, quits and discharges lead to job opening, whereas layoffs do not (Shen, 2001). Therefore, it is generally accepted that under normal macroeconomic conditions, quits and discharges create a monthly turnover rate of 3% as reported by the BLS. Job openings created by turnover can be estimated as follows:

$$ {O_{it}}^{turnover} = 3\%\ per\ month \times E_{it} \times 0.5\ month \quad (3) $$

Second, based on the estimation of job opening of all block groups in the research area, this study creates job accessibility index. This study assumes that job accessibility depends on job opportunities in the surrounding areas and commutes time. This means job accessibility of a block group can increase when it has more job openings in the distance short enough to commute. Job opportunities can be estimated by the number of job openings that allows jobseekers to apply for the vacant working positions. Commute time depends on the different distances of workplaces away from residential locations. To

weigh job openings spatially, the research created a statistical model based on previous studies. Measuring distance-weighted indices follows Parks' (2004) measurement that takes the form of a gravity measure of accessibility that discount job opening farther away a distance-decay function:

$$A_{ki} = \sum_{i=1}^{N} O_{kit} \times \exp(\gamma d_{ij}) \quad (4)$$

where A_{ki} is the accessibility index of block group i to job opening of employment type k in surrounding block groups j; N is the total number of block groups; O_{kit} is the number of job openings of employment type k in block group i in a given year t; γ is an empirically derived distance-decay parameter (a weigh of jobs at different distances from block group i); and d_{ij} is the temporal distance in minutes between those two centroids of i-j pairs. A straight line is drawn between the centroid of every residential block group i, and potential employment block group j, and the distance d_{ij} between those two centroids is measured.

Parks (2004) empirically estimated the parameter γ using a negative binomial count model on household-level data of employment and residential locations for low-skilled workers and arrived at an estimate of -0.058. Then, the estimate weighs jobs at k distance from census tract i by 0 minutes =1, 5 minutes = 0.75, 10 minutes = 0.56, and 20 minutes = 0.31. Using national surveys, Lens (2014) estimated the distance-to-time ratio for commuting as approximately 3 to 1 and I employed this approach. That is, roughly the same proportion of people work 15 minutes away that work 5 miles away; 30 minutes

corresponds to 10 miles; etc. Thus, it arrived at a decay parameter of -0.058 × 3 = -0.174, where 0 miles = 1, 3 miles = 0.59, 5 miles = 0.42, 15 miles = 0.07, 30 miles = 0.005, and 50 miles = 0.0002. Using this parameter allows the estimate to weigh more on closer employment opportunity to jobseekers and to measure an accumulated job accessibility index of block groups.

3.2 Mapping LIHTC Developments and Job Accessibility

In the second step, the study first collected information from the LIHTC database to address the relationship between job accessibility and the geographical distribution of LIHTC projects. The study collected datasets of LIHTC units from the website for LIHTC database created by HUD and available to the public since 1997. The database contains nationwide information on 40,502 LIHTC projects and 2.6 million housing units placed into service between 1987 and 2013 (U.S. Department of Housing and Urban Development). The database provides various information, including project address, number of units and low-income units, number of bedrooms, year the credit was allocated, year the project was placed in service, whether the project was a new construction or a rehab, type of credit provided, and other sources of project financing. As the database has been geocoded, it is useful for mapping the individual LIHTC developments geographically and for understanding the distribution of the projects and neighborhood characteristics of units. The database also provides information on demographic and economic characteristics of each project, thereby allowing researchers to understand socioeconomic features of the program recipients.

I combined the results of the job accessibility index with the socio-economic information of block groups that contain LIHTC housing units and mapped the location of LIHTC projects. I then mapped job centers to show the geographic relationship between the LIHTC developments and employment centers in the urbanized area. Job centers can be shown by employment density measured by the number of job openings per the area of block groups. For the combination, I used 5-year American Community Survey (ACS) data in 2013.

Next, I conducted a cluster analysis on the LIHTC block groups in order to categorize neighborhoods that have similar socio-economic characteristics into several groups. Temkin and Rohe (1998) suggested a useful approach for examining the complexity of neighborhood change. First, it needs to categorize neighborhoods into different quality levels based on their socio-economic status and then analyze the potential causes of changes. This study employed cluster analysis to serve this first goal. Using the results from the cluster analysis, I conducted a comparison analysis between LIHTC neighborhoods and non-LIHTC neighborhoods to help identify the control groups for LIHTC neighborhoods. Cluster analyses have commonly been used in previous studies on neighborhood changes (Deng, 2011).

According to Temkin and Rohe (1998), neighborhood changes can be affected by at least two factors. The first is broad social trends that may alter a region's employment base and social structure. The second is the changes occurring within the neighborhood itself, such as housing development and the transformation of neighborhoods related to the neighborhood life cycle. Therefore, this study assumes that the LIHTC project should have an impact on the neighborhoods and the surrounding areas as not only a broad social

trend, but also a transformation of the neighborhood itself. In addition, this study employed cluster analysis to measure how the different LIHTC projects have changed in the neighborhoods relative to other neighborhoods in the same cluster but without the LIHTC.

I selected five variables for the cluster analysis:

- job accessibility;
- unemployment rate;
- median household income;
- poverty rate; and
- black population percentage.

Those data are from 2013 5-years ACS to collect most recent socio-economic characteristics.

3.3 Identifying Neighborhood Changes

In the last step of this study, I conducted a comparison analysis on neighborhood economic changes in LIHTC neighborhoods and non-LIHTC neighborhoods based on the cluster analysis results. The cluster analysis identified several groups of neighborhoods with different socio-economic characteristics. Based on the groups, I collected information on socio-economic changes between 2000 and 2013 and compared the results from neighborhoods with LIHTC projects to those without projects.

As there is no single indicator that adequately captures the economic conditions and characteristics of a neighborhood, the study selected eight indicators to measure changes experienced by LIHTC neighborhoods between 2000 and 2013 census tracts: (1)

unemployment rate; (2) median household income; (3) poverty rate; (4) median housing value; (5) median rent; (6) vacancy rate; (7) home ownership; and (8) percentage of black population. These indicators are commonly used in many studies to address neighborhoods' economic changes and quality of life as well as to capture different aspects of neighborhoods' economic well-being (Zielenbach, 2003).

However, there is a significant limitation in collecting census economic information in both 2000 and 2013. The geographic boundaries changed in the 2010 census data, and collecting and comparing census data from different census years can be difficult because of the different geographic boundaries. To address the limitation of census boundaries, I used 2010 Neighborhood Change Dataset (NCDB), a normalized census tract dataset for 2010 geographic boundaries, created by GeoLytics. NCDB allows researchers to compare different census year datasets within the 2010 boundaries. I used 2000 census data normalized to the 2010 census tract boundaries.

In order to address the impact of LIHTC projects implemented between 2000 and 2012 on socio-economic conditions of the neighborhoods with LIHTC units, I compared them with comparison groups in the same clusters without LIHTC units. However, as some census tracts contain a very small portion of LIHTC units, I also compared census tracts that contain a large number of LIHTC units to non-LIHTC neighborhoods. This enabled me to address how LIHTC projects affect neighborhoods' economic conditions.

Chapter 4. Results and Findings

Based on the methodology and data sources discussed in previous chapters, this chapter empirically provides the results of analyses, including data collected, measurement of job accessibility, mapping of the LIHTC units, cluster analysis, and comparison analysis of LIHTC neighborhoods in the St. Louis MO–IL urbanized area. Exploring the spatial distribution of LIHTC developments and the relationship with employment opportunities helps answer the question of how LIHTC developments have been implemented in terms of providing more economic opportunities to low-income households. In addition, by comparing LIHTC neighborhoods to non-LIHTC neighborhoods, this study helps understand the role of LIHTC projects in shrinking cities as a tool for socio-economic revitalization.

4.1 LIHTC Projects in the St. Louis MO–IL Urbanized Area

This section provides an overview of the LIHTC projects placed in service in the St. Louis MO–IL urbanized area. The LIHTC data used in this study are from the HUD LIHTC database. Although the LIHTC projects in the study area began in 1987, this study examines the projects from 2000 to 2012, the period for which I could get the most detailed information on the developments because of limitations in data collection and uncertainty about the present unit conditions and existence.

According to the LIHTC database, in the St. Louis MO–IL urbanized area, 153 LIHTC projects (12,724 units) were built between 2000 and 2012. Table 4 presents the characteristics of the LIHTC development portfolio in the study area. As a region containing a shrinking core and a growing suburban area, 68.6 percent of LIHTC

developments projects are placed in the city of St. Louis, although the size of the city accounts for only 6.7 percent of the total area and the population of the city accounts for 15.3 percent of the area's population. Thus, the city of St. Louis has demonstrated greater need for affordable housing for low-income households. In addition, it can be assumed that the LIHTC projects in the city of St. Louis provide greater job accessibility than in suburban areas because the city includes more existing job centers that provide more job opportunities to jobseekers.

Table 4 also shows that the numbers of new construction and rehabilitation projects are similar in the St. Louis MO–IL urbanized area. However, 67 percent of the LIHTC units in the city of St. Louis built between 2000 and 2012 are the rehabilitation and acquisition of existing housing while only 28.9 percent of the units are new construction. This means that developers did far more rehabilitation projects than new construction, which is a common trend in many shrinking cities. For example, 69 percent of LIHTC projects built in the city of Detroit, Michigan, were acquisition and rehabilitation project between 1987 and 2007, whereas 81 percent of the projects in Santa Clara, California were new construction (Deng, 2011). Without public subsidies like the LIHTC, private developers did not have much interest in carrying out new developments in shrinking cities. In addition, there are many abandoned and vacant housing units in the city, as most of the LIHTC funding has supported rehabilitation and acquisition activities for the revitalization of shrinking cores.

Table 4 also indicates that more LIHTC projects were implemented before the 2007 financial crisis. Specifically, 67.3 percent of LIHTC projects were implemented before 2007 compared to 32.7 percent of the projects implemented since 2007. Table 4

also presents the distribution of the LIHTC projects and units by developer type. Despite St. Louis' depressed housing market, for-profit developers have dominated the area's LIHTC development. For-profit developers built more than 72 percent of the LIHTC projects and units in the study area; nonprofits built only about 20 percent, which is even lower than the national average. According to HUD's LIHTC database, nationwide non-profit developers account for 29 percent of LIHTC production. Several factors may explain this situation. For example, the ease of selling the tax credits before the financial crisis made the program popular among for-profit developers. With the generous tax credit subsidies, developers can quickly put together the necessary financing and get the projects built. In return, they earn the developer fees as well as property management fees if they also manage these properties by themselves. Usually, nonprofit developers are fairly small and often cannot compete with for-profits in the LIHTC allocation process (Deng, 2011).

In summary, LIHTC projects in the St. Louis MO–IL urbanized area show the common pattern found in shrinking cities. More LIHTC units are built in higher job accessibility areas, which can indicate meaningful results of the study in terms of identifying the relationship between LIHTC units and job accessibility and the impact of the LIHTC projects on neighborhoods' economic changes.

Table 4. Descriptive analysis of LIHTC development in St. Louis urbanized areas

		Number of Projects	% of Project	Number of Units	% of Units
Project Size	100+	45	29.4%	7,984	62.7%
	50 to 100	44	28.8%	3,137	24.7%
	Less than 50	64	41.8%	1,603	12.6%
Project Location	St. Louis City	105	68.6%	7,891	62.0%
	Other cities	48	31.4%	4,833	38.0%
Low-income Units	100%	109	71.2%	8,194	64.4%
	90 – 100%	9	5.9%	1,272	10.0%
	Under 90%	35	22.9%	3,258	25.6%
Number of Bedroom	1BR	-	-	4,512	35.5%
	2BR	-	-	5,305	41.7%
	Over 2BR	-	-	2,049	16.1%
Year Placed in Service	After 2009	22	14.4%	1,632	12.8%
	2007-2009	28	18.3%	3,027	23.8%
	Before 2007	103	67.3%	8,065	63.5%
Type of Construction	New construction	75	49.0%	4,940	38.8%
	Acquisition & rehab	71	46.4%	7,106	55.8%
	Both	2	1.3%	370	2.9%
	Existing	5	3.3%	308	2.4%
Development Type	For-profit	111	72.5%	10,646	83.7%
	Nonprofit	42	27.5%	2,078	16.3%
Total		153		12,724	

Source: The U.S. Department of Housing and Urban Development LIHTC database

4.2 Job Accessibility

This section focuses on the different patterns of employment changes in shrinking cities and growing suburban areas. Table 5 and Table 6 provide the results of the descriptive analysis of job accessibility in the St. Louis MO–IL urbanized area and in the city of St. Louis. I conducted two analyses on the different geographic scales to compare job openings and job opportunities in old core places and growing metropolitan areas.

The results of the two analyses show explicit differences in employment opportunities in both places and provide significant implications about the spatial location of LIHTC projects in terms of job accessibility.

The analyses focus on the characteristics of employment by comparing all employment with low-income jobs and low-skilled jobs. I followed Lens' (2014) approach to low-income jobs, with wages falling below $1,250 per month. I also followed Lens' definition of low-skilled job that includes those in the following NAISC sectors: 11 (agriculture), 23 (construction), 31–33 (manufacturing), 44–45 (retail), 56 (administrative and support and waste management), 72 (accommodation and food services), and 81 (other services). LEHD data provide employment information including NAISC codes and the categories of income level. These analyses of different types of jobs can help examine accessible jobs by low-income job-seekers, who account for the majority of LIHTC development households. Lens (2014) pointed out that it is important to consider that the concentration of individuals who compete for these low-skilled and low-wage jobs can result in low job accessibility even though the index of total jobs shows a high level.

Table 5 and Table 6 present employment information for 1,463 census block groups in the St. Louis urbanized area and the city of St. Louis, respectively, including the number of jobs, job density, job openings, and job accessibility. The number of jobs increased slightly in the urbanized area between 2009 and 2011, by 3.8 jobs in a census block group on average, while the city showed 23.22 for the increased number of jobs for the same period. Thus, at the regional level, employment conditions kept the previous status without changes. However, the inner city experienced increases in the number of

jobs. The job growth rates indicate this pattern more clearly. The city of St. Louis has a 0.48 job growth rate per census block group on average, compared to a 0.08 job growth rate for the urbanized area in the same period.

As reviewed in the previous chapter, total job openings consist of job openings due to growth and turnover. Table 5 presents the number of job openings due to growth in the urbanized area. During 2009 and 2011, the number of job positions did not increase; rather, low-income jobs decreased during these periods. However, the number of total job openings is positive as the number of jobs from employment turnover was high. According to Table 5, turnover accounted for approximately 99% of total job openings. Thus, during 2009 and 2011, the economy of the urbanized area did not develop, and most of the employment opportunities were the result of employment turnover through quitting and discharges. Job openings in the city presented the same pattern as the urbanized area. The number of new jobs created by job growth is 0.48 on average per census block group, although job turnover created 10.37 jobs. These findings imply that a stagnated region with shrinking cities has lower job growth and most job opportunities are created by job turnover.

Although the average number of job openings per block groups in the city is similar the average number in the urbanized area, the most significant difference in the city is density. The job density in the city of St. Louis is about 3,000, although the density of the study area is about 1,700. This causes a significant difference in job accessibility between the urbanized area and the city. As the job accessibility index is a cumulated gravity-model in relation to surrounding job openings, the job accessibility of the city of St. Louis is much higher than the index of urbanized area. The job accessibility of the

urbanized area is 2,719, while for the city it is 3,838. It can be inferred that, in shrinking cities and stagnated regions, job openings do not influence job accessibility, while proximity to job centers is significantly affected. In addition, these findings indicate that old core city areas still offer potential for employment centers, which support the efforts of urban revitalization in old industrial cities.

Table 7 and Table 8 provide descriptive analyses of census block groups, including LIHTC developments in the urbanized area and the city. The number of block groups including LIHTC units constructed between 2000 and 2012 in the St. Louis urbanized area was 108, while the number in the city of St. Louis was 51. These data highlight similar patterns between LIHTC block groups in the urbanized area and in the city that we observed in the whole block groups. However, comparing the LIHTC block groups with the whole block groups provides significant findings concerning the characteristics of the LIHTC block groups (Table 9). The LIHTC block groups show negative values in job growth in both the urbanized area and the city, while all block groups present positive values. On the contrary, the LIHTC block groups show larger job turnover than the all block groups in both the urbanized area and the city area. Because of the higher job turnover, both job accessibilities of the two different groups show similar values. These different job characteristics indicate that the LIHTC developments in the St. Louis urbanized area were constructed in declining neighborhoods in terms of employment growth. However, based on the results, it can be inferred that the LIHTC developments were also constructed in neighborhoods with more jobs, which produces higher job turnover.

Figure 3 presents the spatial distribution of LIHTC development units and job centers in the St. Louis urbanized area. Job centers are located in several neighborhoods, including the city of St. Louis and the area west of St. Louis. Meanwhile, East St. Louis shows very low job density, which means the city suffers from low employment opportunities and urban shrinkage. In addition, only a few LIHTC units are located in East St. Louis. The locational distribution of the LIHTC units shows clusters in some neighborhoods. A large share of LIHTC units is concentrated in the city of St. Louis, and most of the block groups in the city show higher job density. However, few or no LIHTC units are located in other job centers, while a large number of LIHTC units are located in some neighborhoods with very low job accessibility. In other words, this mapping does not fully explain the correlation between the LIHTC units and job density. This means LIHTC developments can be affected by other factors.

Figure 4 also displays job accessibility and the spatial distribution of the LIHTC units. I sorted census block groups depending on the job accessibility index into four groups. As job accessibility index is based on the cumulated gravity model, the area west of St. Louis shows the highest job accessibility. As shown in Figure 4, the LIHTC development shows a pattern of clustering around each other, without being very relative to job accessibility.

Table 5. Descriptive analysis of census block groups in the St. Louis urbanized area

		N	Mean	Std. Deviation	Min.	Max.
Population	(2010)	1,463	1,379.76	774.77	0	6,437
Housing Units	(2010)	1,463	617.98	305.96	0	2,569
Employment 2011	All Jobs	1,463	717.09	1,909.44	1	33,894
	Low-income Jobs[b]	1,463	192.12	423.60	0	8,441
	Low-skill Jobs[c]	1,463	313.34	786.39	0	12,807
Employment 2009	All Jobs	1,463	713.29	1,879.35	1	27,563
	Low-income Jobs	1,463	193.32	399.80	0	6,244
	Low-skill Jobs	1,463	310.63	760.37	0	11,566
Job Density[a]	(2011)	1,463	1,704.42	5,807.25	7.51	135,143.6
Job Growth, 2009-2011	All Jobs	1,463	0.08	10.17	-245.56	131.90
	Low-income Jobs	1,463	-0.03	2.45	-35.75	45.77
	Low-skill Jobs	1,463	0.06	5.04	-40.67	103.60
Job Turnover 2009-2011	All Jobs	1,463	10.76	28.64	0.015	508.41
	Low-income Jobs	1,463	2.88	6.35	0	126.62
	Low-skill Jobs	1,463	4.70	11.80	0	192.11
Job Opening	All Jobs	1,463	10.84	32.15	-178.89	640.31
	Low-income Jobs	1,463	2.86	7.54	-30.05	172.39
	Low-skill Jobs	1463	4.76	13.98	-40.35	248.15
Job Accessibility	All Jobs	1463	2,719.60	1,152.80	211.89	4,433.99
	Low-income Jobs	1463	681.27	266.74	63.37	1,077.32
	Low-skill Jobs	1463	1,154.40	467.33	101.76	1,885.21

Source: Origin-Destination Employment Statistics (LODES) in the U.S. Census Longitudinal Employer-Household Dynamics (LEHD) database.

Note. a. Job density was estimated by the number of employment in a block group per sq. mile.

b. Low-skilled jobs are those in the following North American Industry Classification System sector: 11 (agriculture), 23 (construction), 31-33 (manufacturing), 44-45 (retail), 56 (administrative and support and waste management), 72 (accommodation and food services), and 81 (other services).

c. Longitudinal Employer-Household Dynamics define the wage of low-income jobs as under $1,250 per month. This study follows the definition.

Table 6. Descriptive analysis of census block groups in the city of St. Louis

		N	Mean	Std. Deviation	Min.	Max.
Population,	(2010)	353	892.15	334.52	0	2,811
Housing Units	(2010)	353	492.01	207.76	0	1,977
Employment 2011	All Jobs	353	659.15	2,489.36	1	33,894
	Low-income Jobs	353	152.24	553.69	0	8,441
	Low-skill Jobs	353	249.75	849.88	0	12,807
Employment 2009	All Jobs	353	635.93	2,229.10	1	27,563
	Low-income Jobs	353	150.06	472.13	0	6,244
	Low-skill Jobs	353	241.10	743.95	0	10,117
Job Density		353	3,060.64	10,597.7	7.51	135,143.6
Job Growth, 2009-2011	All Jobs	353	0.48	9.43	-46.89	131.89
	Low-income Jobs	353	0.045	2.96	-14.27	45.77
	Low-skill Jobs	353	0.18	4.47	-20	56.04
Job Turnover 2009-2011	All Jobs	353	9.89	37.34	0.015	508.41
	Low-income Jobs	353	2.28	8.31	0	126.62
	Low-skill Jobs	353	3.75	12.75	0	192.11
Job Opening	All Jobs	353	10.37	43.94	-15.10	640.31
	Low-income Jobs	353	2.33	10.50	-3.50	172.39
	Low-skill Jobs	353	3.93	15.80	-4.79	248.15
Job Accessibility	All Jobs	353	3,838.05	379.17	2,419.78	4,410.85
	Low-income Jobs	353	930.96	85.10	588.48	1,073.29
	Low-skill Jobs	353	1584.17	147.04	996.54	1,854.18

Source: Origin-Destination Employment Statistics (LODES) in the U.S. Census Longitudinal Employer-Household Dynamics (LEHD) database.
Note. a. Job density was estimated by the number of employment in a block group per sq. mile.
b. Low-skilled jobs are those in the following North American Industry Classification System sector: 11 (agriculture), 23 (construction), 31-33 (manufacturing), 44-45 (retail), 56 (administrative and support and waste management), 72 (accommodation and food services), and 81 (other services).
c. Longitudinal Employer-Household Dynamics define the wage of low-income jobs as under $1,250 per month. This study follows the definition.

Table 7. Descriptive analysis of census block groups including LIHTC units in the St. Louis urbanized area

		N	Mean	Std. Deviation	Min.	Max.
Population	(2010)	108	1,520.991	1,019.12	491	6,241
Housing Units	(2010)	108	725.73	373.46	248	2,205
Employment 2011	All Jobs	108	965.53	2,003.53	2	17,220
	Low-income Jobs[b]	108	234.03	431.96	2	3,477
	Low-skill Jobs[c]	108	397.67	694.39	1	4,958
Employment 2009	All Jobs	108	970.65	2,055.95	1	17,356
	Low-income Jobs	108	236.59	437.95	1	3,443
	Low-skill Jobs	108	408.89	761.94	1	5,602
Job Density[a]	(2011)	108	3,058.53	6,797.30	20.99	57,438.29
Job Growth, 2009-2011	All Jobs	108	-0.11	7.63	-24.79	46.81
	Low-income Jobs	108	-0.05	2.10	-14.27	5.88
	Low-skill Jobs	108	-0.23	3.60	-20.00	8.74
Job Turnover 2009-2011	All Jobs	108	14.48	30.05	0.03	258.30
	Low-income Jobs	108	3.51	6.48	0.03	52.16
	Low-skill Jobs	108	5.97	10.42	0.02	74.37
Job Opening	All Jobs	108	14.38	30.61	-15.10	255.47
	Low-income Jobs	108	3.46	6.92	-4.37	52.86
	Low-skill Jobs	108	5.73	10.00	-6.41	60.95
Job Accessibility	All Jobs	108	3,115.15	1,249.63	235.60	4,401.57
	Low-income Jobs	108	756.82	283.07	70.77	1,048.70
	Low-skill Jobs	108	1,285.70	485.59	116.50	1,793.75

Source: Origin-Destination Employment Statistics (LODES) in the U.S. Census Longitudinal Employer-Household Dynamics (LEHD) database.

Note. a. Job density was estimated by the number of employment in a block group per sq. mile.

b. Low-skilled jobs are those in the following North American Industry Classification System sector: 11 (agriculture), 23 (construction), 31-33 (manufacturing), 44-45 (retail), 56 (administrative and support and waste management), 72 (accommodation and food services), and 81 (other services).

c. Longitudinal Employer-Household Dynamics define the wage of low-income jobs as under $1,250 per month. This study follows the definition.

Table 8. Descriptive analysis of census block groups including LIHTC units in the city of St. Louis

		N	Mean	Std. Deviation	Min.	Max.
Population	(2010)	51	1,145.98	448.18	491	2,811
Housing Units	(2010)	51	647.06	278.55	256	1,577
Employment 2011	All Jobs	51	1,217.22	2,697.60	2	17,220
	Low-income Jobs[b]	51	249.37	522.64	2	3,477
	Low-skill Jobs[c]	51	406.98	836.83	2	4,958
Employment 2009	All Jobs	51	1,231.37	2,765.70	1	17,356
	Low-income Jobs	51	262.10	544.14	1	3,443
	Low-skill Jobs	51	427.25	947.44	1	5,602
Job Density[a]	(2011)	51	4,976.11	9,404.88	24.69	57,438.29
Job Growth, 2009-2011	All Jobs	51	-0.25	8.86	-22.85	46.81
	Low-income Jobs	51	-0.27	2.43	-14.27	5.88
	Low-skill Jobs	51	-0.42	3.97	-20.00	8.97
Job Turnover 2009-2011	All Jobs	51	18.29	40.46	0.03	258.30
	Low-income Jobs	51	3.74	7.84	0.03	52.16
	Low-skill Jobs	51	6.10	12.55	0.03	74.37
Job Opening	All Jobs	51	18.03	40.70	-15.10	255.47
	Low-income Jobs	51	3.48	8.03	-3.50	52.86
	Low-skill Jobs	51	5.68	11.09	-1.66	60.95
Job Accessibility	All Jobs	51	3,966.89	256.63	3,309.14	4,401.57
	Low-income Jobs	51	943.06	59.56	814.88	1,048.70
	Low-skill Jobs	51	1,598.45	100.27	1,393.89	1,776.99

Source: Origin-Destination Employment Statistics (LODES) in the U.S. Census Longitudinal Employer-Household Dynamics (LEHD) database.
Note. a. Job density was estimated by the number of employment in a block group per sq. mile.
b. Low-skilled jobs are those in the following North American Industry Classification System sector: 11 (agriculture), 23 (construction), 31-33 (manufacturing), 44-45 (retail), 56 (administrative and support and waste management), 72 (accommodation and food services), and 81 (other services).
c. Longitudinal Employer-Household Dynamics define the wage of low-income jobs as under $1,250 per month. This study follows the definition.

Table 9. Employment characteristics of all block groups and LIHTC block groups

		All Block Groups		LIHTC Block Groups	
		St. Louis Urbanized Area	St. Louis City	St. Louis Urbanized Area	St. Louis City
Job Opening due to Growth	All Jobs	0.08	0.48	-0.11	-0.25
	Low-income Jobs	-0.03	0.045	-0.05	-0.27
	Low-skill Jobs	0.06	0.18	-0.23	-0.42
Job Opening due to Turnover	All Jobs	10.76	9.89	14.48	18.29
	Low-income Jobs	2.88	2.28	3.51	3.74
	Low-skill Jobs	4.70	3.75	5.97	6.10
Total Job Opening	All Jobs	10.84	10.37	14.38	18.03
	Low-income Jobs	2.86	2.33	3.46	3.48
	Low-skill Jobs	4.76	3.93	5.73	5.68
Job Accessibility	All Jobs	2,719.60	3,838.05	3,115.15	3,966.89
	Low-income Jobs	681.27	930.96	756.82	943.06
	Low-skill Jobs	1,154.40	1584.17	1,285.70	1,598.45
Job Density		1,704.42	3,060.64	3,058.53	4,976.11
Population		2,018,582	318,172	164,267	58,445

Source: Origin-Destination Employment Statistics (LODES) in the U.S. Census Longitudinal Employer-Household Dynamics (LEHD) database.

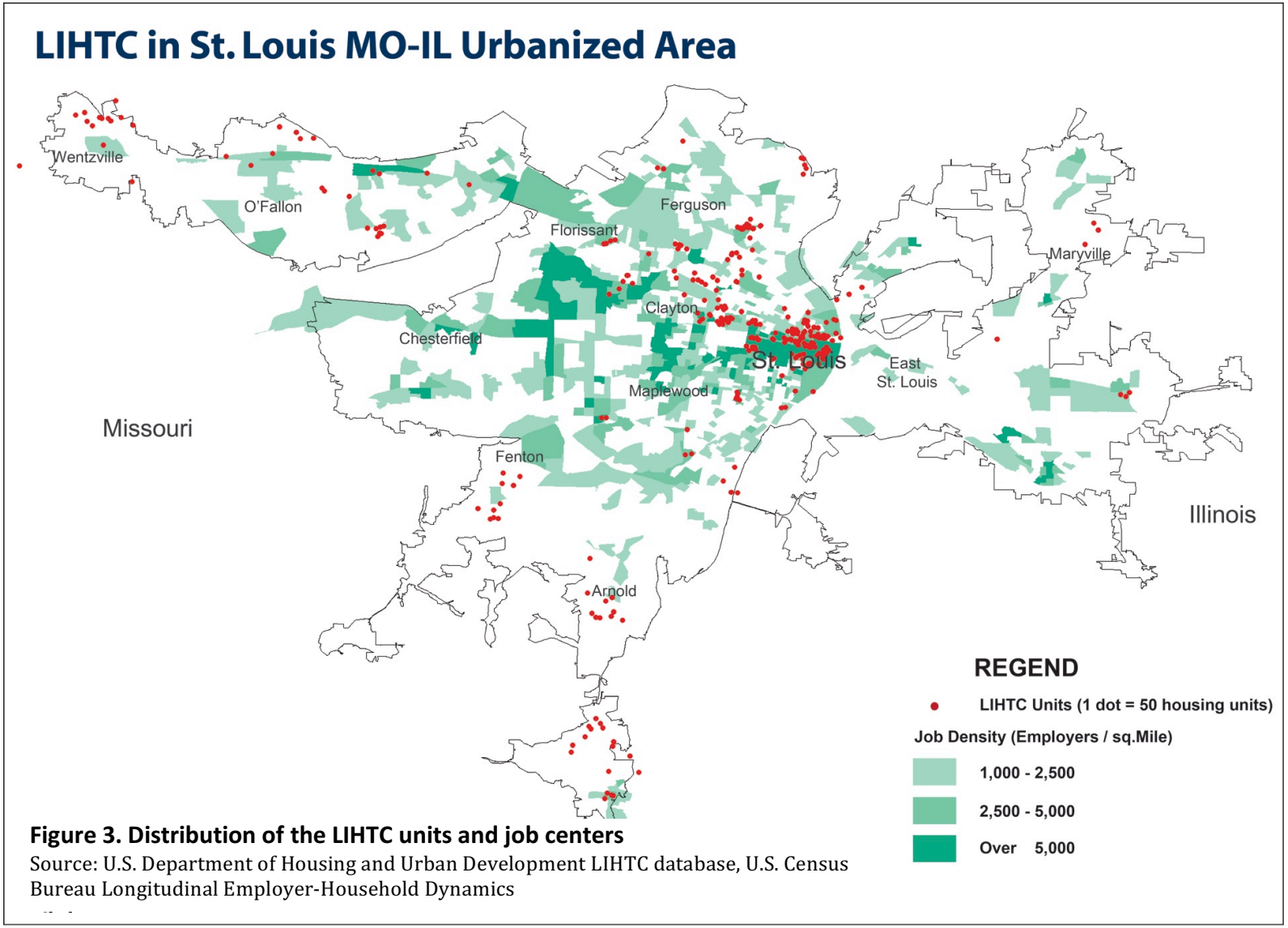

Figure 3. Distribution of the LIHTC units and job centers

Source: U.S. Department of Housing and Urban Development LIHTC database, U.S. Census Bureau Longitudinal Employer-Household Dynamics

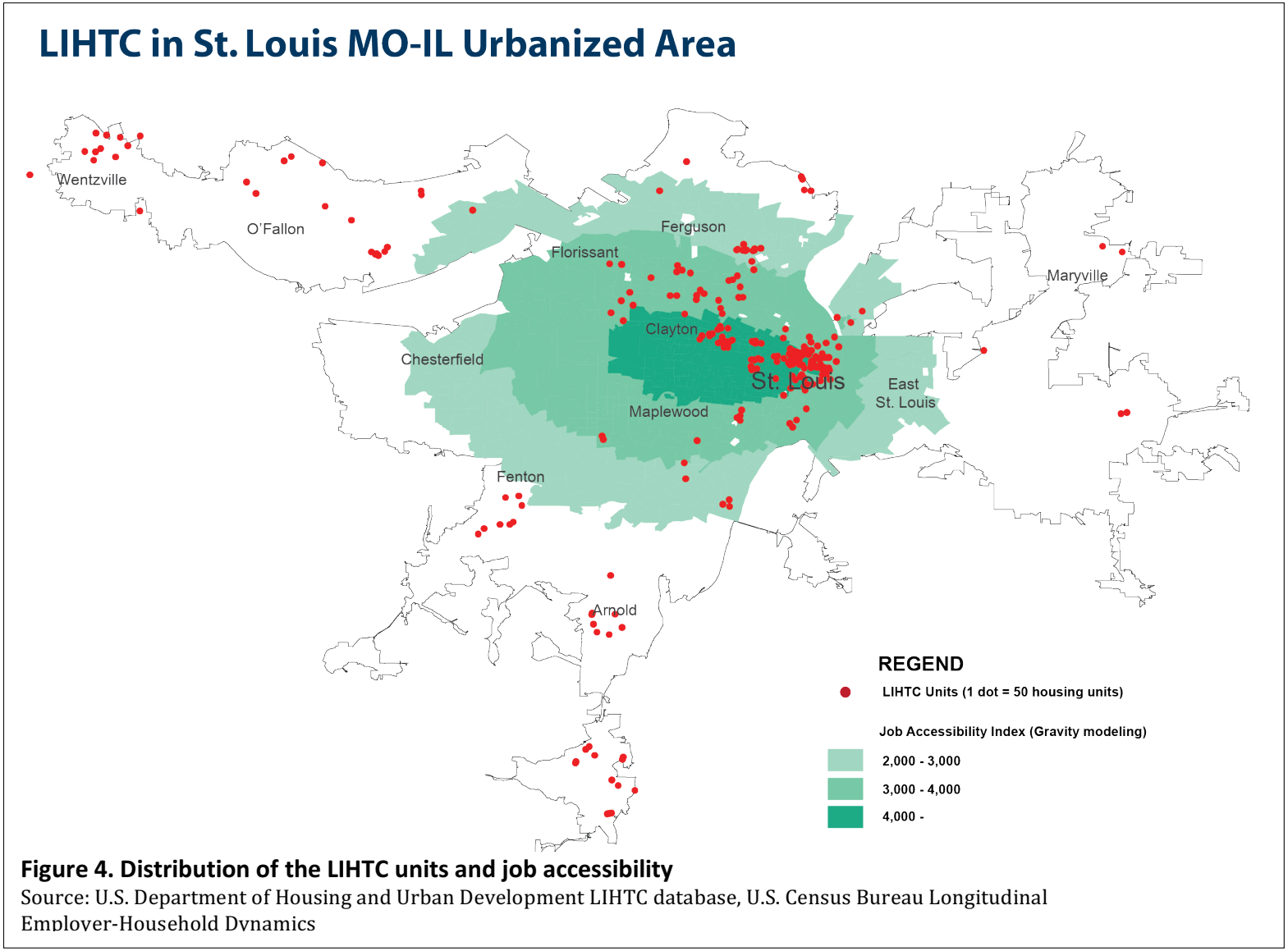

Figure 4. Distribution of the LIHTC units and job accessibility

Source: U.S. Department of Housing and Urban Development LIHTC database, U.S. Census Bureau Longitudinal Employer-Household Dynamics

4.3 Cluster Analysis

Cluster analysis allows for categorizing block groups that have different socio-economic characteristics into several groups using a distance measure. This approach aims to understand how block groups in the urbanized area can be grouped into certain clusters and what kinds of neighborhoods exist in the area. As I stated in chapter 3, this study used nine variables for the cluster analysis of the block groups: (1) job accessibility, (2) unemployment rate, (3) median household income, (4) poverty rate, (5) black population rate, (6) vacancy rate, (7) median rent, (8) median housing value, and (9) homeownership.

Using the distribution of the agglomeration coefficients generated by the cluster analysis, this study identified five clusters of neighborhoods in the St. Louis MO–IL urbanized area. The five-cluster system is easy to interpret and can reveal the neighborhood patterns at an aggregate level. In addition, these clusters' socio-economic characteristics can play a role in the control group for LIHTC neighborhoods, as discussed in the next section. Table 10 shows the selected characteristics of the five clusters of block groups in the study area. The five clusters are mainly distinguished by job accessibility, economic condition, and racial and ethnic diversity. This study refers to each cluster as numbered in Table 10. Figure 5 shows the geographical distribution of the five clusters in neighborhoods, and Table 11 provides more detailed information on the status of the LIHTC projects and job accessibility indices of each cluster. Based on the analyses from Table 10, Table 11, and Figure 5, I defined the clusters as discussed in the following subsections.

Cluster 1: High job accessibility and extremely wealthy neighborhoods

This cluster comprises St. Louis MO–IL urbanized area's most wealthy neighborhoods. A total of 66 block groups, accounting for approximately 4.6 percent of the area's population, fall into this category, which is the smallest cluster among the five. The neighborhoods have an extremely high level of median household income and housing value. The residence characteristics are stable as they have a very low vacancy rate and high homeownership rate. In addition, the economic stability is very good, thanks to the low unemployment rate and the highest job accessibility. Geographically, these neighborhoods are clustered specifically in the western part of the suburban area near the city of St. Louis, while only four block groups in this cluster are located in the city itself. One interesting finding is that these neighborhoods have the highest median job accessibility. It is assumed that new employment centers emerged in the area for people residing in this area during the St. Louis MO–IL urbanized area's suburbanization process. This cluster contains very few units of LIHTC project housing units, which is assumed to be within the margin of error.

Cluster 2: High job accessibility and high-income neighborhoods

This cluster is also characterized by high-income neighborhoods in the area, including 200 block groups and accounting for approximately 18% of the total population of the urbanized area. The neighborhoods in this cluster have lower unemployment and the lowest proportion of the black population. In addition, the neighborhoods are predominantly owner occupied. I assume that these neighborhoods are high-income, white-dominant workers' communities. Geographically, the places in which they reside

are concentrated in the western suburban areas, close to the new employment centers in the suburban area, while there are also a few block groups of this cluster in the city of St. Louis. They also live in places with a very high level of job accessibility. This cluster also contains very small stocks of LIHTC project housing units in their neighborhoods.

Cluster 3: Low job accessibility and middle-income neighborhoods

Cluster 3, the largest of the five, includes 415 block groups and approximately 34% of the total population of the urbanized area. The population in this cluster has an average level of socio-economic characteristics of the area in terms of the median income, black population, poverty rate, and unemployment rate. Geographically, the block groups in this cluster are largely distributed across broad suburban areas, except in the northern St. Louis and East St. Louis areas. The cluster also contains 3,416 LIHTC units that are mostly located in the city of St. Louis. Furthermore, this cluster shows a relatively lower level of job accessibility indices. I assume that the people in this cluster account for the majority of people rushing to suburban areas, thereby leading to the suburbanization of the area.

Cluster 4: Low job accessibility and low-income neighborhoods

Cluster 4, the second largest cluster, is composed of 417 block groups and 26 percent of the total population of the area. The neighborhoods in this cluster have a relatively low level of median household income and a high poverty level. They have the lowest level of job accessibility indices and a high unemployment rate, which means the people living in the neighborhoods of this cluster have unstable employment conditions.

They have the largest number of LIHTC housing units among the five clusters, accounting for approximately 30 percent of all LIHTC units. The LIHTC projects in this cluster are distributed in broad area of St. Louis MO-IL urbanized area. Geographically, these neighborhoods are clustered in the northern and southern suburban areas near the city of St. Louis. They are also located in the eastern suburban areas on the Illinois side. As they are in depressed suburban areas, the cluster has the lowest level of job accessibility.

Cluster 5: High job accessibility and high level of poverty in black neighborhoods

This cluster includes neighborhoods with extremely high levels of poverty. The neighborhoods in this cluster are exclusively concentrated in central St. Louis city and the East St. Louis area and have a very high unemployment rate, poverty rate, and housing vacancy rate. The neighborhoods also have a very low homeownership rate, which means a large number of residents are renters. The neighborhoods contain 3,486 LIHTC housing units that are concentrated on the Missouri side of the city. They also have a high level of job opportunity as they are located in old employment centers downtown.

In summary, the results of the cluster analysis indicate that, despite the area's diverse population, the neighborhoods of the St. Louis MO–IL urbanized area are socio-economically segmented. Specifically, the cities of St. Louis and East St. Louis have experienced severe economic depression and segmentation, while suburban areas are growing and many employment centers are evident in the mapping of job density.

Although shrinking cores and growing suburbs are a common phenomenon in the U.S., the concentration of the low-income population and black population can cause various socio-economic problems. In order to solve the disparity and segmentation in the shrinking cities, providing economic opportunity and job accessibility to low-income populations can be one of the fundamental solutions.

According to the results of the cluster analysis, both high-income neighborhoods located in new employment centers in suburban areas and very low-income neighborhoods in old employment centers have a high level of job accessibility, as I expected. Thus, although the two different clusters have similar rates of job accessibility, the socio-economic characteristics can differ. These findings imply that cluster analyses cannot provide a comprehensive understanding of the LIHTC projects and job accessibility. To address the identified limitations, I further conducted additional descriptive analyses on the clusters.

Table 10. Socio-economic characteristics of clusters

	Cluster 1 *: High-JA extremely -wealthy neigh-borhoods*	**Cluster 2** *: High-JA & high-income neigh-borhoods*	**Cluster 3** *: Low-JA & middle-income neigh-borhoods*	**Cluster 4** *: Low-JA & low-income neigh-borhoods*	**Cluster 5** *: Middle-JA & high-poverty black neigh-borhoods*	**Total**
Number of block groups	66	200	415	417	367	1,463
Job Accessibility	3,650	3,622	2,608	2,493	2,819	2,720
Unemployment Rate	4.5%	3.6%	5.8%	7.5%	15.7%	11.0%
Poverty Rate	5.4%	8.2%	6.8%	9.1%	23.6%	15.7%
Median Household Income	156,662	116,633	89,598	62,762	36,114	56,427
Black Population Portion	6.7%	5.3%	8.5%	12.3%	50.5%	29.7%
Vacancy Rate	5.8%	8.5%	4.9%	7.1%	16.8%	11.5%
Median Rent	317	445	586	698	713	678
Median Housing Value	665,495	458,120	283,081	173,916	81,413	159,797
Home Ownership	86.1%	76.7%	77.9%	71.9%	56.0%	65.4%

Source: American Community Survey 2013

Table 11. Employment opportunities in clusters

	Cluster 1 *: High-JA extremely-wealthy neigh-borhoods*	**Cluster 2** *: High-JA & high-income neigh-borhoods*	**Cluster 3** *: Low-JA & middle-income neigh-borhoods*	**Cluster 4** *: Low-JA & low-income neigh-borhoods*	**Cluster 5** *: High-JA & high-poverty black neigh-borhoods*	**Total**
Population	93,139	359,131	695,998	522,697	352,759	2,023,724
Housing Units	36,519	146,617	304,915	246,514	171,274	905,839
No. of LIHTC Projects	4 (3%)	12 (8%)	41 (27%)	34 (23%)	60 (40%)	151
No. of LIHTC Units	471	1,360	3,416	3,754	3,486	12,487
Share of LIHTC Units	1.29%	0.93%	1.12%	1.52%	2.04%	1.38%
Job Accessibility (all)	3,650	3,622	2,608	2,493	2,819	2,720
Job Accessibility (LI)	897	673	633	654	729	681
Job Accessibility (LS)	1,538	1,136	1,071	1,107	1,237	1,154

Source: LIHTC data from The U.S. Department of Housing and Urban Development LIHTC database; Job data from Origin-Destination Employment Statistics (LODES)

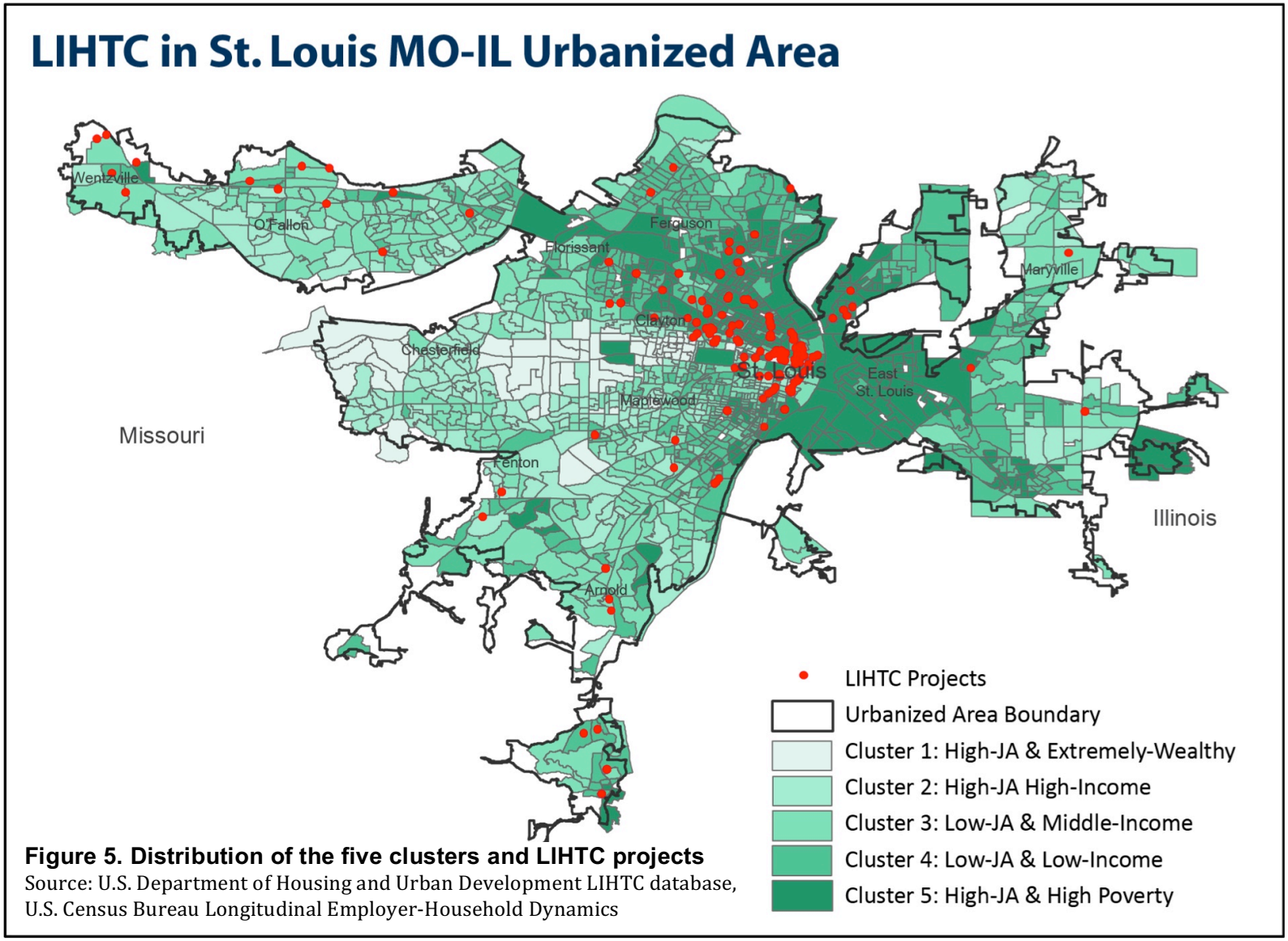

Figure 5. Distribution of the five clusters and LIHTC projects
Source: U.S. Department of Housing and Urban Development LIHTC database, U.S. Census Bureau Longitudinal Employer-Household Dynamics

Analysis of Block Groups including LIHTC Projects

Table 12 shows the results of a description analysis of the five clusters, focusing on only block groups that include LIHTC housing units. I selected the groups based on the data from HUD's LIHTC database and 2013 ACS and addressed which type of neighborhood received LIHTC investment and the block groups' economic and social characteristics. After geocoding and data combining, this study identified 151 LIHTC projects constructed in 108 block groups in the five clusters during 2000 and 2012. As Table 12 shows, the block groups including LIHTC units were considerably different from other block groups in the clusters in terms of economic and employment characteristics. All the block groups seem to be more depressed economically than other block group in the clusters. In fact, this is normal as the LIHTC program aims to subsidize low-income populations and revitalize depressed urban areas.

Cluster 1 comprises the wealthiest neighborhoods with the highest income. The block group including LIHTC units in this cluster shows quite different attributes compared to the characteristics of the whole cluster. The comparison analysis of this neighborhood may provide an interesting finding, but the sample is too small, and the cluster is a sort of outlier that hinders meaningful findings. Thus, this sample was removed from the comparison analysis. In addition, Cluster 2 was removed from the comparison analysis as it includes only a small share of LIHTC housing units (0.93%). The LIHTC housing units occupy a large share of housing stocks in the block groups, including LIHTC units in the three remaining clusters (13%–19%).

The eight socio-economic indicators indicated that the LIHTC block groups are more distressed than other groups in their clusters. In particular, the block groups in

Cluster 5 show the most distressed socio-economic environment with the lowest income level, housing value, and ownership rate and the highest level of unemployment rate, poverty rate, black population composition, and vacancy rate. Cluster 5 also included the largest number of LIHTC projects among the clusters, but the second-highest number of LIHTC units, which means that Cluster 5 has many small-scale development sites.

However, the relatively higher level of job accessibility in Clusters 3, 4, and 5 indicates that the block groups in which the LIHTC developments are located have more employment opportunities, which can be considered as one way to increase employment opportunities to low-income populations. For example, according to Table 12, the job accessibility of block groups in Cluster 5 was 3,441, while the median job accessibility of Cluster 5 was 2,819. The job accessibility of low-income jobs and low-skill jobs in the block groups was also higher than in the clusters, suggesting that housing investments are given to places in need from low-income renters and people's residential decisions tend to focus on areas with relatively higher employment opportunities.

In summary, the cluster analysis shows that, despite the area's diverse population, neighborhoods in the St. Louis urbanized area are highly segmented. This segmentation has particularly negative implications for low-income households, which are mainly concentrated in communities with either low employment rates or black populations. The next section addresses how these LIHTC projects have affected neighborhoods' characteristics in relation to job opportunities and job accessibility.

Table 12. LIHTC block groups in clusters

	Cluster 1 *: High-JA Extremely wealthy neigh-borhoods*	**Cluster 2** *: High-JA & high-income neigh-borhoods*	**Cluster 3** *: Low-JA & middle-income neigh-borhoods*	**Cluster 4** *: Low-JA & low-income neigh-borhoods*	**Cluster 5** *: High-JA & high-poverty black neigh-borhoods*	**Total**
No. of Block Groups with LIHTC	1	9	28	24	46	108
Population	1,813	1,740	2,055	1,567	1,052	8,227
Housing Units	1,072	7,818	26,334	19,277	23,531	78,032
No. of Project	4	12	41	34	60	151
LIHTC Units	471	1,360	3,416	3,754	3,486	12,487
Share of LIHTC Units	44%	17%	13%	19%	15%	16%
JA of All Jobs	4,214	3,136	2,901	2,687	3,441	3,115
JA of Low-Income Jobs	993	762	713	661	828	757
JA of Low-Skill Jobs	1,669	1,297	1,208	1,123	1,407	1,286
Median house Income	23,787	56,323	46,653	32,515	24,475	34,659
Median Housing Value	611,100	258,333	179,375	114,021	51,193	120,833
Median Rent	677	773	799	685	731	741
Unemployment Rate	9.6%	8.0%	12.7%	15.6%	23.4%	17.5%
Poverty Rate	33.7%	15.8%	22.5%	26.9%	34.7%	28.2%
Black Percent	85.8%	22.4%	36.1%	38.8%	79.7%	54.6%
Vacancy Rate	6.3%	12.2%	12.9%	15.3%	22.0%	17.2%
Ownership Rate	3.4%	45.1%	49.0%	44.9%	38.4%	42.8%

Source: LIHTC data from The U.S. Department of Housing and Urban Development LIHTC database; Job data from Origin-Destination Employment Statistics (LODES)

4.4 Measuring LIHTC Neighborhood Changes

The comparison showed more socio-economic changes in neighborhoods that have more LIHTC units than the cluster's average than median changes in the cluster. Datasets for measuring changes in LIHTC neighborhoods were taken from the 2000 Neighborhood Change Database (NCDA) and 2013 5-year ACS to estimate the changes between 2000 and 2013. NCDA is a dataset of GEOLYTIC database that normalizes census tract data in 2000 into 2010 census boundaries in order to normalize datasets that have different geographic boundaries.

The clusters contain many LIHTC census tracts that have a different number of LIHTC units and different socio-economic contexts. I selected several census tracts that have more than 15 percent of the LIHTC housing units as the target groups as those with less than 15 percent of the total housing do not represent the characteristics of LIHTC neighborhoods. Based on the 15 percent limitation, 20 census tracts were selected for the target neighborhoods (5 in Cluster 3, 7 in Cluster 4, 8 in Cluster 5).

The eight indicators used in the estimation were (1) unemployment rate; (2) median household income; (3) poverty rate; (4) median housing value; (5) median rent; (6) vacancy rate; (7) home ownership; and (8) percentage of black population. LIHTC units are not always occupied by families fitting the targeted socio-economic characteristics; rather, families with lower incomes can live there if they receive other housing assistance, such as housing vouchers. In addition, these eight socio-economic characteristics can affect various direct and indirect factors. However, clearly the comparison analysis can show significant observations by comparing control groups that represent other neighborhoods with similar socio-economic contexts. In addition, selected

tracts that have a higher portion of LIHTC housing units strengthen the validity of the target sample.

Table 13 shows neighborhood changes in Clusters 3, 4, and 5 compared to the control groups.

Cluster 3: Low job accessibility and middle-income neighborhoods

Cluster 3 includes 68 LIHTC projects and 5,614 LIHTC units built between 2000 and 2012. Cluster 3 includes a majority of suburban neighborhoods located in the northwest and southern areas in the urbanized area in which mostly middle-income class households reside. The majority of the LIHTC developments categorized in Cluster 3 are constructed in the northwest areas of the urbanized area, which have low job accessibility and low proximity to job centers. They show distinct demographic changes. The total population of Cluster 3 increased by 91,000, which means Cluster 3 represents growing suburban neighborhoods of the St. Louis urbanized area.

In addition, Cluster 3 as a whole showed the most positive socio-economic changes in eight indicators, compared to the changes in Cluster 4 and Cluster 5. For example, Cluster 3 has the smallest increases in unemployment rate, poverty rate, vacancy rate, and black population portion. Furthermore, the cluster shows the largest increases in median household income, median housing value, median rent. These findings mean that the cluster is overall growing. This is assumed that Cluster 3 represent growing suburban neighborhoods in which middle-come households are moving into the area.

According to Table 13, compared to the median changes in all neighborhoods in Cluster 3, the concentrated LIHTC neighborhoods showed positive changes in seven socio-economic indicators (the exception was median household income.) This result indicates that neighborhoods with large share of LIHTC units have experienced economic improvement after the establishment of LIHTC development. However, it is notable that the increase in median household income was lower than the average in the cluster. The LIHTC neighborhoods experienced increase in median household income by $7,521, compared to $12,176 in the comparison group. Given Cluster 3's middle-income neighborhoods, the LIHTC projects are assumed to have resulted in a new influx of low-income populations into the area, thereby decreasing the median household income of the neighborhoods.

Cluster 4: Low-job accessible and low-income neighborhoods

59 LIHTC development projects providing 4,883 housing units are constructed in Cluster 4 neighborhoods between 2000 and 2012. The seven selected tracts in Cluster 4 contain 19 LIHTC development projects with 2,032 LIHTC units. The neighborhoods of Cluster 4 are distributed in the downtown areas of the city of St. Louis and the southern areas near the city of St. Louis. The cluster's population decreased overall, although that of the concentrated LIHTC neighborhoods in the cluster increased. As a whole, the average of population loss per census tract in Cluster 4 is 31, while the seven LIHTC tracts increased in population by 142 on average. This implies that LIHTC developments play a role in reducing population losses in old downtown and distressed neighborhoods.

The concentrated LIHTC tracts also displayed significant positive effects in decreasing vacant rates and racial segregation. However, as evident in the comparison of Cluster 3, these concentrated LIHTC neighborhoods also showed a negative change in median household income. Cluster 3 comprises middle-income neighborhoods and showed the largest increase in median household income among the three clusters analyzed. It suggests that low job accessibility and economically distressed neighborhoods do not experience a huge improvement through LIHTC developments.

Cluster 5: High job accessibility and high-level of poverty in black neighborhoods

Cluster 5 contains 86 LIHTC development projects and 3,409 housing units built through LIHTC program. The eight selected tracts, which contain 28 selected LIHTC projects and 3,409 LIHTC housing units, are distributed in northern areas and the near-north neighborhoods of the city of St. Louis. The neighborhoods categorized into Cluster 5 are almost all distressed communities, yet they have a very high job accessibility. Population changes in Cluster 5 neighborhoods resulted in a drastic decrease between 2000 and 2013. The average population loss per census tract was -327, yet the selected tracts showed a great population increase by 373 on average. These results suggest that the LIHTC program attracted new households into the distressed neighborhoods, which keeps vitality of the community

The socio-economic indicators of the concentrated LIHTC neighborhoods in Cluster 5 also represented the positive effect of LIHTC development in the selected census tracts. In particular, the median household income of the selected LIHTC

neighborhoods increased by 5,076 whereas all neighborhoods in Cluster 5 increased by only 4,294. This is a notable change because the selected LIHTC neighborhoods in Cluster 3 and Cluster 4 showed negative effects in median household income. In addition, notable positive changes were evident in all other indicators in the selected LIHTC neighborhoods. These findings imply that LIHTC developments help revitalize neighborhoods with high poverty rates and high job accessibility. However, we need to consider that the Cluster 5 includes extremely low-income communities. For example, the black population accounted for 50 percent of the population in the entire cluster, compared to 80 percent in the neighborhoods including LIHTC units. Compared to other clusters, these changes can be considered relatively small changes.

One of the most notable and common changes among the eight socio-economic indicators was the significant decrease in the vacancy rate. All of the control groups experienced significant increases in vacancy rate, although the rate in LIHTC neighborhoods decreased. As we expected, LIHTC developments in distressed communities and shrinking cities bring positive neighborhood effects through the rehabilitation and reconstruction of abandoned and distressed housing units, which causes a decrease in the vacancy rate. Another indicator that showed significant and common changes among the three clusters was the decrease in the proportion of the black population. All the three clusters showed a significant decrease in the proportion of the black population in their neighborhoods while other neighborhoods showed an increase.

Table 13. Changes in LIHTC neighborhoods and comparison with control groups

		Cluster 3 *: Low-JA & middle-income neighborhoods*		Cluster 4 *: Low-JA & low-income neighborhoods*		Cluster 5 *: High-JA & high-poverty black neighborhoods*	
		Concentrated LIHTC Neighborhoods	All Neighborhoods	Concentrated LIHTC Neighborhoods	All Neighborhoods	Concentrated LIHTC Neighborhoods	All Neighborhoods
No. of Tracts		5	219	7	203	8	160
No. of LIHTC projects		20	68	19	59	28	86
No. of LIHTC units		1,731	5,614	2,032	4,883	3,409	6,623
Population growth in a tract		656.8	415.5	142.0	-31.4	373.3	-327.6
Median changes	**Unemployment Rate**	−2.8%	+2.9%	+3.2%	+4.8%	+3.2%	+5.4%
	Median Household Income	+7,521	+12,176	+1,497	+6,946	+5,076	+4,294
	Poverty Rate	−2.6%	+2.3%	+3.0%	+5.3%	+0.3%	+5.6%
	Vacancy Rate	−5.6%	+2.1%	−6.3%	+3.8%	−6.5%	+5.7%
	Median Housing Value	+80,324	+60,176	+37,494	+42,153	+58,476	+28,969
	Median Rent	+236	+298	+211	+270	+277	+279
	Homeownership Rate	+8.8%	+1.2%	+5.1%	+0.8%	+2.6%	+1.6%
	Black Population Portion	−4.6%	+0.5%	−1.5%	+3.8%	−4.5%	+3.4%

Source: LIHTC data from The U.S. Department of Housing and Urban Development LIHTC database; Socio-economic data from 2013 American Community Survey and GEOLYTIC 2000 Neighborhood Change Dataset
Note: Concentrated LIHTC neighborhoods are census tracts that have LIHTC housing units as 15% of their total housing units.

Chapter 5. Conclusion

This study started from a question:

Do housing developments subsidized by the government help urban revitalization in shrinking cities?

To answer this question, this research examined the characteristics of LIHTC development projects in relation to job accessibility and neighborhood spillover effects of LIHTC developments in socio-economically varied communities in the St. Louis MO–IL urbanized area. I first considered providing employment opportunity as one of the most important purposes of housing policy focused on the sustainable revitalization of shrinking cities and suburbanized regions. To determine the job accessibility index of each census block group, the study employed Shen's cumulative gravity model, which measures the proximity of each block group to employment opportunities based on the distance to the job places and the number of job openings. Then, I mapped locational patterns of LIHTC housing units in relation to job accessibility. In addition, this study employed cluster analyses to compare the LIHTC development neighborhoods to control groups. I selected several census tracts with a large proportion of LIHTC units and measured the socio-economic changes through eight indicators.

The analysis provided evidence that, first, LIHTC development has been constructed in neighborhoods with high job accessibility. The LIHTC program intends to attract private developers and investors for residential development, which results in locational preference in high-demand neighborhoods by private sector. To make more profit, the private sectors locate their development projects near job centers that have generally higher housing needs.

In addition, as one of the most important purposes of the LIHTC program is to promote residential investment and revitalize distressed neighborhoods, the locational pattern of the LIHTC project seems to work well in shrinking cities. As each neighborhood has a different socio-economic context that affects the neighborhood's quality, this study clustered neighborhoods into five groups to identify the neighborhood changes resulting from LIHTC development. The results indicate that, in severely distressed neighborhoods, the LIHTC programs help revitalize the communities' economic conditions, although the extent of the effects varied. To be specific, median household income in the concentrated LIHTC neighborhoods relatively decreased compared to the control groups, while the income level in extremely low-income neighborhoods increased. This result indicates the negative impact of subsidized housing development that many critiques argued happens. The influx of new households who are receiving housing subsidies might lower the median household income.

Overall, this study contributes to providing a basic research frame for measuring the effectiveness of housing policy. Most previous literature examining the LIHTC program did not account for providing economic opportunities to low-income households. The current study made a connection between an LIHTC program's neighborhood effects and economic opportunities. Furthermore, this study focused on shrinking cities, which have different socio-economic contexts than growing and stable cities.

However, this research also has several limitations. Due to data limitations, this study used different scales for the dataset. This study used a dataset at the census block group level for job information, LIHTC data, and census data. However, the comparison

analysis, I needed normalized census block group data in both 2000 and 2013. Because of this data limitation, I had to use census tract data. I combined the block group data into tract data—while still ensuring that the result of the comparison analysis provided reasonable implications. Finally, follow-up research should be conducted to determine the neighborhood effect of LIHTC programs in different regions and compare the impact of the program in shrinking cities to its role in a growing region.

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