

ABSTRACT

Title of Dissertation: A BETTER NEIGHBORHOOD FOR
HOUSING VOUCHER HOUSEHOLDS:
OBSTACLES AND OPPORTUNITIES

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Since the 1970s, the emphasis of federal housing policy has shifted from place-based subsidies to tenant-based subsidies that are provided directly to low-income households for the purpose of renting in the private market. Although many hoped that the Housing Choice Voucher, a tenant-based housing assistance program, would be a new tool in the fight against concentrated poverty and its associated problems, housing voucher recipients still face obstacles when trying to secure housing in high-opportunity neighborhoods over the long-term. The growing body of evidence linking neighborhood conditions to household outcomes points to the need for a better understanding of how housing vouchers improve access to opportunities. While previous studies have explored neighborhood outcomes of housing voucher recipients, it still remains unclear what factors play a significant role in their residential location choices.

My dissertation examines the constraints that housing voucher households face in neighborhood choices. Drawing upon data from the Moving to Opportunity experiment, it specifically analyzes trends in affordable housing inequality, estimates the effect of vehicle access on locational attainment, and explores social networks as a determinant of mobility behavior. The results of these analyses show that obstacles such as affordable housing inequality across the metropolitan area, strong social networks in the initial, poor neighborhood, and a lack of access to vehicles negatively affect the likelihood of moving to neighborhoods in which opportunities are expanded for low-income households.

My findings shed light on the dynamics of residential mobility and neighborhood improvements for low-income households. The expansion of the Housing Choice Voucher program, supported by localized payment standard, connection to automobile subsidies, and extensive housing search services that provide information about the opportunities available in across all geographic units, may have a significant impact on poverty de-concentration and access to opportunity over time. These findings are also expected to bridge the gap between research and policy with regard to how housing voucher program could be improved in the context of the federal government's charge to Affirmatively Further Fair Housing (AFFH).

A BETTER NEIGHBORHOOD FOR HOUSING VOUCHER HOUSEHOLDS:
OBSTACLES AND OPPORTUNITIES

by

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Table of Contents

Acknowledgements.....	ii
Table of Contents.....	iii
List of Tables.....	v
Chapter 1: Introduction.....	1
Chapter 2: Literature Review.....	5
2.1. Poverty Concentration.....	5
2.2. The Geography of Opportunity.....	6
2.3. Housing Choice Vouchers.....	9
2.4. Moving to Opportunity.....	11
2.5. Constraints in Residential Location Choices.....	14
2.6. The Gap in the Literature.....	17
Chapter 3: Landscape of Affordable Housing.....	20
3.1. Background.....	20
3.1.1. Rental Housing Crisis and Affordability.....	20
3.1.2. Fair Market Rents and Neighborhood Choices.....	24
3.2. Data and Methods.....	27
3.2.1. Geography of Affordable Housing.....	27
3.2.2. Measurement of Segregation.....	31
3.3. Results.....	34
3.3.1. The Dynamics of MTO Rental Housing Markets.....	34
3.3.2. Spatial Distribution of Affordable Housing.....	38
3.3.3. Segregation of Affordable Housing.....	42
3.4. Discussion.....	49
Chapter 4: Social Networks and Residential Mobility.....	52
4.1. Background.....	52
4.1.1. The Role of Social Networks in Residential Mobility.....	52
4.1.2. Mobility Outcomes of Housing Voucher Recipients.....	55
4.2. Residential Mobility Models.....	58
4.2.1. Descriptive Metrics of Neighborhood Mobility.....	58
4.2.2. Logit Models.....	59
4.3. Results.....	66
4.3.1. The Pattern of Neighborhood Mobility.....	66
4.3.2. Logistic Regression Results.....	69
4.3.3. Multinomial Logistic Regression Results.....	78
4.4. Discussion.....	87
Chapter 5: Vehicle Access and Locational Attainment.....	91
5.1. Background.....	91
5.1.1. Transportation and Location Choices.....	91
5.1.2. Neighborhood Outcomes of Housing Voucher Recipients.....	93
5.2. Locational Attainment Models.....	95
5.3. Results.....	102
5.3.1. Changes in Neighborhood Characteristics.....	102
5.3.2. Linear Regression Results.....	105

5.4. Discussion	118
Chapter 6: Policy Implications and Conclusions	123
6.1. Policy Implications	123
6.1.1. Fair Market Rents and Affordable Housing.....	123
6.1.2. Social Networks	125
6.1.3. Vehicle Access.....	126
6.2. Conclusions.....	128
References.....	131

List of Tables

Table 1. Change in Rental Units by Income Needed to Make the Rent Affordable, 2000-2009	35
Table 2. Share of Affordable Housing Stock for Low-Income Renters, 2000-2009 ..	35
Table 3. Change in Renters by Income Group, 2000-2009	36
Table 4. Share of Rental Units by Income Needed to Make the Rent Affordable, 2000-2009	36
Table 5. Affordable Housing Gap by Income Category, 2000-2009.....	37
Table 6. Rental Units with the Rent below the Fair Market Rent, 2000-2009	38
Table 7. Affordable Housing Gap by Income Category and Tract Poverty Rate, 2000-2009.....	39
Table 8. Affordable and Available Housing Gap by Income Category and Tract Poverty Rate, 2000-2009	40
Table 9. Rental Units with the Rent below the Fair Market Rent and Tract Poverty Rate, 2000-2009	41
Table 10. Rental Units with the Rent below the Hypothetical Small Area Fair Market Rent and Tract Poverty Rate, 2009	42
Table 11. Theil's Information Theory (<i>H</i>) index, 2000-2009.....	43
Table 12. Decomposition of Theil's Information Theory (<i>H</i>) index, Spatial Aspect, 2000-2009	44
Table 13. Decomposition of Theil's Information Theory (<i>H</i>) index, Spatial Aspect, Between-Group Inequality, 2000-2009	45
Table 14. Decomposition of Theil's Information Theory (<i>H</i>) index, Economic Aspect, 2000-2009	46
Table 15. Decomposition of Theil's Information Theory (<i>H</i>) index, Economic Aspect, Between-Group Inequality, 2000-2009	47
Table 16. Decomposition of Theil's Information Theory (<i>H</i>) index, Racial Aspect, Between-Group Inequality, 2000-2009	48
Table 17. Decomposition of Theil's Information Theory (<i>H</i>) index, Racial Aspect, Between-Group Inequality, 2000-2009	49
Table 18. Variable Descriptions for the Logit and Multinomial Logit Regression Analyses.....	62
Table 19. Description of Social Resources Score	65
Table 20. Descriptive Analysis of Neighborhood Mobility, MTO Participants.....	67
Table 21. Descriptive Statistics for Variables Used in the Logit and Multinomial Logit Regression Analyses, MTO Baseline Survey	70
Table 22. Descriptive Statistics for Social Networks Variables	72
Table 23. Logit Results of the First Move and Second Move Models	72
Table 24. Logit Results of the First Move and Second Move Models by MTO Treatment Group.....	75
Table 25. Logit Results of the First Move and Second Move Models by Race and Ethnicity.....	76
Table 26. Multinomial Logit Results of the First Move and Second Move Models ..	79

Table 27. Multinomial Logit Results of the First Move and Second Move Models by MTO Treatment Group	82
Table 28. Multinomial Logit Results of the First Move and Second Move Models by Race and Ethnicity	83
Table 29. Predicted Probabilities of Moving Back to a Baseline Neighborhood by Kinship/Friendship and Social Resources	87
Table 30. Neighborhood Characteristic Descriptions and Sources for the Linear Regression Analyses	99
Table 31. Descriptive Statistics for Variables Used in the Linear Regression Analyses, MTO Final Survey	102
Table 32. Changes in Neighborhood Characteristics, MTO Baseline to Final Survey	103
Table 33. Linear Regression Results of Locational Attainment, Functional Environment.....	106
Table 34. Linear Regression Results of Locational Attainment, Social Environment	110
Table 35. Linear Regression Results of Locational Attainment, Natural Environment	113
Table 36. Linear Regression Results of Locational Attainment, Economic Vitality and Access to Opportunity.....	116
Table 37. Summary of Linear Regression Coefficients of Locational Attainment Models.....	119

Chapter 1: Introduction

Housing policy often addresses more than the provision of affordable housing. Many housing programs designed to help low-income families have focused not only on the affordability and physical adequacy of housing, but also on achieving greater racial and economic diversities in neighborhoods. Deconcentrating housing subsidies may play a substantial role in reaching such goals, especially for current federal housing policies. Dispersal efforts that initially emerged in the 1970s marked a turnaround. The court-ordered Gautreaux program in Chicago, the nation's first large-scale residential mobility program, vouchered out approximately a half of public housing tenants to majority-white neighborhoods, and some participants gained employment and educational benefits upon suburban relocation (DeLuca et al 2010, Popkin et al. 1993, Rubinowitz and Rosenbaum 2000). While retaining approaches to the creation and preservation of affordable housing, the federal government has expanded the scope of housing policy to acknowledge the importance of neighborhood opportunities for low-income families. As a means of deconcentrating urban poverty, the U.S. Department of Housing and Urban Development (HUD) has turned to the Housing Choice Voucher (HCV, formerly Section 8) program, a tenant-based housing assistance program, to “expand housing choice outside areas of poverty or minority concentration” (U.S. Department of Housing and Urban Development, 2001).

Through the HCV program, eligible families pay 30 percent of their income for rental costs and HUD pays the rest up to a payment standard for the metropolitan area. Households receiving HCVs chose to live in a wider range of neighborhoods than public housing residents and unassisted renters (Schwartz 2010). Such deconcentration effort is crucial because living in neighborhoods with more social and economic opportunities might lead

low-income households to achieve positive outcomes compared to living in less advantageous neighborhoods. Neighborhood improvements for low-income households have important implications for policies designed to enhance access to opportunity and build self-sufficiency. The growing body of evidence linking neighborhood effects to household outcomes points to the need for a better understanding of the factors that influence low-income households' residential location choices. In the Moving to Opportunity (MTO) program, a 10-year housing mobility demonstration conducted by HUD, adults and children showed significant mental health improvements upon improvements in housing and neighborhood conditions (Briggs et al. 2010, Ludwig et al. 2013, Sanbonmatsu et al. 2011). Recently, Chetty and Hendren (2016) and Chetty et al. (2016) found that when compared to children remaining in disadvantaged neighborhoods, those that moved to better neighborhoods showed lower rates of teenage pregnancy, higher education attainment, higher marriage rates, and bigger earning gains as adults. Such emerging literature on positive outcomes on adults and children of housing mobility programs points to the need for a better understanding of how housing vouchers improve access to opportunities.

By enabling the mobility of families in poverty areas to residential environments that exhibit less segregation and more social and economic opportunities, many hoped that the tenant-based housing assistance program could be a new tool in the fight against poverty and its associated problems. However, research on the links between the use of housing vouchers and residential locational outcomes suggests that HCV recipients still face obstacles when trying to secure housing in high-opportunity neighborhoods over the long-term. Evidence from the MTO program found that even when voucher recipients are initially required to use their voucher in low-poverty neighborhoods, many eventually return to high-poverty neighborhoods once the requirement is lifted (Sanbonmatsu et al. 2011). Explanations for the inability to maintain residence in low-poverty neighborhoods include pre-existing social ties

to neighbors and families living in high-poverty neighborhoods (Briggs et al. 2010) and rising rental housing costs in low-poverty neighborhoods (Rosenblatt and DeLuca 2012). Vehicle access and proximity to available public transportation also have positive effects on securing a lease in low-poverty neighborhoods with the use of a voucher in the long term (Shroder 2002, Dawkins et al. 2015). These barriers compel low-income households to face a more constrained set of housing options.

This dissertation seeks to fill part of the research gap by examining what factors are barriers in the relocation of low-income households receiving housing assistance to opportunity neighborhoods. While previous studies investigate the obstacles and opportunities with regard to improvements in low-income families' neighborhood outcomes, it remains unclear which factors of housing vouchers matter most and which will improve the outcome most effectively. Analysis will proceed by refining constraints in residential location choices of voucher recipients at the macro, meso, and micro levels. In doing this, three specific questions will be addressed. First, to what extent do housing vouchers expand affordable housing options for low-income households in opportunity neighborhoods? Second, what aspects of social networks bind low-income households to the original neighborhoods? Third, how does vehicle access influence the types of neighborhood opportunities in which low-income households are able to secure housing following a move to a new neighborhood? Answering these questions will shed light on understanding the dynamics of residential mobility and neighborhood improvements for low-income households receiving rental housing assistance. To estimate the impact of housing vouchers statistically accurately, all analysis models are developed and multiple simulations are conducted using data from the MTO survey and neighborhood characteristics at the census tract level in the MTO metropolitan areas.

The remainder of this dissertation is organized as follows. Chapter Two presents a literature review of neighborhood choices of low-income households and the gap in the literature. In Chapter Three, the landscape of affordable housing in the MTO metropolitan areas is explored. Chapter Four examines the link between social networks and residential mobility of MTO participants. In Chapter Five, the effects of vehicle access on locational attainment of MTO participants during the survey period is estimated. Finally, a set of policy implications and conclusions are presented in Chapter Six.

Chapter 2: Literature Review

This chapter presents a literature review of poverty concentration and the geography of opportunity, followed by discussions of the Housing Choice Voucher program, Moving to Opportunity, and constraints in residential location choices of voucher recipients. The scope of housing policies has expanded to address a much broader range of social policy objectives. The emerging concerns of poverty concentration have shifted the paradigm of federal housing policy to promote deconcentration of subsidized households, and such historical evolution of federal housing policies has shaped discussions on the expansion of neighborhood opportunity to low-income households. I explore backgrounds in the rise of the tenant-based housing subsidy and residential mobility programs, and draw attention to the gap in the literature with respect to neighborhood choices of households receiving housing assistance.

2.1. Poverty Concentration

Since the 1970s, neighborhood effects of concentrated poverty have been explored by focusing on the emergence of high-poverty neighborhoods and consequent challenges faced by poor, minority residents with respect to crime, health, education, employment, and well-being. From the perspective of sociology, the rise of inner city poverty has primarily been grounded on Wilson's two striking works, *The Truly Disadvantaged* (1986) and *When Work Disappears* (1996). He argued that increasingly concentrated poverty in urban areas during the 1970s and 1980s was mainly due to the suburbanizing movement of middle-class households, social services, institutional resources, and human and finance capital. While scholars explained high concentrations of the poor in terms of spatial mismatch between the inner city residential locations and suburbanized low-skill job opportunities (Kain 1992, Jencks and Mayer 1990) or residential segregation in predominantly poor neighborhoods due

to poorly enforced fair housing laws (Massey and Denton 1993), most studies highlighted that deprived conditions of concentrated poverty in the central city has reinforced the social dislocation of the minority residents (Jargowsky 1996, Wilson 1986, 1996). Furthermore, racial discrimination and the lack of affordable housing in suburban housing markets has limited low-income black households' ability to suburbanize to take advantage of decentralizing job opportunities. Disconnection with the resources and networks has exacerbated conditions of inner city neighborhoods that suffer from serious crime, health, and education problems, eventually further limiting the opportunities for people residing in such locations.

Several studies on neighborhood effects of concentrated poverty have examined health, employment, earnings, crime and delinquency, and unfavorable sexual and fertility outcomes for adolescents. Ellen and Turner (1997) reviewed the literature of the effect of neighborhood attributes on the socioeconomic status of an individual's life at different stages. They concluded that there is an abundance of evidence that those living in poor, inner-city neighborhoods showed lower education attainment and higher crime involvement. Sampson et al. (2002) found that neighborhood ties and patterns of interaction, collective efficacy, institutional resources, and routine activity patterns were related to crime outcomes, such as records of homicide, robbery, stranger assault, and violent property victimization. A stream of empirical evidence on the effects of concentrated poverty has led many in the federal government to rethink housing policy.

2.2. The Geography of Opportunity

The concept of the "geography of opportunity" was grounded upon the theoretical framework by Galster and Killen (1995), which introduced the importance of a geographic element in equal opportunity. The authors outlined the normative principles of the geography of

opportunity, stating that all people in need should be treated equally by markets and institutions, but some might be left behind just because they live far apart from the resources that they need. They viewed opportunity as having dimensions of both process and prospects, and characterized the metropolitan opportunity structure and an individual's perceived opportunity set as associated perspectives of each dimension. The metropolitan opportunity structure serves as a package of markets, institutions, and systems that convert personal attributes into outputs affecting social advancement. Several elements of the opportunity structure such as education, labor market, criminal justice, social welfare, and social networks, constrain individuals' collection of choice sets which can also be influenced by the person's indelible endowments (e.g. race), acquired attributes (e.g. education, job), and the person's subjective perceptions of how the opportunity structure will judge and transform these attributes.

Galster and Sharkey (2017) provide a recent review of the evidence on various dimensions of inequality of opportunity and outcomes. Spatial inequality is prevalent in economic status, access to well-paid jobs, exposure to environmental hazards, and exposure to community violence. Trends in segregation of neighborhoods and schools are consistent with persistent racial and ethnic inequality and the long-term rise of concentrated poverty. Economic segregation within racial and ethnic groups, especially for black and Hispanic families, has risen over time (Bischoff and Reardon 2014, Jargowsky 2015). Inequality of employment opportunities has grown due to inequality in education and labor market across cities and metropolitan areas (Lindley and Machin 2014), and racial and economic gaps in exposure to environmental toxins have persisted (Downey 2007, Ard 2015). Only the inequality in community violence between racial groups have declined over the past twenty years (Ellen and O'Regan 2009).

Several scholars have extended the discussion on the geography of opportunity by focusing on the philosophy and value of equality. Arneson (1989) argued that in order for opportunities to be equal individuals must be aware of available options to them and must have an equivalent number and types of choices. Dawkins (2017) expanded the discussion in terms of geographic equality of opportunity. He argued that equal spatial accessibility to opportunities (or a spatially uniform distribution of resources) in terms of certain goods or social networks is required across all geographic units, and that opportunity in the context of housing policy can be defined as “opportunities to consume housing itself, in addition to the prospects for enhancing well-being that are provided by the geographic resources that are accessible from one’s home” (Dawkins 2017, p. 904). His definition of the equality of spatial access criterion has implications in multiple policies from residential mobility assistance and housing counseling to inclusionary land-use regulations, which ensure that individuals can freely make a residential mobility to gain access to a desirable resource if that resource is unavailable at the individual’s current neighborhood.

Academic discussions on the geography of opportunity have become substantial in the realms of public policy and urban planning. The federal government’s charge to Affirmatively Furthering Fair Housing (AFFH) is one of the remarkable results. The Fair Housing Act was enacted in 1968 to prohibit housing discrimination on the basis of race, color, religion, sex, and national origin. Disability and familial status were added in 1988. For federally assisted housing, HUD has applied this charge to ensure that subsidized households do not cluster by race or income in the sites of assisted units, establishing site selection criteria that helps minorities locate to places other than racially segregated areas in order to expand opportunities (Lev 1981). In July 2015, HUD released a final rule implementing the Fair Housing Act that aims not only to overcome housing discrimination but also to increase access to opportunity for low-income households. The final AFFH rule places an emphasis on

fair housing goals that include “strategically enhancing access to opportunity” through “promoting greater housing choice within or outside of areas of concentrated poverty and greater access to areas of high opportunity” (24 CFR §5.150 2015). The clustering of voucher families has become more crucial especially for public housing agencies which administer federal housing assistance programs. Specific content requirements are provided in the publicly available Assessment Tools, AFFH data and mapping tool (AFFH-T), for use by program participating local governments to access HUD-provided data to conduct the fair housing analysis required as part of the Assessment of Fair Housing. Based on the assessment of location, availability, and accessibility of affordable housing, the fair housing law promotes State and localities to overcome spatial segregation and discourage discrimination in all housing choices.

2.3. Housing Choice Vouchers

Federal housing policy has evolved to be consistent with the broad objective to link disadvantaged households to opportunity neighborhoods. Since the 1970s, the emphasis of federal housing policy administered by HUD has shifted from place-based subsidies that support the construction of affordable housing to tenant-based subsidies provided directly to low-income households for the purpose of renting privately owned units. While the Low-Income Housing Tax Credit (LIHTC) is still a major place-based program in providing affordable rental housing to moderately-low-income households, it is administered by the Internal Revenue Service (IRS). The Housing Choice Voucher (HCV) program, a tenant-based rental subsidy, is the largest federal rental housing assistance program administered by HUD (Landis and McClure 2010). The HCV program is designed in part to enable households to overcome these constraints and secure affordable rental housing units in a wider range of neighborhoods. HUD has implemented a variety of policies designed to

expand opportunities for assisted renters in areas where they have traditionally been underrepresented, particularly in locations exhibiting lower levels of racial and economic segregation and in areas offering greater access to employment and other opportunities (U.S. Department of Housing and Urban Development 2008: ch. 2, p. 2-1).

As a demand-side approach, the HCV program was designed to be a flexible and cost-effective way of providing affordable rental housing to low-income households. The program has aimed to reduce poverty concentration and offer voucher holders greater accessibility to various neighborhood opportunities. Despite this program goal, many voucher households remain concentrated in neighborhoods with fewer opportunities. Findings of previous research show that many voucher recipients are disproportionately located in racially segregated and impoverished neighborhoods, even with the increased budget for housing consumption (Pendall 2000, Devine et al. 2002, McClure et al. 2015). Neither voucher users nor public housing residents can find enough housing in high-opportunity neighborhoods (McClure 2010).

The choice of whether or where to move is influenced by household-level factors, such as household income, marital status, presence of children, age, and family size, and neighborhood-level factors such as crime, school quality, and access to jobs. Households normally make compromises among a range of neighborhood characteristics to realize their prioritized needs. However, low-income families face constraints in the housing market, which hinder those to move to preferred neighborhoods. A lack of public transportation service, a limited affordable housing stock, and racial and economic discriminatory barriers have been factors that decrease housing options in locations offering greater access to employment and other opportunities.

Several case studies have examined mobility programs using a voucher. Jacob (2004) provides evidence from a natural experiment in Chicago, where public housing residents were

offered vouchers following the demolition of their public housing units. These households' locational outcomes were compared to a control group of households whose units were not scheduled for demolition. Compared to the control group, those whose units were scheduled for demolition used their vouchers within census tracts with poverty rates of 53 percent, compared to the control group households who resided in neighborhoods with an average poverty rate of 67 percent. Carlson et al. (2012) employed a propensity score matching procedure to control for selection bias in their examination of the short-term and long-term locational outcomes for voucher recipients living in the state of Wisconsin. Compared with a sample of households with otherwise similar household characteristics, those receiving a voucher did not display markedly different locational outcomes in the short term, but after four years, voucher recipients lived in neighborhoods with observably lower poverty rates and unemployment rates, although the differences were small.

2.4. Moving to Opportunity

HUD has introduced a range of housing mobility programs to specifically deconcentrate low-income families that receive rental housing assistance. Residential mobility programs were established in response to litigation against HUD for past discrimination and segregation in public and other subsidized housing programs, which usually involved housing vouchers and counseling or other forms of housing search assistance (Schwartz 2010). The most famous litigation program is the court-ordered Gautreaux program in Chicago. The Chicago Housing Authority vouchered out approximately half of the public housing tenants to majority-white neighborhoods, while the rest of the families remained in the central city to address discrimination against the black located in concentrated poor, black areas. Some vouchered-out participants experienced employment and educational benefits throughout suburban placements (DeLuca et al 2010, Popkin et al. 1993, Rubinowitz and Rosenbaum 2000).

However, evidence from the Gautreaux program is limited due to its administrative procedure and design; participants were non-randomly selected through home visits and credit checks (Popkin et al. 2000).

Inspired by the Gautreaux program, the Moving to Opportunity (MTO) program was initiated in 1994 for the purpose of understanding the impact of geographic-restricted housing assistance on the outcomes of participating low-income families in five large metropolitan areas: Baltimore, Boston, Chicago, Los Angeles, and New York. Such housing dispersal programs was built upon the argument that high concentrations of poverty result in community decline and poor socio-economic outcomes for individuals, and the expectation that housing dispersal produces relief from the effects of concentrated poverty and alleviates individual poverty through enhanced employment and earnings (Goetz and Chapple 2010).

In the MTO experiment, over 4,600 households were randomly assigned to one of three groups: (1) the experimental group received a Section 8 voucher along with housing search assistance and was required to use the voucher in a low-poverty neighborhood with poverty rates less than 10%; (2) the Section 8 comparison group received a voucher but faced no geographic restrictions on its use; and (3) the control group of households did not receive a voucher and remained in their current assisted housing unit. Participants were recruited from those residing in project-based subsidized housing in neighborhoods with poverty rates of 40 percent or more (Orr et al. 2003). This research design allows researchers to isolate the treatment of the voucher itself, and examine the impact of the location restriction of assignment to a low-poverty neighborhood, controlling for factors that influence voucher selection. The counterfactual in this case is the control group of public housing residents, allowing researchers to identify the “treatment” of receiving either a location-restricted voucher with housing search assistance or an unrestricted voucher. After households were randomly-assigned to these groups from 1994 through 1998, two follow-up surveys were

conducted: an interim-survey five to seven years after random assignment and a final survey conducted 10 to 15 years after random assignment.

The MTO Final Evaluation (Sanbonmatsu et al. 2011) finds that by the end of the study, households assigned to the experimental and Section 8 comparison groups resided in neighborhoods with average poverty rates of 31 percent and 33 percent respectively, compared to the 40 percent average poverty rate in neighborhoods inhabited by those assigned to the control group. The neighborhoods chosen by those in the experimental and Section 8 group were also inhabited by fewer female-headed households and by households earning higher median incomes. Impacts on racial segregation were much weaker. While those in the experimental and Section 8 comparison groups lived in neighborhoods with fewer minority residents compared to those in the control group, both the experimental and Section 8 groups lived in neighborhoods that were overwhelmingly populated by minority residents. Furthermore, Nguyen et al. (2016) compares locational attainment of MTO treatment groups. Compared to the control group, Experimental and Section 8 groups experienced substantial improvements in neighborhood conditions across diverse measures, including economic conditions, social systems, physical features of the environment, and health outcomes.

As found in the housing voucher literature, MTO participants also achieved limited success in stable mobility towards neighborhoods in which opportunities are expanded for low-income households. Most participants initially gained access to less disadvantage neighborhoods but lost access soon thereafter moving back to the original neighborhoods or similarly distressed (Briggs et al. 2010). Few sustained access to better neighborhoods over the long term, and those that did not initially gain access rarely ever gained access (Dawkins et al. 2015).

2.5. Constraints in Residential Location Choices

There are several factors that limit the degree of neighborhood improvement experienced by low-income households receiving rental housing assistance. The literature accounts for multiple scales of constraints in residential location choices: macro-level (market- or metropolitan-level) forces, meso-level (program-level) barriers, and micro-level (individual-level) limitations.

Macro-level forces include structural aspects of the constraints in residential location choices for housing voucher households. Voucher recipients face a limited set of housing options in the private housing market due to a shortage of affordable housing in high-opportunity neighborhoods. Previous studies suggest that the availability of affordable housing tends to be negatively associated with the existing supply of market-rate rental units in neighborhoods with greater accessibility to opportunity (Basolo and Nguyen 2005, Talen 2010). Housing options are even further restricted by transportation constraints. Metropolitan areas have been evolved in expansive and complex ways, leading most quality neighborhoods to have less access to public transit and to make cars necessary even in transit-rich places for shopping, work, and recreation. It was found that the availability of public transportation is an important factor that determines the location of moves (Varady and Walker 2007).

Meso-level barriers include programmatic aspects of the constraints in residential location choices in the Housing Choice Voucher program. Program design constrains voucher households' location choices in various ways. In theory, vouchers augment a household's financial capacity to occupy an appropriate residential unit and eventually improve the quality of life by relocating to a better neighborhood. However, voucher families have difficulty selecting a residential unit with a rent above a payment standard set by Fair Market Rents (FMRs), which is HUD's estimate of the amount needed to cover rent and utility costs in a given metropolitan area or county. HCV recipients are required by HUD program rules to

spend no more than 40 percent of their income when entering the program or moving to a new unit. The limitation of FMR is its inflexibility. Although rental prices vary across a metropolitan area, a single FMR is applied to determine the maximum subsidy which limits available housing options to areas with rents below the FMR. McClure (2010, 2013) finds that the majority of rental units in low-poverty neighborhoods are listed above the FMR levels. Moreover, voucher families have difficulty using vouchers when they move to a jurisdiction where the program is administered by a different local public housing agency (PHA), although such a move is permitted under the program's portability provisions (Climaco et al. 2008). In the administration procedure, these "portability moves" might be restricted by PHAs for new voucher recipients before their first lease-up within the jurisdiction, and might even be cancelled if the household that wishes to move fails to lease-up in the new location in a given time period. Greenlee (2011) found a disincentive to portability moves such that additional costs of receiving portable vouchers often uncovered by the federal government increase the burden on PHAs' financial and administrative responsibilities.

In addition to program design aspects, discrimination of landlords limit housing options for housing voucher households at the program level. Many voucher families experience discrimination related to their housing search process. In the sociological literature, the perception of racial discrimination by landlords has been shown to be a major barrier in residential mobility (Ondrich et al. 1999, Weisbrod and Vidal 1981). Graves (2016) found at least two kinds of discrimination: racial discrimination and source of income discrimination. Racial discrimination discourages minority voucher households from relocating to predominantly white neighborhoods, generally in the suburbs, despite the availability of housing options in such areas (Yinger 1998). Source of income discrimination, as many qualitative studies have found (Greenlee 2014, Rosen 2014), results in fewer housing

options for voucher households due to landlords' reluctance to accept vouchers. Although legislation prohibiting source of income discrimination has been shown to be associated with improved neighborhood outcomes (Freeman 2012, Metzger 2014), voucher families are often rejected based on their employment or receipt of other government subsidies (Popkin and Cunningham 2000). Unfortunately, the Fair Housing Act covers racial discrimination only, and not discrimination of source of income.

Micro-level constraints include behavioral aspects of the limitations in moving housing voucher households to quality neighborhoods. In general, staying close to social ties is central to the lives of many poor families. They are less likely to make a distance move because survival of poor families demands sacrifice (Stack 1974). Briggs et al. (2010) found in their study on the Moving to Opportunity experiment that families moved to neighborhoods in which they were able to exercise their strong kinship or friendship for practical help or emotional support (Further discussion in Chapter 4.1.2.). Also, an individual's access to a vehicle inhibits residential choices. Only about a quarter of urban households earning less than \$20,000 in 2001 traveled without a car, and even those who had no car took an estimated 34 percent of their trips in 2001 either by borrowing a car or riding with a household who had one (Pucher and Renne 2003). Because even low-income households usually have cars, people who earn little and have no car access face tremendous constraints in their residential choices. Housing voucher households are more likely to sacrifice other neighborhood amenities to maximize access to public transit or gain access to a car through social networks.

Most of the barriers at multiple scales are connected to each other, and consequently generate more limitations in residential location choices. For housing voucher households, a lack of affordable housing in expensive markets is affected by the applicable Fair Market Rent, as the payment standard determines the number of rental units affordable to voucher

recipients for which they can rent without spending more than 30 percent of their income. While vouchers can expand housing options within the PHA jurisdictions, moving to transit-poor places is influenced by an access to a vehicle. Failure to rent a unit in high-opportunity neighborhoods due to discrimination is likely to lead voucher recipients to move back to their initial neighborhood where strong social networks is prevalent. Therefore, it is important to take a comprehensive approach to address such constraints in residential location choices for voucher households.

2.6. The Gap in the Literature

While the studies discussed above investigate the obstacles and opportunities in residential location choices of housing voucher households in efforts to improve low-income families' neighborhood outcomes, it remains unclear which factors matter most and which will improve the outcome most effectively. My dissertation focuses on the three most unexplored, overlapping barriers of residential location choices of low-income households receiving a housing voucher: affordable housing, social networks, and vehicle access.

A missing link in the body of research on a shortage of affordable housing in the Housing Choice Voucher program is the impact of Fair Market Rents (FMRs) on location choices. Each voucher recipient's payment standard is determined by the FMR, and HUD only covers the difference between the payment standard and 30 percent of a voucher household's adjusted monthly income when they choose a unit in which the gross rent is above the payment standard. As a result, it is likely to limit affordable housing options to areas with rents below the applicable FMR and discourage voucher households from renting a unit in safer neighborhoods with better schools and access to jobs or other services. While evidence from empirical studies suggests that the choice set of voucher households is restricted by the establishment of a single FMR for an entire metropolitan housing market

(McClure 2010, 2013), less is known to what extent housing vouchers reduce segregation of affordable housing across the metropolitan area. In addition, while HUD has proposed establishing Small Area FMRs, localized FMRs that vary by zip code, little is known about whether this change in the program rule improves affordable housing inequality across the metropolitan area.

Intra-neighborhood social networks also influence the relocation of housing voucher recipients. The vast body of literature that addressed residential mobility of low-income households with respect to social networks found that social relations were the driving factor in residential mobility, with mixed results on strong social ties (i.e. kinship, friendship) and social resources (i.e. resources for costly social services – childcare, ride to work). Findings from the Moving to Opportunity (MTO) experiment also demonstrate that social networks persisted at the core of most participants' lives, regardless of relocation, and influenced how they structured their daily lives. However, little attention has been paid to whether households tend to live closer to relatives and friends for companionship or emotional support, or for essential practical help such as childcare. Also, no studies to date have examined whether social networks in the old neighborhood and past residential mobility affect current residential mobility, although many findings from studies on housing mobility programs and vouchers shed light on the missing link between the tendency of MTO households (or voucher households in general) to move back to disadvantaged neighborhoods.

Furthermore, the literature suggests that while the links between transportation access and residential location decisions have been explored in-depth, there is a paucity of studies examining the impact of transportation access on the neighborhood choices of low income households receiving rental housing assistance. One unexplored explanation is that housing voucher recipients, many of whom lack access to automobiles, are unable to search for housing in high-opportunity transit-poor neighborhoods. Even when housing search

assistance is provided, transit-poor suburban environments may not be perceived as offering access to opportunity if the opportunities can only be reached via the automobile. Part of the challenge is likely due to the limited number of datasets offering information on car access, housing assistance, and residential location outcomes.

To this end, my dissertation seeks to answer one central research question: What factors are barriers in the relocation of low-income households receiving housing assistance to opportunity neighborhoods? Under this central question, three specific questions are addressed. First, to what extent does the Housing Choice Voucher program expand affordable housing options for low-income households in opportunity neighborhoods? Second, what aspects of social networks bind low-income households to the original neighborhoods? Third, how does vehicle access influence the types of neighborhood opportunities in which low-income households are able to secure housing following a move to a new neighborhood? To answer these questions, I examine the impacts of Fair Market Rents, social networks, and vehicle access on residential location choices of housing voucher households. In the following chapters, drawing upon data from the MTO survey and various tract-level characteristics, I specifically explore trends in affordable housing supply and inequality, analyze social networks as a determinant of mobility, and estimate the effect of vehicle access on locational attainment. Using the MTO data set allows me to control for unobserved characteristics which influence the likelihood of applying for a rental voucher, because vouchers were randomly assigned to households in both experimental programs.

Chapter 3: Landscape of Affordable Housing

This chapter explores the landscape of affordable housing in the Moving to Opportunity metropolitan areas. Evidence suggests that growth in demand has been the primary force behind the widespread tightness in rental markets (Joint Center for Housing Studies of Harvard University 2015). However, little attention has been paid to the dynamics of segregation of affordable housing for housing voucher households. During the 2000 and 2009 period, I examine the dynamics of the (1) affordable housing gap for low-income households, (2) spatial distribution of affordable housing, and (3) affordable housing inequality for housing voucher households. Furthermore, I run a simulation of implementing Small Area Fair Market Rents to address whether a localized payment standard reduce segregation of affordable housing for housing voucher households.

3.1. Background

3.1.1. Rental Housing Crisis and Affordability

Rental demand has recently grown even though the supply of affordable housing that has shrunk. The share of all U.S. renters reached a peak of 37 percent in 2015 for the first time, since the mid-1960s (Joint Center for Housing Studies of Harvard University 2015). The collapse of the housing bubble in 2007 which is a primary cause of the broader economic downturn played an important role in the high rental demand. This sharp downturn increased housing instability by exposing homeowners to foreclosure. Tightened access to mortgage credit (Fligstein and Goldstein 2010, Lewis 2010, Tomaskovic-Devey and Lin 2011) and a decline in income due to job loss (Schwartz et al. 2016) drove many to foreclosure, making them transition from homeowners to renters. While the Great Recession negatively affected

the national rental housing market, the heterogeneity of housing markets across metropolitan areas has produced divergent rent trends at the metropolitan level.

In response to significant job losses and rising unemployment rates especially among the young during the recession, the rental housing market experienced a rise in vacancy rates and decline in real rents in most markets (DiPasquale 2011). A sudden decline in rental demand created downward pressure on rents. Collinson (2011) found that rents fell by a significant six- to eight-percent range from 2007 to 2010 in housing markets that were hit hard by foreclosures, such as Phoenix, Arizona, and Tampa, Florida. Although high vacancy rates and low rent growth likely alleviated rental housing affordability in the short term, weakening housing market fundamentals created challenges for property owners, which potentially threatens the future supply and quality of affordable rental housing. Shilling (2010) provided a detailed analysis of the impact of foreclosures on the rental stock, showing that rental foreclosures are highly concentrated in low- and moderate-income neighborhoods.

Rather than suffering from high vacancy rates, some large markets have experienced consistent rising rents over time. In a study of the 11 largest metropolitan areas in the U.S., the Atlanta, Boston, Chicago, Dallas, Houston, Los Angeles, Miami, New York City, Philadelphia, San Francisco, and Washington, DC metropolitan areas, Ellen and Karfunkel (2016) found that the median gross rent rose and the rental vacancy rate dropped in 10 of the 11 metropolitan areas between 2006 and 2014. In such housing markets with steady or rising demand, inelastic housing supply played an important role in significant upward pressure on rents. Glaeser and Gyourko (2008) demonstrated the volatility of rental housing cost in large coastal metropolitan areas, in which regulatory constraints and limited developable land hinder rental housing stock growth and contribute to rising rents. In the economic literature, partial equilibrium analysis suggests that the impact of inequality on the housing outcomes of

the poor depends critically on the price elasticity of supply in the market (Matlack and Vigdor 2008).

The rental housing crisis forces the majority of renters to face affordability challenges. Spending large fractions of income on rent has been a longstanding policy concern. Quigley and Raphael (2004) found that the median renter saw a substantial increase in the share of income spent on housing in the 1970s, while low-income renters have been spending a larger share of income on rent. One approach researchers commonly use in the policy contexts is to choose a benchmark income level, and define housing affordability as 30 percent or less of income spent on rent. HUD classifies housing costs exceeding 30 percent of income as moderate cost burdens and costs exceeding 50 percent of income as severe cost burdens. While analyses of housing affordability problems have generally focused on supply-side determinants (Gyourko and Linneman 1993), evidence of a link between income inequality and housing affordability has garnered considerable attention. Quigley and Raphael (2004) decomposed the affordability changes decade-by-decade from 1960 to 2000, and found that nearly half of the decline in the affordability of rental housing during the 1970s is attributable to a decline in the median income of renter households. DiPasquale and Murray (2017) showed that during the recession the real price of rental housing services was at its highest recorded level, whereas renters' incomes were lower than in 1970. Joint Center for Housing Studies of Harvard University (2015) also provides evidence of the nationwide cost burdens over the last decade. Between 2001 and 2014, national trends in rising rents and falling incomes pushed the number of cost-burdened renters up from 14.8 million to a new high of 21.3 million. Even worse, the number of these households with severe burdens jumped from 7.5 million to 11.4 million.

Rent burdens, i.e. cost burdens for renters, tend to be more severe for low-income households. The Joint Center for Housing Studies of Harvard University (2015) found that

the cost-burdened share rose from 69 percent in 2001 to 77 percent in 2014 among renters earning between \$15,000 and \$30,000, with a ten percentage-point increase in the incidence of severe burdens accounting for all of the change. Ellen and Karfunkel (2016) also showed that in 2014 more than half of low-income renters, earning less than the 25th percentile renter income in their metropolitan area, faced rents at or above half of their household income in the 11 largest metro areas. Scholars argue that severe rent burden is a serious national problem because it leaves very little income for families to spend on other essentials, such as food, medical care, transportation expenses, education, and childcare.

Finding affordable housing has been more difficult for low-income households, even though the rental housing stock has somewhat expanded since the recession in response to record growth in demand. The nationwide lack of sufficient affordable housing for the poor is well illustrated in several studies. The HUD's Worst Case Housing Needs report (Steffen et al. 2015) illustrated inadequate supply of rental units that are affordable to extremely low-income (ELI) renters whose income is at or below 30 percent of the area median income, showing that only 65 affordable units exist for every 100 ELI renters nationwide. If both the affordability and availability are taken into account, only 31 affordable and available units exist for every 100 ELI renter households (Aurand et al. 2017). Leopold et al. (2015) also found that between 2000 and 2013, the number of ELI renter households increased by 38 percent, while the supply of adequate, affordable, and available rental homes for these households increased by only seven percent, resulting in a widening of the housing affordability gap over time.

Backgrounds in the dynamics of rental housing markets and housing affordability for low-income households enable us to understand the extent to which low-income renters expand affordable housing options through rental housing assistance. Low-income renters in housing needs would greatly increase the set of housing and neighborhood options through

housing vouchers. Nevertheless, little is known about how the affordable housing gap varies across neighborhoods, and to what extent low-income renters improve housing affordability through housing assistance. A shortage of affordable housing is prevalent nationwide, but it is unclear whether such shortage exists in high-poverty neighborhoods, predominantly minority neighborhoods or affluent neighborhoods.

3.1.2. Fair Market Rents and Neighborhood Choices

The Housing Choice Voucher (HCV) program is targeted to families who need them most. The Quality Housing and Work Responsibility Act of 1998 requires local Public Housing Agencies (PHAs) to provide 75 percent of its vouchers to households whose incomes do not exceed 30 percent of the area median income (Hunt et al. 1998). Although the demand-side subsidy has offered low-income families more flexibility in location choices, those receiving housing vouchers are still constrained in moving to high-opportunity neighborhoods. The vast body of literature has addressed mobility of voucher households and their neighborhood outcomes. To explore economic, racial, and spatial concentration of housing vouchers, Metzger (2014) computed a Herfindahl index, and found that voucher households are more segregated by race and income, and more clustered within specific census tracts, than a comparison group of households earning less than \$15,000. The locations of voucher recipients tend to be associated with less sustainable neighborhood characteristics in terms of accessibility, pedestrian orientation, connectivity, and diversity (Talen and Koschinsky 2011, 2014).

While some scholars have examined programmatic problems of segregated neighborhood outcomes of HCV households, others have identified structural aspects in HCV households' constrained location choices (See Chapter 2.5 for details). Despite making progress through heated discussion, little research has paid attention to the housing voucher

subsidy mechanism as a constraint for a wide variety of neighborhood choices. Only McClure (2010, 2013) found that the payment standard of the program, Fair Market Rents (FMRs), limits affordable housing options to areas with rents below the FMR in which moderate- and high-poverty rates are exhibited.

To calculate the subsidy level, each HCV recipient's payment standard is determined based on the Fair Market Rent after adjustment for household size. The FMR is HUD's estimate of the amount needed to cover the rent and utility costs in a given local area, mostly setting at the 40th percentile of market rents for standard-quality, recently-rented units in an entire metropolitan area. A single metro-wide FMR is designed to be high enough to provide a variety of housing and neighborhood choices. The housing assistance payment (HAP) is calculated as the lower of gross rent or the payment standard minus 30 percent of adjusted income. If a voucher household chooses a unit in which gross rent is below the payment standard, the amount above 30 percent of adjusted monthly income is fully subsidized. If a selected unit's gross rent is higher than the payment standard, HUD only covers the difference between payment standard and 30 percent of the income. In such cases, the family's share of housing costs may exceed 30 percent, but the program limits tenant rent to 40 percent of the income.

Presumably, the current method of HAP determination might increase voucher households' inability to rent a unit in high-quality neighborhoods, because a single FMR within a metropolitan area or county fails to properly reflect rising rents in volatile housing markets. Rental units affordable to HCV households depend on Fair Market Rents, considering most voucher households have extremely low income. If FMRs are not high enough, voucher households may not be able to rent a unit in a desirable neighborhood. Several studies showed that setting FMRs at the 50th percentile of market rents was not enough to expand housing and neighborhood choices across the metropolitan area. McClure

et al. (2015) found that between 2000 and 2010, voucher households in the 50 largest metropolitan areas became more concentrated and more likely to live in neighborhoods with poverty rates at or above 30 percent, even though 50th percentile FMRs were used in most of those areas at some point during that period. Similarly, Collinson and Ganong (2017) found that the main effect of the initial implementation of 50th percentile FMRs in 2001 had been to raise costs without improving the quality of the housing where voucher holders lived.

HUD has tried to implement Small Area Fair Market Rents within many U.S. metropolitan areas, which would be used to set Housing Choice Voucher payment standards that vary by Zip Code. The idea behind Small Area FMRs is simply about more residential choices. Through the housing voucher program, eligible families spend 30 percent of their income to pay for part of the rental costs and HUD pays the rest up to a payment standard. Each recipient's payment standard is determined by the FMR, which is HUD's estimate of the amount needed to cover rent and utility costs in a given metropolitan area or county. HUD only covers the difference between the payment standard and 30 percent of a voucher household's adjusted monthly income when they choose a unit in which the gross rent is above the payment standard. As a result, it is likely to limit affordable housing options to areas with rents below the applicable FMR and discourage voucher households to rent a unit in safer neighborhoods with better schools and access to jobs or other services. However, a final rule on using Small Area FMRs was recently suspended, as HUD claimed that they needed more time to analyze the impact of the policy change's costs and benefits.

In an effort to expand opportunity, a test of small area Fair Market Rents already showed positive impacts on relocation to quality neighborhoods. Drawing upon data from the Small Area FMR Demonstration Program in five housing authorities, Meryl et al. (2017) found that high-rent zip codes offer more opportunities than low-rent zip codes do, although there were 3.4 percent fewer units available overall. Collinson and Ganong (2017) analyzed

the impact of the policy change on neighborhood quality of HCV recipients in the Dallas, TX metropolitan area. Their difference-in-difference model found that quality of neighborhoods chosen by HCV households in Dallas showed higher increase than HCV households in nearby areas using a single FMR. In the economic literature, Geyer (2017) simulated how changes in a geographic unit of FMR influence voucher households' neighborhood outcomes, resulting from neighborhood preferences estimation. The policy simulation suggests that allowing a payment standard to vary based on census tract would be twice as effective as, and 63 percent less expensive than, increasing the current maximum subsidy by 20 percent. However, less is known to what extent Small Area FMRs expand housing options in quality neighborhoods and reduce segregation of affordable housing across the metropolitan area.

3.2. Data and Methods

3.2.1. Geography of Affordable Housing

The geography of affordable housing is explored to understand how housing market conditions have changed over time for participants in the Moving to Opportunity (MTO) demonstration. Five MTO metropolitan areas are used as targeted study areas. To use consistent metropolitan area boundaries, I use the definition of metropolitan areas delineated by the Office of Management and Budget as of December 2009. Since most MTO participants were randomly-assigned from 1994 through 1998 and stayed 10 to 15 years in the demonstration, I use 2000 and 2009 data to depict the geography of affordable housing after random assignment. Drawing data from multiple sources published in 2000 and 2009 including Census 2000, 2009 American Community Survey, Picture of Subsidized Households, Comprehensive Housing Affordability Strategy (CHAS) and Fair Market Rents (FMRs), the dynamics of metropolitan rental housing markets and spatial distribution of affordable housing are examined. Specifically, I address (1) trends in overall supply and

demand in rental housing by affordability in terms of income as a percentage of the area median income (AMI), (2) trends in the affordable housing gap by neighborhood poverty rates, and (3) trends in the share of rental units affordable to housing voucher households by neighborhood poverty rates.

To understand the extent to which housing vouchers expand affordable housing options for low-income households, I select extremely low-income (ELI) and very low-income renters (VLI) as comparison groups in the analyses. Households belong to these groups are similar to voucher households regarding levels of income in particular, given that eligibility for a housing voucher requires families' income do not exceed 50 percent of the AMI, and Public Housing Agencies must provide at least 75 percent of its voucher to applicants whose incomes are at or below 30 percent of the AMI. As in other housing assistance programs administered by HUD, the income limits of the housing voucher program are determined based upon the AMI. Three terms of income limits are defined: "extremely low-income" (ELI), "very low-income" (VLI), and "low-income" (LI). Households whose incomes do not exceed the higher of the federal poverty level or 30 percent of AMI are defined as ELI, where as those earning between 31 and 50 percent of AMI as VLI and those earning at or below 80 percent of AMI are defined as LI.

Affordability measures the extent to which enough rental housing units of different costs can provide each renter household with a unit it can afford (based on the 30-percent-of-income standard), which addresses whether sufficient housing units would exist if allocated solely on the basis of cost. The affordable stock includes both vacant and occupied units. For ELI and VLI renters, a rental unit is considered affordable to a renter if the gross rent does not exceed 30 percent of the maximum income of their income category. I use 2000 and 2009 CHAS data to obtain the number of affordable rental units by income category. For housing voucher households, a rental unit is considered affordable if the rent is below the applicable

FMR, because voucher households are awarded housing assistance payments that cover the difference between 30 percent of a household's adjusted gross income and a payment standard which is mainly determined by the FMR (McClure 2005). 2000 Census and 2009 ACS are used to obtain the number of rental units by gross rent category, and 2000 and 2009 FMRs are used to obtain the applicable FMR for each metropolitan area. I determine the number of affordable units by computing the number of rental units with the gross rent below the applicable FMR. While HUD usually sets a single FMR for every county and metropolitan area, large-scale metropolitan areas have more than one FMR areas. In case of MTO metropolitan areas, between 2000 and 2009, Baltimore and Los Angeles had two FMRs, Boston had five FMRs, Chicago had seven FMRs, and New York had eight FMR areas within each metropolitan area. As more FMR areas exist, voucher households would have more affordable housing options as local housing market conditions would be well accounted for.

In addition to the concept of affordability, availability is considered as an additional criterion to determine the severity of the affordable housing gap. Availability measures the extent to which affordable rental housing units are available to renters within a particular income range. Availability is a more restrictive concept, because units that meet the definition must be available and affordable. Some renters choose to spend less than 30 percent of their incomes on rent, occupying housing that is affordable to renters of lower incomes. These units thus are not available to lower income renters. A unit is available at a given level of income if (1) it is affordable at that level and (2) it is occupied by a renter either at that income level or at a lower level or is vacant. Measures of affordability and availability compare the entire rental housing stock with the entire renter population, which allows me to compute the ratio of affordable units and affordable-and-available units per every 100 renters.

To explore the spatial distribution of affordable housing stock, I chose poverty rates as a neighborhood attribute that divides census tracts within the metropolitan area into three groups: low-, moderate-, and high-poverty neighborhoods. In the literature, poverty rates have been frequently used as an indicator to determine neighborhood opportunity in which neighborhoods with low-poverty rates are deemed as quality neighborhoods exhibiting greater access to opportunities. Especially in the MTO experiment, households in the experimental group were required to use their vouchers only in low-poverty neighborhoods with poverty rates below ten percent. To achieve the poverty-deconcentration goal, rental housing supply across the metropolitan area must provide MTO participants with enough affordable housing options in low-poverty neighborhoods, or those might be crowded out because of competitiveness in the market despite the use of vouchers. Therefore, I examine how the number of affordable housing options for low-income renters and voucher households differ between neighborhoods grouped by poverty rates. I define low-poverty neighborhoods as where poverty rate is 10 percent or less, moderate-poverty neighborhoods as where poverty rate is between 11 and 20 percent, and high-poverty neighborhoods as where poverty rate is more than 20 percent. Furthermore, I explore how the share of affordable housing options would change if the definition of FMR is changed to Small Area FMR using FY2010 hypothetical Small Area FMRs. The localized, zip-code determination of payment standards are expected to expand housing options in high-opportunity neighborhoods by allowing higher payment standards in expensive markets based on zip code. I use the HUD-USPS zip crosswalk file to allocate zip codes to census tracts, and determine the number of rental units affordable to voucher households whose rent is below the applicable Small Area FMR.

3.2.2. Measurement of Segregation

Segregation of affordable housing for housing voucher households is attributed to the disparity in rentable housing options between neighborhoods. If affordable housing options through housing vouchers are constrained in certain neighborhoods, neighborhood choices of voucher households would inevitably be limited in these neighborhoods. Several studies found a negative effect of Fair Market Rents (FMRs) as a limitation forcing voucher households into low-poverty neighborhoods because of a lack of affordable and available options measured as rental units below the applicable FMR (McClure 2010; 2013, McClure et al. 2015). I extend these studies to address whether spatial and racial aspects of segregation of affordable housing for voucher households exist in addition to economic segregation. I compare trends in segregation of affordable housing across different neighborhood characteristics between 2000 and 2009. Particularly, I explore how segregation of affordable housing would change if the definition of FMR is changed to Small Area FMR using FY2010 hypothetical Small Area FMRs. The localized, zip-code determination of payment standards are expected to reduce segregation of affordable housing by evening out the share of affordable housing in each neighborhood across the metropolitan area.

The most common measures of inequality are one-number-summary statistics that measure inequality throughout the distribution and differ somewhat in their sensitivity to changes in the tails versus the middle of the distribution. A popular measure in the literature on economic inequality is the Gini coefficient. Varying from zero to one, it measures deviation from a perfectly equitable distribution. Landis et al. (2002) generated the rent Gini coefficient to explore the effects of industrial structure on the distribution of housing outcomes within metropolitan areas. While the Gini coefficient has many desirable properties, one disadvantage is that it cannot easily be decomposed to show the sources of inequality.

In the context of decomposability, Theil (1967) introduced the concept of entropy to the social sciences as a measure of inequality. Theil's (1972) entropy index of segregation, the Information Theory index (H), has been consistently presented in the sociological literature as a measure of residential segregation (Reardon and Firebaugh 2002, Reardon and O'Sullivan 2004, White 1986), and it has become the standard for decomposition studies of segregation (Bischoff 2008, Farrell 2008, Fischer 2008, Fischer et al. 2004, Parisi et al. 2011). The Theil's H index measures the extent of evenness to which groups are evenly distributed across spatial units (Massey and Denton 1988), indicating how diverse neighborhoods are on average compared with the diversity of the entire metropolitan area.

To depict segregation of affordable housing in the MTO metropolitan areas, Theil's H index is calculated in three categories: rental units affordable to ELI renters, rental units with the rent below the FMR, and rental units with the rent below the Small Area FMR (2009 only). For each category, Theil's H index is computed using different definitions of affordable housing: rental units affordable to ELI renters, rental units with the rent below the applicable FMR, and rental units with the rent below the applicable Small Area FMR. Due to their zip code-based determinations, Small Area FMRs are expected to reduce segregation of affordable housing. Consideration of more local housing market conditions would result in more affordable housing options through vouchers in less segregated neighborhoods. My simulation of implementing Small Area FMRs instead of the current FMRs reveals to what extent the HUD's newly proposed rule, designed for FMRs to vary at zip code level, increases the capacity of affordable housing for voucher households and expands housing options in less segregated neighborhoods.

The calculation of H begins with entropy (E) which is defined as below.

$$E = \sum_{i=1}^i p_i \ln \left(\frac{1}{p_i} \right)$$

where p_i refers to the share of affordable housing of a particular geographical area. By comparing all the E_s for the subareas, census tracts, to the overall E for the large area, the metropolitan area, the Theil's H index is computed, which can be interpreted as the average difference between E_s of census tracts and the overall E , expressed as a proportion of overall E and weighted by the census tract's share of the total rental units.

$$H = \sum_{n=1}^N \frac{R_n}{R} \left(\frac{E_j - E_n}{E_j} \right)$$

where R is the total rental units of the metropolitan area, R_n is rental units in census tract n , E_j is overall entropy in metropolitan j , and E_n is the entropy in census tract n . Lower levels of segregation occurs when the level of affordable housing stock in the metropolitan area is similarly observed in as many as census tracts. Higher level of segregation is apparent when census tracts are more homogenous than their metropolitan contexts, showing that rental units are either affordable or not affordable. At its extremes, the index reflects that all census tracts have the same proportion of affordable housing ($H=0$), or that each census tract has either all rental units affordable or all rental units unaffordable ($H=1$).

An essential part of this analysis is the Theil's H is decomposition into its group components. Reardon et al. (2000) show that the Theil's H can be decomposed as

$$H = H_S + \sum_{s=1}^S \frac{R_s E_s}{R E_j} H_s$$

where H_S is the segregation computed between subgroups, R_s is rental units in subgroup s , E_s is the entropy in subgroup s , and H_s is the segregation computed within subgroup s . To address how segregation of affordable housing has changed over time in spatial, economic, and racial aspects, the degree of overall metropolitan segregation is disaggregated into (1) central city and other suburbs, (2) low-poverty neighborhoods, where poverty rate is 10 percent or less, moderate-poverty neighborhoods, where poverty rate is

between 11 and 20 percent, and high-poverty neighborhoods, where poverty rate is more than 20 percent, and (3) low-percentage-white neighborhoods, where the proportion of the white is 50 percent or less, moderate-percentage-white neighborhoods, where the proportion of the white is between 51 and 80 percent, and high-percentage-white neighborhoods, where the proportion of the white is more than 80 percent. Percentage-white represents the white self-segregation and exclusion of affordable housing from white communities (Briggs et al. 1999, Polikoff 2006, South et al. 2011).

For each split, between- and within-group components are respectively shown as the proportion of inequality that can only be reduced through redistributing elements in that component. Given that these between- and within-group components of each decomposition add up to the total metropolitan inequality, it is also possible to calculate the percentage of metropolitan inequality attributed to each element simply by dividing them by total inequality (Reardon and Firebaugh 2002). This is a useful way to make comparisons over time and across places irrespective of differences in levels of inequality.

3.3. Results

3.3.1. The Dynamics of MTO Rental Housing Markets

I begin with an examination of the dynamics of housing markets in the Moving to Opportunity metropolitan areas between 2000 and 2009. Table 1 presents percentage changes in affordable rental units by income. The last column of the table shows that all five metropolitan areas decreased in the percentage of total rental units, in which Boston saw the greatest decline and Los Angeles saw the smallest decline. The percentage of affordable units to upper high-income (more than 80 percent of AMI) renters increased, while Los Angeles saw a decrease by 21 percent. With the exception of Los Angeles, all other areas saw a decrease in affordable rental units to very low-income (VLI) renters. The reduction in

affordable rental units to extremely low-income (ELI) renters was the largest in Baltimore and Chicago. On the other hand, Boston and New York saw the smallest decrease in affordable rental units to VLI renters. Affordable units to ELI and VLI renters in Los Angeles increased by 20 and 36 percent, respectively.

Table 1. Change in Rental Units by Income Needed to Make the Rent Affordable, 2000-2009

Change 00-09	Rental units by the affordability of their rents relative to the AMI					Total
	0–30% of AMI	30–50% of AMI	50–80% of AMI	>80% of AMI		
Baltimore	-26.5%	-23.6%	15.9%	83.7%	-2.1%	
Boston	-10.8%	-35.5%	-6.8%	36.7%	-6.7%	
Chicago	-31.1%	-27.7%	19.8%	22.0%	-4.5%	
LA	20.2%	36.3%	2.9%	-21.1%	-2.3%	
New York	-9.9%	-15.3%	-12.0%	14.3%	-5.4%	

Table 2 displays trends in the share of the affordable housing stock between 2000 and 2009. All areas except Los Angeles saw a decrease in the total share of affordable housing to ELI and VLI renters. Despite the small increase in its share, Los Angeles still had the smallest share compared with other areas. There was a five percentage point decline in the shares of affordable housing to ELI renters in Baltimore and Chicago, while there was an eight percentage point decline in the shares of affordable housing to VLI renters in Baltimore, Boston, and Chicago.

Table 2. Share of Affordable Housing Stock for Low-Income Renters, 2000-2009

	Share of units by the affordability of their rents relative to the AMI			
	2000		2009	
	0–30% of AMI	30–50% of AMI	0–30% of AMI	30–50% of AMI
Baltimore	21.3%	34.9%	16.0%	27.2%
Boston	20.7%	26.2%	19.8%	18.1%
Chicago	16.1%	34.3%	11.6%	26.0%
LA	6.0%	9.2%	7.4%	12.8%
New York	14.6%	19.1%	13.9%	17.1%

The situation is completely different on the demand side. Table 3 shows the change in the number of renters in MTO metropolitan areas by income as a percentage of the AMI between 2000 and 2009. While the total number of renters decreased over time, the number of ELI and VLI renters increased in most metropolitan areas during the same period. This contrasts with the changes on the supply side, as there was a drastic decline in affordable housing stock for low-income households. Notably, Los Angeles saw the greatest increase. While Boston and Chicago saw a large increase in ELI renters, Baltimore and New York saw a large increase in VLI renters. In all metropolitan areas, there was a decrease in the number of renters with income higher than 80 percent of the AMI.

Table 3. Change in Renters by Income Group, 2000-2009

Change 00-09	Renters by income as a % of AMI				
	0–30% of AMI	30–50% of AMI	50–80% of AMI	>80% of AMI	Total
Baltimore	2.1%	8.2%	-9.6%	-5.8%	-2.4%
Boston	7.5%	-3.8%	-21.5%	-12.1%	-7.3%
Chicago	7.6%	3.8%	-11.1%	-13.4%	-4.9%
LA	24.5%	16.6%	4.6%	-17.5%	0.7%
New York	1.3%	5.9%	-2.9%	-12.1%	-4.6%

Table 4 shows trends in the share of renters by income group between 2000 and 2009. All areas saw an increase in the share of ELI and VLI renters, whereas the total share of affordable housing to ELI and VLI renters declined during the same period (Table 2). In Los Angeles’s case, the share of ELI renters increased by a five percentage point. In Boston and Chicago, the increase in the share of ELI renters was larger than that of VLI renters.

Table 4. Share of Rental Units by Income Needed to Make the Rent Affordable, 2000-2009

	Share of renters by income as a % of AMI			
	2000		2009	
	0–30% of AMI	30–50% of AMI	0–30% of AMI	30–50% of AMI
Baltimore	25.3%	16.3%	26.4%	18.0%

Boston	26.2%	15.3%	30.3%	15.9%
Chicago	25.0%	15.9%	28.3%	17.4%
LA	19.9%	16.1%	24.6%	18.6%
New York	25.5%	14.2%	27.1%	15.8%

Table 5 shows trends in the affordable housing gap by income group between 2000 and 2009. For ELI renters, the affordable housing gap has exacerbated with the exception of Los Angeles metropolitan area. A severe mismatch exists between the number of ELI renters and the number of affordable units available to them. In total, only 58 affordable units exist for every 100 ELI renters in 2000, which decreased by 10 in 2009. In Los Angeles, the affordable housing gap for VLI renters somewhat improved from 2000 to 2009, although it still remained the lowest. With the exception of Los Angeles, more than 100 affordable units existed per 100 VLI renters, which was enough to provide affordable housing to every renter under ideally perfect allocation.

Table 5. Affordable Housing Gap by Income Category, 2000-2009

	Affordable Rental Units per 100 Renters			
	2000		2009	
	0–30% of AMI	30–50% of AMI	0–30% of AMI	30–50% of AMI
Baltimore	90.0	229.0	64.8	161.7
Boston	81.7	176.5	67.7	118.3
Chicago	68.6	228.4	43.9	159.1
LA	31.4	59.1	30.3	69.1
New York	59.2	139.0	52.7	111.1
Total	58.1	138.2	47.5	108.6

Table 6 presents the share of rental units with rents below the FMR. Compared with trends in affordable housing for ELI and VLI renters, affordable housing options in the Housing Choice Voucher program improved during the 2000 and 2009 period. Because MTO metropolitan areas are large in size, there are several FMR areas that are designated. FMRs in these metropolitan areas are more likely to reflect local market conditions and offer housing

voucher households more housing options. While McClure et al. (2015) showed that the nationwide share of units with the rent below the applicable FMR was 18 percent of all housing in 2010, all MTO metropolitan areas show more than 50 percent of housing affordable to voucher holders. During this period, all areas except for Chicago saw an increase in the ratio of the number of housing voucher households to the total number of renters. The size of the HCV program is relatively small compared to the number of renters in the private market, so the affordable housing gap is seldom found in the program.

Table 6. Rental Units with the Rent below the Fair Market Rent, 2000-2009

	2000		2009	
	Share of rental units with the rent below the FMR	Share of housing voucher households	Share of rental units with the rent below the FMR	Share of housing voucher households
BAL	46.3%	4.2%	55.0%	8.9%
BOS	60.3%	5.3%	51.6%	6.6%
CHI	61.6%	4.1%	53.7%	2.8%
LA	52.3%	3.9%	63.5%	5.4%
NY	69.1%	4.2%	61.6%	7.0%

3.3.2. Spatial Distribution of Affordable Housing

The results in Section 3.3.1 show that affordable housing gaps exist in MTO metropolitan areas particularly for ELI renters, yet they can be concentrated in certain geographic areas. The spatial distribution of affordable housing is also affected by neighborhood attributes. Using poverty rate as a target neighborhood characteristic of the analysis, Table 7 shows trends in the affordable housing gap by income group and by census tract poverty rate between 2000 and 2009. Consistent with Table 5, the affordable housing gap has exacerbated in all neighborhoods with the exception of Los Angeles metropolitan area. In Los Angeles, the supply of housing affordable to VLI renters somewhat improved from 2000 to 2009, although it still remained the lowest. With the exception of Los Angeles and low-poverty

areas in New York, more than 100 affordable units existed per 100 VLI renters in all neighborhoods. The difference in the ratio of affordable units between low-, moderate-, and high-poverty neighborhoods showed different results. Deficiencies in the affordable stock to ELI renters were more severe in moderate-poverty neighborhoods than low-poverty neighborhoods. The decrease in the shortage was substantial, especially in Baltimore, Boston, and Chicago. The supply of affordable housing stock for ELI renters in these neighborhoods decreased by about 16 units per 100 renters.

Table 7. Affordable Housing Gap by Income Category and Tract Poverty Rate, 2000-2009

		Affordable Rental Units per 100 Renters			
		2000		2009	
		0-30% of AMI	30-50% of AMI	0-30% of AMI	30-50% of AMI
BAL	Poverty rate \leq 10%	93.8	197.2	69.2	126.1
	11% \leq 20%	67.3	267.5	52.5	189.1
	Poverty rate > 20%	99.9	226.8	69.9	188.3
BOS	Poverty rate \leq 10%	88.1	175.4	77.7	111.7
	11% \leq 20%	75.9	186.6	59.2	121.6
	Poverty rate > 20%	76.0	165.5	65.4	125.7
CHI	Poverty rate \leq 10%	63.4	177.6	53.6	113.2
	11% \leq 20%	54.7	259.9	35.9	150.4
	Poverty rate > 20%	76.9	264.9	44.0	206.8
LA	Poverty rate \leq 10%	46.7	40.4	44.2	46.9
	11% \leq 20%	28.8	45.7	27.1	55.9
	Poverty rate > 20%	27.3	71.1	27.0	94.8
NY	Poverty rate \leq 10%	61.9	126.4	54.1	95.3
	11% \leq 20%	44.4	130.6	39.9	101.2
	Poverty rate > 20%	63.6	150.6	58.4	130.5

Table 8 shows the affordable-and-available ratios by tract poverty rate during the same sample period, which includes the criterion of availability in addition to affordability that considers whether higher income renters currently occupy affordable units. Availability

poses an important additional constraint on renters seeking affordable units. Rental markets are constrained for ELI renters across the five metropolitan areas despite substantial variation in the availability of affordable rental units. In Chicago, Los Angeles, and New York, less than 25 percent of ELI renters could actually find an affordable and available unit in low-poverty neighborhoods between 2000 and 2009. The paucity of affordable and available units was worsened by the occupancy of a considerable proportion of the most affordable housing stock by renters who could afford to spend more. Subtracting numbers in Table 8 from numbers in Table 7, I find that higher income families occupied more than 20 units affordable to every 100 ELI renters in low-poverty neighborhoods in 2009.

Table 8. Affordable and Available Housing Gap by Income Category and Tract Poverty Rate, 2000-2009

		Affordable and Available Rental Units per 100 Renters			
		2000		2009	
		0-30% of AMI	30-50% of AMI	0-30% of AMI	30-50% of AMI
BAL	Poverty rate \leq 10%	27.7	64.0	29.1	54.9
	11% \leq 20%	34.2	114.9	33.3	90.4
	Poverty rate $>$ 20%	55.9	128.6	46.8	106.9
BOS	Poverty rate \leq 10%	45.7	63.3	44.7	46.1
	11% \leq 20%	45.1	80.9	41.4	60.4
	Poverty rate $>$ 20%	51.5	89.3	50.8	75.5
CHI	Poverty rate \leq 10%	24.7	61.9	22.8	45.9
	11% \leq 20%	24.7	113.4	18.8	70.2
	Poverty rate $>$ 20%	45.0	143.5	30.5	115.6
LA	Poverty rate \leq 10%	15.1	16.8	20.6	23.5
	11% \leq 20%	13.6	23.4	15.3	33.1
	Poverty rate $>$ 20%	15.7	42.6	19.0	65.4
NY	Poverty rate \leq 10%	24.9	49.5	23.9	42.5
	11% \leq 20%	22.3	60.3	23.8	51.3
	Poverty rate $>$ 20%	37.9	78.9	40.7	71.5

Table 9 displays the difference in affordable housing for housing voucher households between low-, moderate-, and high-poverty neighborhoods. Although housing affordability improved from 2000 and 2009, low-poverty neighborhoods had the least affordable housing stock for voucher holders. While Baltimore and Los Angeles had less than 27 percent of rental units with the rent below the FMR in 2000, all metropolitan areas displayed a comparable share of affordable housing units, 42 to 56 percent, in low-poverty neighborhoods in 2009. Boston showed the highest affordability in these neighborhoods. Also, in 2009, more than 30 percent of the difference in share of affordable housing between low- and high-poverty neighborhoods was observed in Baltimore, Los Angeles, and New York.

Table 9. Rental Units with the Rent below the Fair Market Rent and Tract Poverty Rate, 2000-2009

	Share of Rental Units with the Rent below the FMR					
	2000			2009		
	Poverty rate ≤ 10%	11% ≤ 20%	Poverty rate > 20%	Poverty rate ≤ 10%	11% ≤ 20%	Poverty rate > 20%
BAL	26.6%	52.0%	73.8%	41.7%	63.6%	72.4%
BOS	55.3%	63.2%	69.5%	46.2%	51.6%	62.2%
CHI	45.4%	69.3%	81.7%	47.7%	53.2%	60.7%
LA	26.2%	47.6%	73.9%	46.4%	63.6%	80.9%
NY	49.3%	68.3%	86.2%	44.4%	60.9%	78.7%

Table 10 presents the share of affordable units for housing voucher households if the definition of the FMR is changed to Small Area FMR. Compared with the share of rental units with the rent below the FMR (Table 6), Housing voucher households in all of the MTO metropolitan area would have rented more units under Small Area FMRs than under the current FMR. Los Angeles shows an 11 percentage point incline of the share of affordable housing with the zip code-based payment standards (74.6 percent under Small Area FMRs and 63.5 percent under the current FMR). Compared to Table 9, the share of affordable

housing across different neighborhoods would have been comparatively evened out, as the gain in units in high-rent zip codes cancels out a loss in units in the low-rent and moderate-rent zip codes. Notably, the share of affordable housing would have increased by more than 13 percentage points in low-poverty neighborhoods in Baltimore, Los Angeles, and New York under the applicable Small Area FMR. While the share remains constant in high-poverty neighborhoods, the new rule would have also added more affordable housing options in moderate-poverty neighborhoods.

Table 10. Rental Units with the Rent below the Hypothetical Small Area Fair Market Rent and Tract Poverty Rate, 2009

2009	Share of Rental Units with the Rent below the SAFMR			
	Total Metropolitan Area	Poverty rate $\leq 10\%$	$11\% \leq 20\%$	Poverty rate $> 20\%$
BAL	63.1%	54.7%	67.5%	74.9%
BOS	58.2%	55.8%	56.5%	65.2%
CHI	61.9%	50.5%	63.1%	73.4%
LA	74.6%	68.2%	73.3%	82.7%
NYC	70.5%	59.6%	69.5%	81.9%

3.3.3. Segregation of Affordable Housing

The previous section shows that affordable housing gaps are more severe in low- and moderate-poverty neighborhoods and that rental units affordable to housing voucher households are also more prevalent in high-poverty neighborhoods. I now turn to the measurement of segregation of affordability housing to address whether affordable units are evenly distributed across different neighborhoods in the metropolitan area. Table 11 displays results for Theil's H indices by different traits of rental units. I focus on the changes in inequality between 2000 and 2009. The segregation of housing affordable to both ELI renters and housing voucher households improved in Baltimore, Chicago, and Los Angeles. In the former two areas, the segregation of housing affordable to ELI renters showed greater

improvement than those for voucher households. In Baltimore and New York, compared with ELI renters, voucher households faced less segregated affordable housing options in 2000, but had more segregated affordable housing options within the metropolitan area in 2009. On the other hand, in Chicago and Los Angeles, the segregation of affordable housing for voucher households remained the greatest throughout the period. In 2009, Baltimore showed the highest H index for units with the rent below the FMR (0.22), while Boston showed the lowest (0.12). When hypothetical Small Area FMRs are implemented, the segregation of housing affordable to voucher households would considerably reduce by more than 30 percent on average, which becomes drastically lower than the segregation of housing affordable to ELI renters.

Table 11. Theil's Information Theory (H) index, 2000-2009

	Theil's Information Theory (H) Index		2009		
	2000 Units Affordable to ELI Renters	Units with the Rent below the FMR	Units Affordable to ELI Renters	Units with the Rent below the FMR	Units with the Rent below the SAFMR
BAL	0.27	0.26	0.21	0.22	0.14
BOS	0.13	0.12	0.14	0.12	0.09
CHI	0.21	0.22	0.12	0.15	0.10
LA	0.11	0.22	0.10	0.18	0.12
NY	0.21	0.17	0.17	0.19	0.12

Theil's H indices are decomposed into spatial, economic, and racial aspects. Table 12 presents decomposed Theil's H indices from a spatial aspect. During the 2000 and 2009 period, the segregation of affordable housing for voucher households declined in central cities while increasing in suburbs within Baltimore, Boston, and New York. In Chicago, ELI renters living in the central city faced more segregated affordable housing options than voucher households living in the central city, while voucher households living in the suburbs had more segregated affordable housing options than ELI renters living in suburbs. In

contrast, greater segregation of affordable housing was observed in the central city for voucher households and in the suburbs for ELI renters. In 2009, the central city in New York showed the highest H index for units with the rent below the FMR (0.23), while Boston showed the lowest (0.12). When hypothetical Small Area FMRs are implemented, the segregation of housing affordable to voucher households would reduce both in central city and suburbs, which becomes lower than the segregation of housing affordable to ELI renters.

Table 12. Decomposition of Theil's Information Theory (H) index, Spatial Aspect, 2000-2009

Decomposition of Theil's H index, Central City						
		2000		2009		
		Units Affordable to ELI Renters	Units with the Rent below the FMR	Units Affordable to ELI Renters	Units with the Rent below the FMR	Units with the Rent below the SAFMR
B A L	Cent City	0.20	0.11	0.19	0.11	0.10
	Suburbs	0.22	0.21	0.17	0.22	0.14
B O S	Cent City	0.14	0.13	0.16	0.12	0.08
	Suburbs	0.12	0.12	0.13	0.12	0.09
C H I	Cent City	0.22	0.17	0.14	0.14	0.08
	Suburbs	0.18	0.22	0.10	0.16	0.13
L A	Cent City	0.14	0.22	0.13	0.19	0.10
	Suburbs	0.09	0.20	0.07	0.17	0.13
N Y	Cent City	0.21	0.24	0.18	0.23	0.15
	Suburbs	0.21	0.14	0.17	0.16	0.11

The decomposition distinguishes between-group from within-group components of segregation for separate elements. Table 13 shows between-group segregation of affordable housing from a spatial aspect. With the exception of Baltimore, less than five percent of the segregation of affordable housing in terms of central city versus suburbs could be accounted for by between-group segregation, which indicates that at least 95 percent of the segregation

of affordable housing in terms of central city versus suburbs could be accounted for by within-group segregation. The average number of affordable housing units may vary from the central city to suburbs, and this alone implies between-group segregation. If the number of affordable housing units vary inside the central city and suburbs, respectively, this accounts for within-group segregation. In Baltimore, between-group segregation declined by ten percent in housing affordable to ELI renters and by 20 percent in housing affordable to voucher households. In 2009, 17 percent of the total segregation in units with the rent below the FMR was attributable to the difference in affordability levels between central city and suburbs, whereas between-group segregation accounted for eight percent of the segregation of affordable housing in the voucher program using the Small Area FMR.

Table 13. Decomposition of Theil's Information Theory (H) index, Spatial Aspect, Between-Group Inequality, 2000-2009

	Between-Group Inequality, Central City		2009		
	2000 Units Affordable to ELI Renters	Units with the Rent below the FMR	Units Affordable to ELI Renters	Units with the Rent below the FMR	Units with the Rent below the SAFMR
BAL	27.9%	36.7%	17.0%	16.8%	7.7%
BOS	1.0%	0.6%	0.7%	1.9%	0.3%
CHI	4.0%	11.9%	0.6%	3.1%	0.2%
LA	2.0%	5.1%	0.1%	0.9%	0.6%
NY	0.0%	6.4%	0.0%	3.9%	1.6%

Table 14 presents decomposed Theil's H indices by census tract poverty rate. During the 2000 and 2009 period, the segregation of affordable housing for voucher households increased in low-poverty neighborhoods in Baltimore, Boston, Los Angeles, and New York. The segregation of affordable housing for voucher households was more severe in low-poverty neighborhoods than high-poverty neighborhood in all MTO metropolitan areas throughout the same period. Similarly, in all MTO metropolitan areas in 2009, voucher

households living in low-poverty neighborhoods faced more segregation affordable housing options than ELI renters living in such neighborhoods, while ELI renters living in high-poverty neighborhoods had more segregated affordable housing options than voucher households living in these neighborhoods. Low-poverty neighborhoods in Baltimore showed the highest *H* index for the units with the rent below the FMR (0.23), while high-poverty neighborhoods in Chicago and Los Angeles showed the lowest (0.08). When hypothetical Small Area FMRs are implemented, the segregation of housing affordable to voucher households would reduce considerably in low-income neighborhoods, especially in Baltimore with a 40 percent decrease and in New York with a 31 percent decrease.

Table 14. Decomposition of Theil's Information Theory (*H*) index, Economic Aspect, 2000-2009

		Decomposition of Theil's H index, Poverty Rate					
		2000		2009			
		Units Affordable to ELI Renters	Units with the Rent below the FMR	Units Affordable to ELI Renters	Units with the Rent below the FMR	Units with the Rent below the SAFMR	
B	Pov ≤ 10%	0.22	0.19	0.16	0.23	0.14	
A	11 ≤ ≤ 20%	0.15	0.13	0.16	0.10	0.08	
L	Pov > 20%	0.17	0.11	0.18	0.11	0.09	
B	Pov ≤ 10%	0.11	0.12	0.12	0.13	0.10	
O	11 ≤ ≤ 20%	0.07	0.10	0.10	0.10	0.05	
S	Pov > 20%	0.14	0.11	0.15	0.12	0.07	
C	Pov ≤ 10%	0.14	0.20	0.07	0.18	0.13	
H	11 ≤ ≤ 20%	0.11	0.11	0.07	0.11	0.07	
I	Pov > 20%	0.17	0.08	0.16	0.08	0.07	
L	Pov ≤ 10%	0.08	0.15	0.06	0.17	0.18	
A	11 ≤ ≤ 20%	0.08	0.10	0.08	0.12	0.07	
	Pov > 20%	0.13	0.09	0.13	0.08	0.05	
N	Pov ≤ 10%	0.14	0.15	0.12	0.18	0.12	
Y	11 ≤ ≤ 20%	0.11	0.08	0.09	0.11	0.07	
	Pov > 20%	0.20	0.06	0.17	0.09	0.06	

Table 15 shows between-group segregation of affordable housing from an economic aspect. Between-group segregation of units with the rent below the FMR decreased between 2000 and 2009. While Los Angeles had a higher share of between-group segregation of units affordable to voucher households than units affordable to ELI renters, Boston showed the opposite; the share of between-group segregation over the total segregation of units affordable to ELI renters was higher than units affordable to voucher households. In New York, 31 percent of the total segregation of units with a rent below the FMR was attributable to the difference in affordability levels between low-, moderate-, and high-poverty neighborhoods. In all metropolitan areas except Boston, between-group segregation was less likely to account for the segregation of affordable housing in the voucher program when hypothetical Small Area FMRs are implemented.

Table 15. Decomposition of Theil's Information Theory (H) index, Economic Aspect, Between-Group Inequality, 2000-2009

	Between-Group Inequality, Poverty Rate		2009		
	2000 Units Affordable to ELI Renters	Units with the Rent below the FMR	Units Affordable to ELI Renters	Units with the Rent below the FMR	Units with the Rent below the SAFMR
BAL	38.9%	45.7%	23.4%	23.3%	15.4%
BOS	15.8%	7.6%	13.6%	3.4%	12.4%
CHI	36.6%	32.2%	16.7%	16.9%	8.2%
LA	5.8%	53.5%	6.4%	30.3%	9.3%
NY	24.1%	41.5%	25.7%	31.1%	22.4%

Table 16 presents decomposed Theil's H indices by census tract racial composition. During the 2000 and 2009 period, the segregation of affordable housing for voucher households declined in high-percentage-white neighborhoods while increasing in low-percentage-white neighborhoods in Baltimore, Boston, and Chicago. The segregation of

affordable housing for voucher households were more severe in high-percentage-white neighborhoods than low-percentage-white neighborhood in all MTO metropolitan areas except Baltimore. In all MTO metropolitan areas except Los Angeles, voucher households living in high-percentage-white neighborhoods faced more segregated affordable housing options than ELI renters living in such neighborhoods, while ELI renters living in low-percentage-white neighborhoods had more segregated affordable housing options than voucher households living in these neighborhoods. When hypothetical Small Area FMRs are implemented, the segregation of housing affordable to voucher households would considerably reduce in high-percentage-white neighborhoods, with the exception of Los Angeles where the segregation increased by 99 percent.

Table 16. Decomposition of Theil's Information Theory (*H*) index, Racial Aspect, Between-Group Inequality, 2000-2009

		Decomposition of Theil's H index, % White					
		2000		2009			
		Units Affordable to ELI Renters	Units with the Rent below the FMR	Units Affordable to ELI Renters	Units with the Rent below the FMR	Units with the Rent below the SAFMR	
B	Whi ≤ 50%	0.24	0.16	0.24	0.21	0.11	
A	51 ≤ ≤ 80%	0.27	0.23	0.17	0.21	0.13	
L	Whi > 80%	0.15	0.21	0.15	0.20	0.16	
B	Whi ≤ 50%	0.12	0.05	0.15	0.06	0.08	
O	51 ≤ ≤ 80%	0.13	0.10	0.13	0.12	0.08	
S	Whi > 80%	0.10	0.13	0.11	0.12	0.09	
C	Whi ≤ 50%	0.19	0.07	0.14	0.08	0.08	
H	51 ≤ ≤ 80%	0.18	0.19	0.11	0.17	0.11	
I	Whi > 80%	0.12	0.18	0.07	0.16	0.13	
L	Whi ≤ 50%	0.12	0.12	0.10	0.12	0.08	
A	51 ≤ ≤ 80%	0.09	0.16	0.05	0.15	0.16	
	Whi > 80%	0.08	0.15	0.12	0.13	0.25	
	Whi ≤ 50%	0.22	0.09	0.18	0.14	0.09	

N	51 ≤ ≤ 80%	0.11	0.12	0.11	0.16	0.11
Y	Whi > 80%	0.14	0.16	0.14	0.19	0.12

Table 17 shows between-group segregation of affordable housing from a racial aspect. Between-group segregation of both units affordable to ELI renters and units affordable to voucher households increased between 2000 and 2009. In 2009, less than ten percent of the total segregation of housing affordable to ELI renters was attributable to the between-group difference, whereas more than 20 percent was explained by between-group segregation in certain metropolitan areas such as Los Angeles and New York. In all metropolitan areas except New York, between-group segregation of affordable housing for voucher households tends to decrease comparable to between-group inequality in affordable housing for ELI renters, if hypothetical Small Area FMRs are implemented.

Table 17. Decomposition of Theil's Information Theory (*H*) index, Racial Aspect, Between-Group Inequality, 2000-2009

	Between-Group Inequality, % White		2009		
	2000 Units Affordable to ELI Renters	Units with the Rent below the FMR	Units Affordable to ELI Renters	Units with the Rent below the FMR	Units with the Rent below the SAFMR
BAL	22.0%	25.7%	5.4%	7.9%	6.8%
BOS	12.5%	9.5%	8.5%	8.1%	6.0%
CHI	25.3%	33.7%	6.7%	18.4%	4.9%
LA	3.7%	42.1%	2.3%	32.6%	4.2%
NYC	13.7%	31.9%	9.2%	20.4%	15.0%

3.4. Discussion

During the 2000 and 2009 period, the supply of rental units affordable to low-income renters drastically decreased, while the number of low-income renters increased. The rental housing stock affordable to extremely low-income (ELI) and very low-income (VLI) renters became more constrained during this period. This finding is consistent with previous studies of

declining affordable housing stock since 2000. Relatively few rental units are affordable, and even fewer are available to renters with the lowest incomes, particularly in low-poverty neighborhoods. The supply of rental units that are affordable to extremely low-income households remains substantially inadequate, and this shortage is worsened by the natural preference of higher income renters for more affordable units. Among five MTO metropolitan areas, the most severe case of affordable housing gap was Los Angeles, while the least severe case was Boston.

Given the scarcity of affordable and available units for the poorest renters, housing vouchers continues to be an important policy option for addressing the growing problem of unmet needs with the existing housing stock. With regard to housing vouchers, MTO metropolitan areas consist of more than one Fair Market Rent (FMR) area, which allows voucher households to have more housing options across the metropolitan area relative to other areas with a single FMR. However, being consistent with the literature, my findings suggest that housing options for voucher households are relatively concentrated in moderate- and high-poverty neighborhoods, because FMRs were not high enough to include expensive rental units in low-poverty neighborhoods.

Affordable housing for housing voucher households was as segregated as affordable housing for ELI renters, or even worse in some metropolitan areas. Interestingly, the segregation of FMR exacerbated in low-poverty neighborhoods and high-percentage-white neighborhoods, while the segregation reduced in central cities. This result implies not only that FMRs were not effective in taking into account local rental market conditions to provide more housing options to voucher recipients whose income is comparable to ELI renters, but also that rental units with the rent below the applicable FMR are likely to cluster in certain low-poverty neighborhoods and high-percentage-white neighborhoods rather than being evenly distributed across these neighborhoods. Since the FMR is limited in its consideration

in terms of local market conditions, expansion of housing options through vouchers might be concentrated in certain areas, which results in greater segregation in affordable housing for voucher households. However, my findings on Small Area FMRs show that the zip code-based payment standard would greatly reduce the segregation of affordable housing and provide voucher recipients with more evenly distributed affordable units across the metropolitan area.

Regarding the importance of metropolitan rental markets, several findings are noteworthy. Los Angeles's severe shortage of affordable housing has particularly affected low-income renters negatively. While both supply and demand have increased, the affordable housing gap for ELI and VLI renters was the most severe. The affordable housing gap is also severe in Chicago and New York. Less than 55 affordable units exist for every 100 ELI renters in 2009. Housing vouchers would help these households to increase the set of affordable housing options, although mostly in high-poverty neighborhoods. These large markets have had steady or rising demand during the housing boom and bust, and have experienced consistent rising rents over time (Ellen and Karfunkel 2016). Regulatory constraints in building multifamily properties and limited developable land tend to hinder rental housing stock growth and contribute to rising rents. Boston and Baltimore also showed some levels of housing unaffordability to low-income households, but comparably less so than other metropolitan areas.

Chapter 4: Social Networks and Residential Mobility

This chapter analyzes the impact of social networks on residential mobility. Despite extensive evidence on the link between low-income households' strong social ties and residential mobility, there is a paucity of work that investigates whether households tend to live closer to relatives and friends for companionship or emotional support, or for essential practical help such as childcare or a ride to work. If households stay close by their social networks for costly services and are bound to their original neighborhoods, providing more access to social services might lead them to move to high-opportunity neighborhoods. I explore the pattern of neighborhood mobility in terms of the probability of moving back to a baseline neighborhood by MTO treatment groups and by race and ethnicity, and estimate logit models to examine how kinship/friendship and social resources in the place that households left behind influence subsequent mobility behaviors, particularly a move towards the baseline neighborhood.

4.1. Background

4.1.1. The Role of Social Networks in Residential Mobility

Residential mobility is generally viewed as a way to bridge the gap between one's desired housing bundle and the actual housing bundle they consume. When current living arrangements become non-optimal, households make a decision to move. Adjustment costs and other losses of moving sometimes deter mobility despite such disequilibrium. The decision of whether to move can be seen as weighing satisfaction with current housing relative to the anticipated satisfaction with alternatives (Speare 1970, Speare 1974). Changes in the relative attractiveness of alternative locations act as push and pull factors that motivate households to adjust their housing consumption and restore equilibrium. A combination of

push and pull factors determines if, when, and where a household moves, and are subject to various constraints on or barriers to mobility. Residential mobility is also viewed from a life-course perspective in that life events such as marriage or divorce; birth of children; children leaving home or attending college; change of employer, income, or assets; and retirement are potential causes of mobility (Clark 2005, Clark and Withers 1999).

Households may feel attracted to other housing units or neighborhoods for a variety of reasons including housing quality, physical environments, and school quality, which often work as pull factors to consider relocation. Issues such as aging units, neighborhood safety, and crime, on the other hand, force households to move. At the same time, households are reluctant to move because of their attachment to their current residence and relationships that would be disrupted by the move. In the literature, scholars have focused on differentiating triggers of residential mobility. Coulton et al (2012) anticipated that some households may make positive moves to better housing or neighborhoods, while some may move due to changes in family composition or economic insecurity. Furthermore, some households that stayed may be satisfied with their house and neighborhood, but others may be dissatisfied but unable to move due to barriers.

People often make mobility decisions within the context of social relations. Granovetter (1973), an influential study on the value of far-flung acquaintanceships, emphasizes the strength of weak ties that tend to link members of different social groups. In the neighborhood context, socialization is one of the primary function of a neighborhood (Hunter 1974). Weak ties among neighbors centered on the residential neighborhood can be effective and useful in accomplishing shared goals such as keeping the streets safe or keeping an eye on local children (Sampson 1999, Sampson et al. 1997). Such intra-neighborhood social networks are based on informal channels of trust and repeated local social interaction,

therefore difficult to replicate in new surroundings because of its ties to the neighborhood (DaVanzo 1981).

In general, social networks uniquely shape the informational context of decision making that affects the perception of neighborhoods. Galster and Killen (1995) conceptualized the role of local social networks in the geography of opportunity that filters information and guides individuals to form subjective perceptions of elements of the opportunity structure such as education, labor market, and social welfare. The resources provided through these networks can be described as a form of ‘location-specific social capital’ which may enable families to depend on their networks regarding in-kind services or job searches (Briggs 1998, Granovetter 1995). Kinship and friendship available within neighborhoods are more likely accessible to families seeking social networks. In particular, there is strong evidence that the social ties of blacks tend to be very kin-centered and more local than those of Whites, and there is some evidence of the same pattern among Hispanics (Fischer 1982, Menjivar 1995, Oliver 1988).

Social ties for low-income families are particularly distinctive. On average, the poor’s social ties are not only more localized, but also more drained than those of middle- and upper-income people (Fischer 1982, Kadushin and Jones 1992). In contrast to the strength of weak ties suggested by Granovetter (1973), Briggs et al. (2010) referred to social networks of low-income households as the “weakness of strong ties”, based on Stack (1974)’s findings on a dysfunctional “culture of poverty” among the persistently poor. Strong social ties may provide emotional and practical support, but they typically come with enormous obligations as well. Stack (1974) argued that the survival of poor families demands the sacrifice of upward mobility and neighborhood mobility, and obligations to kin can be draining because of some needy members of the extended family that place burdens on household resources.

This evidence suggests that staying close to kinship or friendship is central to the lives of many poor families for positive, negative, and mixed reasons.

Results of previous studies on the link between social networks and residential mobility vary depending on different aspects of social ties. The presence of relatives or friends is an important factor when mobility intentions are deterred (Speare 1974, Myers 2000, Oh 2003). Similar results are found in Landale and Guest (1985) in that no friends in the neighborhood is positively associated with the decision to move. On the other hand, Connerly (1986) provided counterintuitive findings: neighborhood-level social ties do not inhibit mobility despite its little impact, compared to magnitudes of other measures such as age, tenure, and perceived housing and neighborhood quality. Although results are somewhat mixed, most studies support the importance of social networks regarding residential location choices.

4.1.2. Mobility Outcomes of Housing Voucher Recipients

Frequent mobility of low-income households can sometimes be viewed as a sign of housing instability and insecurity because of problems with landlords, creditors, or housing conditions. In a study of the housing careers of low-income families, participants described a high proportion of moves as being forced moves (Skobba 2008). Renters with children may also be frequent movers whose moves are a response to financial stress or problems in their rental housing arrangements (Coulton et al. 2012). Such involuntary moves bring concern that low-income households' moves resulted from unstable housing arrangements may have negative consequences. For example, regular moving during childhood weakens educational attainment (Wood et al. 1993). Similarly, in many cases staying in the existing neighborhood may reflect that a family lacks the resources to move to better housing or to a desirable neighborhood, whereas it usually reflects a family's security, satisfaction, and stability with

its home and neighborhood surroundings. In several studies regarding historical trends of residential mobility in urban poverty areas, minority households with lower-income tend to remain in high-poverty neighborhoods regardless of mobility intentions (Gramlich et al. 1992, South et al. 2005). Race often functions as structural barriers in residential mobility. Blacks are more likely to regularly use social resources thus resistant to relocate than any other ethnic group (Spilimbergo and Ubeda 2004, Krysan 2008).

On the other hand, the mobility of low-income households that receive housing assistance has been mainly deterred by strong social ties. Several studies regarding housing vouchers explains mobility patterns focusing on social networks. Varady and Walker (2000) reported that more than half of the residents vouchered out of HUD projects in four cities had very weak attachments to their new neighborhoods and reported that they would like to move again soon. Varady and Walker (2007) found that major factors determining location choices of housing voucher holders are proximity to friends and relatives and the availability of public transportation. Among “leased-up” voucher recipients, those who moved close proximity to their old neighborhoods were more satisfied, maintaining local ties with friends and relatives (Varady et al. 2001). These studies suggest that the possibility of maintaining the existing social connections may play a key role in considering a move, relocating, and improving housing and neighborhood satisfaction for voucher households, unless they completely replace the old social ties with new ones in the following neighborhood.

The poverty-dispersal housing program such as the Moving to Opportunity (MTO) demonstration expected participants to relocate to quality neighborhoods and form relationships with their higher-income neighbors, thus building the bridging social networks that leverage information used to access employment and other resources to improve one’s financial self-sufficiency (Curley 2009). However, Cove et al. (2008) found that a few MTO movers converted their new housing locations into valuable new social capital while many

formed limited relationships with their new neighbors, reducing the potential positive effect of relocation on the development of more useful job networks. Rather, some MTO movers lost access to useful social resources as a result of their moves to low-poverty neighborhoods.

Findings come from the MTO experiment show that social networks persisted at the core of most participants' lives regardless of relocation, and influenced how they structured their daily lives. The MTO Interim Evaluation (Orr et al. 2003) found that a few of MTO participants who moved to low-poverty neighborhoods reported having ties to more educated, higher income people living nearby, while many reported regular contact with the poor neighborhoods they had supposedly left behind. Briggs et al. (2010) identified the major types of neighborhood mobility and social relations, focusing on those in the experimental group who relocated to a low-poverty neighborhood. The most common pattern is that households moved to neighborhoods where relatives (kin) lived that played a central role in daily life, providing companionship and vital practical supports such as childcare. Some households were transplanted into a new neighborhood while weakening social ties to the place behind. Some households moved to a new neighborhood by putting distance between themselves and their constantly needy relatives or friends. The other very uncommon type of households chose to be socially isolated after relocation. Although these patterns well explain the link between social networks and neighborhood mobility, little attention was paid to how kinship/friendship and social resources have different impacts on low-income households' mobility towards their initial neighborhoods.

Access to social resources might play an important role in the residential mobility of low-income families. Although localized, kin-centered social networks can be often draining to the poor with obligations, at the same time social ties benefit low-income families in terms of pooling resources to share costs of social services, which may take excessive time to re-establish new usable social networks. Dawkins (2006) found that compared with high-income

families, the effect of social connections on residential mobility is relatively more ‘binding’ among low-income families due to their dependence on informal social networks for the provision of social services. A qualitative study of the housing careers of very low-income families by Skobba and Goetz (2013) also found that forced relocation out of the existing neighborhood and into high-opportunity neighborhoods is insensitive to social resources that are necessary to maintain a daily life. Nevertheless, the provision of social services has been overlooked in policy discussions that link social resources to residential mobility. If households have access to social services in a neighborhood, they may not need to close proximity to social ties for costly services. No studies have examined the joint effects of social resources and access to neighborhood-level social services on the pattern of residential mobility of low-income households receiving housing assistance.

4.2. Residential Mobility Models

4.2.1. Descriptive Metrics of Neighborhood Mobility

To address the propensity for moving back to the baseline neighborhood, I explore various descriptive metrics of neighborhood mobility with regard to the baseline neighborhood. The baseline neighborhood refers to the neighborhood in which MTO households lived upon participation to the demonstration. Drawing upon data from the MTO spell database and Census TIGER shapefiles, I track all participants in the baseline survey from random assignment until they exit from the program or until the final survey was conducted. The MTO data includes a residential spell file that identifies the duration of time (in days) that households reside in different residential locations. I focus on whether MTO participants leave their baseline neighborhoods, and whether they come back to their baseline neighborhoods or closer proximity to such neighborhoods-once they left. For those who left the baseline neighborhood, I categorize their residential mobility into three patterns: (1) the

household moved elsewhere and re-entered the baseline neighborhood, (2) the household moved to one of adjacent the neighborhoods that surround the baseline neighborhood, and (3) the household moved to a neighborhood other than the baseline neighborhood or its nearby neighborhoods. Each pattern is repeatedly grouped into whether the household stayed in or exited from the current neighborhood. All neighborhoods are defined in terms of census tracts, and all segments are presented as percentages of the total sample size. I also identify the median duration of time in days that households reside in different residential locations.

The metrics of neighborhood mobility are separately examined by MTO treatment group and race/ethnicity. The MTO treatment involves random assignment to different groups which receive different types of housing subsidies and different geographic requirements for the use of the subsidy. Previous studies found that a certain degree of racial difference exists regarding the link between the use of social networks and the frequency of residential relocation (Spilimbergo and Ubeda 2004, Krysan 2008). In this sense, I compare the influences of these policy impacts on neighborhood mobility over time relative to race and ethnicity.

4.2.2. Logit Models

Previous studies extensively use logistic regressions to examine the link between social networks and mobility decisions. I employ logit models to describe residential mobility of Moving to Opportunity (MTO) households after their initial random assignment, in particular for the first two moves. One dependent variable is an indicator of the first move, which equals to one if the household moved from the first residence at the time of the baseline survey. The other dependent variable addresses the second move, which equals to one if the household moved from the second residence. The universe of this variable is those who moved once prior to current relocation, excluding those who remained in their first residence

and those relocated within the baseline neighborhood. Since the purpose of the second move analysis is to explore the impact of initial social networks on mobility towards an initial neighborhood, I also excluded households who made the second move after spending more than three years in a second neighborhood. I assume that the longer duration of residency implies stable settlement in a place other than the baseline neighborhood.

Relying on this variable specification, I also employ multinomial logit regressions to examine the propensity for mobility of moving back to the baseline neighborhood over the propensity for mobility of moving far away for the baseline neighborhood. Since deciding whether to move or stay and deciding where to move are two distinctive behaviors, I conduct separate analyses that explore multiple alternatives in terms of mobility decisions.

Establishment of the dependent variable is drawn from mobility patterns, defined in mobility distance categories in a descriptive analysis of neighborhood mobility. Two models with respect to the first move and second move are estimated respectively. For the first move model, the dependent variable is defined by the distance to the initial neighborhood: (1) the household moved within the baseline neighborhood, (2) the household moved to one of the adjacent neighborhoods that surround the baseline neighborhood, and (3) the household moved to a neighborhood other than the baseline neighborhood or its nearby neighborhoods.

For the second move model, the dependent variable is determined similarly: (1) the household moved back to the baseline neighborhood, (2) the household moved to one of the adjacent neighborhoods that surround the baseline neighborhood, and (3) the household moved to a neighborhood other than the baseline neighborhood or its nearby neighborhoods.

Alternatives in these models do not depend on each other and do not act as substitutes, which hold the Independence of Irrelevant Alternatives (IIA) and enable regressions to produce valid estimators.

The estimation of each dependent variable is a function of (1) MTO treatment effects, (2) metropolitan controls, (3) household characteristics, (4) neighborhood characteristics, and (5) measures of social networks that decompose into kinship/friendship and social resources.

The logit regression models can be specified as follows:

$$P(Y_{t=1}) = \frac{e^{\alpha + X_{t=1}\beta + Z\gamma}}{1 + e^{\alpha + X_{t=1}\beta + Z\gamma}}$$

$$P(Y_{t=2}) = \frac{e^{\alpha + X_{t=1}\beta + X_{t=2}\delta + Z\gamma}}{1 + e^{\alpha + X_{t=1}\beta + X_{t=2}\delta + Z\gamma}}$$

where P is the probability of Y occurring, e is the natural logarithm base, X is a vector of social networks variables, and Z is a vector of household and neighborhood-level determinants of residential mobility. Dependent variable $Y_{t=1}$ is whether one moved from the first residence, and $Y_{t=2}$ is whether one moved from the second residence. In light of the dynamic effects of social networks, the duration of residency in the second neighborhood ($X_{t=2}$) is included in the logit model regarding the second move ($Y_{t=2}$), while social networks variables in the first neighborhood ($X_{t=1}$) are also included to distinguish the effects of new social ties following relocation from previous social ties prior to mobility. Since social networks information is not available for the household's subsequent residential locations, the duration of time in days until a household moves to another neighborhood is included as an indirect proxy of social networks to tease out the effect of lagged measures of social networks as a pull factor on their second move. Similarly, the multinomial logit regression models can be specified as follows:

$$P(Y_{t=1}) = \frac{e^{\alpha + X_{t=1}\beta + Z\gamma}}{1 + e^{\alpha + X_{t=1}\beta + Z\gamma}}$$

$$P(Y_{t=2}) = \frac{e^{\alpha + X_{t=1}\beta + X_{t=2}\delta + Z\gamma}}{1 + e^{\alpha + X_{t=1}\beta + X_{t=2}\delta + Z\gamma}}$$

where P is the probability of Y occurring, e is the natural logarithm base, X is a vector of social networks variables, and Z is a vector of household and neighborhood-level determinants of residential mobility.

All variables employed in the analysis are described in detail in Table 18.

Table 18. Variable Descriptions for the Logit and Multinomial Logit Regression Analyses

Variable	Definition
Dependent variables	
First move	1=moved from the first residence
Within baseline neighborhood	1=moved within the baseline neighborhood
Adjacent neighborhood	1=moved to an adjacent neighborhood to the baseline neighborhood
Another neighborhood	1=moved to another neighborhood
Second move	1=moved from the second residence
Baseline neighborhood	1=moved back to a baseline neighborhood
Adjacent neighborhood	1=moved to an adjacent neighborhood to the baseline neighborhood
Another neighborhood	1=moved to another neighborhood
Independent variables	
Treatment effects	
Experimental group	1=Experiment group
Section 8 group	1=Section 8 group
Metro controls	
Baltimore	1=lived in Baltimore
Boston	1=lived in Boston
Los Angeles	1=lived in Los Angeles
New York	1=lived in New York
Household characteristics	
Vehicle access	1=the household owned a car, van, or truck that runs
Income	household income
# children in HH	# children in the household
Age of HH head	age of the household head
HH head Black	1=household head is Black

HH head Hispanic	1=household head is Hispanic
HH head female	1=household head is female
HH head married	1=household head is married
HH head has high school degree	1=household head has high school degree or GED
HH head employed	1=household head is employed
Census tract characteristics	
Poverty rate	Poverty rate
% White	% Non-Hispanic White population
Distance to central city	Distance to central city (miles)
% Housing affordable to housing voucher HHs	% Rental units with the rent below the FMR
Social services density	# jobs in NAICS sector 62 (Health Care and Social Assistance) divided by area
Social networks	
Friends in a baseline neighborhood	1=HH has friend(s) living in the same neighborhood
Family members in a baseline neighborhood	1=HH has family member(s) living in the same neighborhood
Social resources in a baseline neighborhood	Standardized score based on item-response model estimation of social resources
Duration of residency (2nd move model only)	Length of stay in residence prior to move

All household-level data comes from the MTO baseline survey. Experimental and Section 8 groups are included to compare the influences of these policy groups on mobility behavior relative to a household's level of social networks. An indicator of the household's metro location is also included, with Chicago omitted as the reference category. Household characteristics include vehicle access, income, and the number of children in the household. The measure of vehicle access is equal to one if anyone in the household owned a car, van, or truck that runs. Characteristics of the household head include age, race and ethnicity, gender, marital status, education, and employment status. I also include measures of neighborhood-level affordable housing, poverty rate, racial composition, and distance to central city from the 2000 Census, along with social service density from 2002 Census Longitudinal

Employer-Household Dynamics (LEHD) to capture observable neighborhood characteristics that are associated with social networks and mobility behavior.

I consider two dimensions of social networks that consist of kinship/friendship and social resources. In empirical studies of residential mobility, various measures of neighborhood-level social networks have been employed. In early studies, duration of residency is included as an indirect proxy of social networks, assuming that time allows residents to develop meaningful social relationships (Lansing and Mueller 1967, Speare 1970). Several studies employed direct measures of social networks in the format of presence of relatives and friends (Myers 2000), number or percentage of relatives and friends (Landale and Guest 1985), and frequency of neighbors' visit (Connerly 1986). The presence of friends and family members is a popular measurement of kinship/friendship, which assumes that strong social ties exist when living in the same neighborhood with friends and family members. On the other hand, Dawkins (2006) employed measures of social resources as well as social networks. Social resources capture a different aspect of social networks. Provided that kinship/friendship represents the density of local social networks, social resources measure how such networks would actually benefit the household. Separating social resources from kinship/friendship enables estimation models to tease out the effect of dependence of social networks for the provision of costly services such as day-care, transportation, and recreation. If there is a significant effect of social resources on a probability of moving within or back to an initial neighborhood, policy could intervene in providing social services to low-income households so that they can move to quality neighborhoods.

Kinship and friendship is defined as the presence of family member(s) living in the same neighborhood and the presence of friend(s) living in the same neighborhood, respectively. To measure social resources, I compute a standardized score of social resources

estimated from the Item Response Theory (IRT) model. Social resources cannot be measured directly due to its unobservable characteristics, but can be quantified by a collection of question responses in the MTO survey that is designed to measure a household's level of the latent trait. In social networks research, for example, Sampson et al. (1997) measured social cohesion and informal social control that were represented by a range of conceptually related questions. Consistent with the literature, the social resources score is estimated by three questions. These questions were asked to obtain binary responses regarding whether a household borrows things from a neighbor, whether a household rides with neighbors or carpool, and whether a household receives childcare from a relative or neighbor. I used a simple one-parameter logistic model (1PL) and predicted the score based on the estimation result. The other benefit of using the IRT estimation is that any household responding to at least one question can provide data. The IRT model takes into account the number and difficulty of the questions to which each household responded, and estimates one parameter to measure a representative value for all households. Table 19 displays a description of the variables that were used in the IRT estimation of social resources. Those without observation in these variables obtained data of a predicted estimation score through the IRT model, which allowed my analyses to include 4,580 households with the social resources score that varies from zero to one. The higher the score, the more dependence on social networks for costly services such as childcare and transportation.

Table 19. Description of Social Resources Score

Variables to estimate social resources score	Obs	Mean	Std Dev	Min	Max
Borrow things from a neighbor	4,580	0.20	0.40	0	1
Ride or carpool when commute	1,224	0.03	0.18	0	1
Child care by a relative or neighbor	2,149	0.35	0.48	0	1

As briefly explained above, due to the data limitation of self-evaluated social networks in MTO participants' second neighborhoods, the second move model includes the duration of time in years until a household moves to a different residential location in addition to two dimensions of social networks. The duration of residency is deemed to be an indirect proxy of social networks, as suggested in the literature (Lansing and Mueller 1967, Speare 1970).

4.3. Results

4.3.1. The Pattern of Neighborhood Mobility

I begin with a descriptive analysis of the dynamics of neighborhood mobility, comparing the differences in mobility patterns between MTO treatment groups and between race and ethnicity. This analysis shows the extent to which MTO participants are bound to their initial neighborhoods. The results are shown in Table 20.

Table 20. Descriptive Analysis of Neighborhood Mobility, MTO Participants

	Treatment Group				Race/Ethnicity			
	Total HHs	Exp	Sec8	Cont	White (Non-Hispanic)	Black (Non-Hispanic)	Other (Non-Hispanic)	Hispanic
Sample Size	4,594	1,812	1,348	1,434	119	2844	189	1439
Percentage who have consistently stayed in a baseline neighborhood	15.2%	11.6%	13.3%	21.4%	20.2%	10.8%	21.2%	22.5%
Percentage who have never moved	11.6%	9.4%	9.9%	16.0%	11.8%	8.5%	13.8%	17.3%
Percentage who have moved within the baseline neighborhood	3.6%	2.2%	3.4%	5.4%	8.4%	2.3%	7.4%	5.2%
Percentage who left a baseline neighborhood	84.8%	88.4%	86.7%	78.6%	79.8%	89.2%	78.8%	77.5%
Percentage who re-entered the baseline neighborhood	7.1%	6.3%	6.9%	8.4%	5.9%	7.6%	8.5%	6.2%
Percentage who have stayed in the baseline neighborhood after re-entering	3.3%	2.7%	2.8%	4.5%	3.4%	3.0%	5.8%	3.6%
Percentage who re-exited the baseline neighborhood	3.8%	3.6%	4.1%	3.8%	2.5%	4.6%	2.6%	2.6%
Median duration in another neighborhoods before re-entering the baseline neighborhood (days)	1,126	1,088	896	1,389	1,014	1,126	1,067	1,159
Percentage who entered an adjacent neighborhood to the baseline neighborhood	8.2%	7.6%	7.8%	9.5%	14.3%	8.5%	5.3%	7.6%
Percentage who have stayed in an adjacent neighborhood to the baseline neighborhood	4.5%	4.5%	4.2%	5.0%	8.4%	4.5%	1.6%	4.8%
Percentage who exited and moved to a neighborhood far from the baseline neighborhood	3.7%	3.1%	3.6%	4.5%	5.9%	4.1%	3.7%	2.8%
Median duration in another neighborhoods before entering this neighborhood (days)	0	542	0	0	0	0	633	0
Percentage who moved to a neighborhood far from the baseline neighborhood	69.2%	74.2%	72.0%	60.3%	58.8%	72.8%	64.6%	63.5%
Percentage who have stayed within the metropolitan area	56.7%	61.5%	58.7%	49.0%	46.2%	61.8%	54.5%	47.8%
Percentage who moved out from the metropolitan area	12.5%	12.7%	13.3%	11.3%	12.6%	11.0%	10.1%	15.7%

About 22 percent of the total MTO baseline sample has consistently stayed in a baseline neighborhood (15 percent), or re-entered a baseline neighborhood after the initial move out (seven percent). About 15 percent of the total sample has consistently stayed in the baseline neighborhood, while 12 percent has never moved and 4 percent has moved only within the baseline neighborhood. The majority of those who left the baseline neighborhood moved to a neighborhood far from the baseline neighborhood. About 15 percent of the total sample moved to a neighborhood nearby the baseline neighborhood, or re-entered the baseline neighborhood. For those who moved to one of the adjacent neighborhoods that surround the baseline neighborhood, the median duration in another neighborhood before entering the current one is zero, which implies that at least a half of such households made their first move from the baseline neighborhood to an adjacent neighborhood to the baseline neighborhood. The median household who re-entered the baseline neighborhoods spent 1,126 days (3.1 years) in another neighborhood(s) before re-entering.

About 18 percent of the experimental households have stayed in (12 percent) or re-entered (six percent) a baseline neighborhood, whereas 30 percent of the control households have stayed in or re-entered a baseline neighborhood. About 9 percent of the experimental households and 10 percent of Section 8 households have never moved, while 16 percent of the control households have never moved. The lowest share of households re-entered the baseline neighborhood within experimental households. The median duration in another neighborhood before entering an adjacent neighborhood to the baseline neighborhood was 542 days for experimental households, whereas Section 8 households and the control households showed zero.

Contrary to previous studies, non-Hispanic black households showed the lowest percentage of staying in or re-entering a baseline neighborhood (18 percent), compared with non-Hispanic white (26 percent), non-Hispanic others (30 percent), and Hispanic households

(29 percent). Almost 90 percent of black households left the baseline neighborhood, but only 16 percent of the black moved back to the baseline neighborhood or its adjacent neighborhoods. For white households, only 6 percent re-entered the baseline neighborhood, which is the lowest among race and ethnicity groups. However, 14 percent of the Whites moved to one of the adjacent neighborhoods that surround the baseline neighborhood, which is highest among race and ethnicity groups.

4.3.2. Logistic Regression Results

Table 21 presents descriptive statistics for variables used in both logit and multinomial logit regressions. Note that in the second move model, MTO participants who stayed in the baseline neighborhood and who moved to a third neighborhood after spending more than three years in a second neighborhood are excluded. About eight percent of the sample moved within a baseline neighborhood with their first move, and about five percent of the sample moved back to the baseline neighborhood with their second move. The households were somewhat unevenly divided between the experimental group (39 percent), the Section 8 group (29 percent), and the control group (32 percent). MTO households were predominantly unmarried, non-working women with an average of between two and three children, an average income less than \$10,000, and without access to vehicle. About 63 percent of the householders were black, and 31 percent were Hispanic. Comparing the census tract characteristics between the first and second neighborhoods of MTO participants, I find that after the first move households are likely to live in neighborhoods with lower poverty rates, higher percentage-white population, longer distance to central city, less affordable housing options for housing voucher households, and a lower social services job density. At the time the baseline survey was conducted, about 60 percent of the total MTO participants had friends living in the same neighborhood, and about 36 percent of the households had family

members living in the same neighborhood. The average social resources score estimated from the Item Response Theory (IRT) model was 0.81, which implies that most MTO participants depend on social networks for social services. On average, the sample of the second move model spent nearly five years in the second neighborhood.

Table 21. Descriptive Statistics for Variables Used in the Logit and Multinomial Logit Regression Analyses, MTO Baseline Survey

Variable Description	Mean	Std Dev	Min	Max
Dependent Variable				
First Move				
Not Moved	0.12	0.32	0	1
Moved to				
Same Neighborhood	0.08	0.27	0	1
Adjacent Neighborhood	0.06	0.23	0	1
Another Neighborhood	0.75	0.43	0	1
Second Move				
Not Moved	0.41	0.49	0	1
Moved to				
Baseline Neighborhood	0.05	0.23	0	1
Adjacent to Baseline Neighborhood	0.02	0.16	0	1
Another Neighborhood	0.51	0.50	0	1
Independent Variable				
Treatment effects				
Experimental group	0.39	0.49	0	1
Section 8 group	0.29	0.46	0	1
Metro controls				
Baltimore	0.14	0.35	0	1
Boston	0.21	0.41	0	1
Los Angeles	0.22	0.42	0	1
New York	0.23	0.42	0	1
Household characteristics				
Vehicle Access	0.18	0.39	0	1
Income	9,292.49	5,501.66	2	133,333
Age of HH head	33.68	9.37	17	87
HH head Black	0.63	0.48	0	1
HH head Hispanic	0.31	0.46	0	1
HH head female	0.93	0.25	0	1
HH head married	0.11	0.32	0	1

# children in HH	2.86	1.64	0	15
HH head has high school degree	0.59	0.49	0	1
HH head employed	0.27	0.45	0	1
Neighborhood characteristics				
First Neighborhood				
Poverty rate	0.49	0.15	0	1
% White	0.10	0.21	0	1
Distance to central city (mile)	4.10	2.83	0	19
% Rental units with the rent below the FMR	0.89	0.15	0	1
Social services jobs per 100 persons	11.25	54.85	0	2,200
Second Neighborhood				
Poverty rate	0.27	0.15	0	1
% White	0.20	0.27	0	1
Distance to central city (mile)	6.87	5.59	0	55
% Rental units with the rent below the FMR	0.74	0.19	0	1
Social services jobs per 100 persons	6.96	33.47	0	564
Social Networks				
Friend(s) living in a baseline neighborhood	0.60	0.49	0	1
Family member(s) living in a baseline neighborhood	0.36	0.48	0	1
Social resources in a baseline neighborhood	0.81	0.18	0	1
Duration of residency in a second neighborhood	4.67	4.54	0	15

Table 22 displays descriptive statistics for the social networks variable by the dependent variable. Households that moved within or moved back to a baseline neighborhood are more likely to have friends and family members living in the baseline neighborhood than those that moved to an adjacent neighborhood to the baseline neighborhood and those that moved to another neighborhood. On average, those moved to one of the adjacent neighborhoods that surround the baseline neighborhood had a higher mean value in the presence of friends and family members than those that moved to another neighborhood. While those that moved or not moved in the sample of the first move model showed comparable social resources scores, those that moved back to the baseline neighborhood in the sample of the second move model showed the largest average social resources score.

Table 22. Descriptive Statistics for Social Networks Variables

Variable Description	Social Networks			Duration of Residency in Second Neighborhood
	Friends	Family Members	Social Resources	
First Move				
Not Moved	0.59	0.32	0.81	-
Moved to				
Same Neighborhood	0.65	0.40	0.81	-
Adjacent Neighborhood	0.61	0.39	0.83	-
Another Neighborhood	0.59	0.36	0.80	-
Second Move				
Not Moved	0.58	0.37	0.82	9.18
Moved to				
Baseline Neighborhood	0.73	0.51	0.82	1.44
Adjacent to Baseline Neighborhood	0.67	0.44	0.80	1.70
Another Neighborhood	0.59	0.36	0.79	1.62

Table 23 reports the logit coefficients from the first move and second move models. The goodness of fit for the first move model is somewhat low, but comparable with other studies of residential mobility (Dawkins 2006, Oh 2003). Given that many households stayed more than three years in a second neighborhood and excluded as first moved within a baseline neighborhood, the sample size for the second move model is smaller than the first move model. Despite the smaller sample size, the goodness of fit is much higher for the second move model.

Table 23. Logit Results of the First Move and Second Move Models

Variable	First Move, Coefficient	Second Move, Coefficient
Treatment Effects		
Experimental group	0.697***	0.961***
Section 8 group	0.884***	1.067***
Metro Controls		
Baltimore	-0.098	0.387
Boston	-1.189***	-1.309***

LA	-1.333***	-1.113**
NYC	-2.452***	-2.030***
Household Characteristics		
Vehicle Access	0.110	0.475
Income	-0.000	-0.000
Age of HH head	-0.050***	-0.032**
HH head Black	0.303	0.328
HH head Hispanic	0.159	0.471
HH head female	0.149	0.613
HH head married	0.252	0.610
# children in HH	0.031	0.068
HH head has high school degree	0.014	0.599**
HH head employed	-0.041	-0.355
Neighborhood Characteristics		
Poverty rate	-0.909	-2.081
% White	0.482	-0.149
Distance to central city (mile)	0.002	-0.003
% Rental units with the rent below the FMR	-0.831	0.024
Social services jobs per 100 persons	-0.002**	0.004
Social Networks		
Friend(s) living in a baseline neighborhood	-0.065	-0.043
Family member(s) living in a baseline neighborhood	0.051	-0.076
Social resources in a baseline neighborhood	0.057	-0.088
Duration of residency in a second neighborhood	-	-2.256***
constant	5.522***	8.018***
Number of observations	4,014	1,825
Wald chi-square	372.42***	227.21***
Pseudo R2	0.165	0.818

Regarding the effect of various covariates, results from both models show that those in the experimental and Section 8 groups show higher probabilities of moving, compared with the control group. Households in the Section 8 group are slightly more likely to move than those in the experimental group. For metropolitan controls, those in Boston, Los Angeles, and New York are less likely to move compared to the omitted metropolitan area (Chicago). A few household characteristics are associated with residential mobility. In the first move

model, only age of household head is nonlinearly associated with the likelihood of moving. In the second move model, young households with higher educational attainment are more likely to move. Consistent with Dawkins et al. (2015), Vehicle access has a positive impact on mobility, although its effect is not statistically significant. Only one census tract characteristic is shown to be statistically associated with the likelihood of moving. In the first move model, those living in a lower social services job density are more likely to move. Surprisingly, none of social networks variables are statistically associated with residential mobility, except duration of residency in the second move model. Those that spent less time in the current neighborhood are more likely to move to a new neighborhood.

Table 24 and Table 25 examine models estimated separately for each MTO treatment group and for households by race and ethnicity. Note that all Hispanic households in Baltimore moved from the baseline neighborhood and were excluded from the analysis. Several findings related to neighborhood characteristics emerge from these models. I find that when separate models are estimated for each treatment group, the impact of poverty rate is significant and negative for the control group sample in the first move model, while it is significant and negative for the experimental group sample in the second move model. Consistent with the full model, the impact of social services density is significant and negative for the experimental group in the first move model and is significant and positive for the Section 8 group in the second move model. Comparing the models estimated for black and Hispanic households, I find that poverty rate is negatively associated with the likelihood of moving for both households. On the other hand, distance to central city is positively associated with the likelihood of moving for black households and negatively associated with the likelihood of moving for Hispanic households.

Table 24. Logit Results of the First Move and Second Move Models by MTO Treatment Group

Variable	First Move, Coefficient			Second Move, Coefficient		
	Experimental	Section 8	Control	Experimental	Section 8	Control
Metro Controls						
Baltimore	0.972	-1.454	-0.637	0.800	2.666**	0.546
Boston	-0.659	-2.229*	-1.736***	-2.427**	-2.881*	-0.242
LA	-0.850*	-2.660**	-1.590***	-1.408	0.164	-1.816***
NYC	-1.872***	-3.602***	-2.931***	-1.018	-3.324**	-3.011***
Household Characteristics						
Vehicle Access	0.232	0.072	0.056	0.077	0.639	1.246
Income	-0.000	-0.000	-0.000	0.000	-0.000**	-0.000
Age of HH head	-0.050***	-0.059***	-0.045***	-0.041*	-0.019	-0.026
HH head Black	0.463	0.706*	0.003	0.198	-1.197	1.178
HH head Hispanic	0.551	0.509	-0.332	-0.232	-0.977	2.577**
HH head female	0.309	0.271	-0.026	0.152	0.194	1.230
HH head married	0.128	0.286	0.454	2.192**	-1.637	-0.044
# children in HH	-0.007	0.007	0.079	-0.169	0.490*	0.069
HH head has high school degree	0.002	0.023	0.021	0.561	0.496	0.337
HH head employed	-0.011	0.259	-0.231	-0.900	0.108	-0.119
Neighborhood Characteristics						
Poverty rate	0.156	-0.161	-2.341**	-4.098*	-4.319	1.928
% White	0.940	0.447	0.509	2.044*	-1.519	0.463
Distance to central city (mile)	-0.029	0.102	-0.026	0.016	-0.082**	0.028
% Rental units with the rent below the FMR	-1.859	-1.103	0.334	-2.093	-0.438	1.844
Social services jobs per 100 persons	-0.004**	-0.001	-0.001	-0.012	0.028**	0.003

Social Networks						
Friend(s) living in a baseline neighborhood	-0.052	0.202	-0.244	0.528	-0.529	0.395
Family member(s) living in a baseline neighborhood	0.315	-0.408*	0.122	0.109	0.009	0.111
Social resources in a baseline neighborhood	0.028	0.500	-0.126	0.067	0.098	-0.552
Duration of residency in a second neighborhood	-	-	-	-2.646***	-2.113***	-2.752***
constant	5.875***	6.669***	6.208***	12.383***	13.392***	4.573*
Number of observations	1,617	1,169	1,228	771	532	522
Wald chi-square	153.32***	107.30***	124.16***	117.93***	84.10***	121.38***
Pseudo R2	0.169	0.181	0.156	0.874	0.862	0.798

Table 25. Logit Results of the First Move and Second Move Models by Race and Ethnicity

Variable	First Move, Coefficient		Second Move, Coefficient	
	Black	Hispanic	Black	Hispanic
Treatment Effects				
Experimental group	0.692***	0.920***	1.094***	0.287
Section 8 group	0.973***	1.027***	1.324***	0.108
Metro Controls				
Baltimore	0.107	(dropped)	0.352	3.856
Boston	-1.169**	-12.205***	-1.633***	-8.410***
LA	-1.911***	-12.009***	-1.553***	-7.105***
NYC	-2.863***	-13.041***	-2.013***	-9.342***
Household Characteristics				

Vehicle Access	-0.062	0.350	0.892	0.240
Income	-0.000	-0.000	0.000	0.000
Age of HH head	-0.063***	-0.047***	-0.030	-0.057**
HH head female	-0.202	0.360	0.815	0.793
HH head married	0.818**	0.054	-0.143	0.925
# children in HH	0.041	0.094**	0.154	-0.049
HH head has high school degree	-0.026	0.148	0.168	1.782***
HH head employed	0.064	-0.151	-0.869**	0.217
Neighborhood Characteristics				
Poverty rate	-1.783*	-0.352	-1.610	-4.694
% White	0.678	0.473	0.954	-2.073**
Distance to central city (mile)	0.151**	-0.053	0.057	-0.078**
% Rental units with the rent below the FMR	0.766	-3.060*	0.280	0.292
Social services jobs per 100 persons	0.001	-0.005***	0.008*	0.001
Social Networks				
Friend(s) living in a baseline neighborhood	0.013	-0.096	-0.074	0.168
Family member(s) living in a baseline neighborhood	-0.011	0.149	-0.430	1.351*
Social resources in a baseline neighborhood	-0.139	0.203	0.242	-0.512
Duration of residency in a second neighborhood	-	-	-2.211***	-2.935***
constant	5.353***	17.691***	7.008***	19.325***
Number of observations	2,517	1,274	1,235	519
Wald chi-square	243.36***	654.38***	168.23***	329.36***
Pseudo R2	0.209	0.123	0.827	0.828

4.3.3. Multinomial Logistic Regression Results

Table 26 reports multinomial logit results of the first move and second move models. In the first move model, MTO treatment group effects were large and significant. As expected, those in the experimental and Section 8 groups are less likely to move within a baseline neighborhood or to enter one of the adjacent neighborhoods that surround the baseline neighborhood, compared to moving to another neighborhood. On the other hand, being a member of a MTO treatment group is not statistically associated with residential mobility in the second model. Both of the models present the influence of the Boston control consistently across the dependent variables, which indicates that those living in Boston are more likely to move closer proximity to a baseline neighborhood compared with those living in Chicago. Among all household characteristics, measures of age of household head and vehicle access contribute the most to residential mobility towards the baseline neighborhood, although the effect of vehicle access is only significant in the first move within the baseline neighborhood. Those with a high school degree are more likely to move back to the baseline neighborhood from a second neighborhood, rather than moving to another neighborhood. Regarding the measures of neighborhood characteristics, I find that poverty rates are positively associated with the likelihood of moving within or back to a baseline neighborhood. In the first move model, households are more likely to move within the baseline neighborhood that exhibit higher poverty rates, lower percentage-white population, and fewer affordable housing options for housing voucher recipients. On the other hand, in the second move model, those living closer proximity to central city are more likely to move back to the baseline neighborhood rather than moving to another neighborhood.

Table 26. Multinomial Logit Results of the First Move and Second Move Models

Variable	First Move, Coefficient		Second Move, Coefficient	
	Within baseline neighbor hood	Adjacent neighbor hood	Baseline neighbor hood	Adjacent to baseline neighbor hood
Treatment Effects				
Experimental group	-0.868***	-0.801***	-0.390	-0.634
Section 8 group	-0.958***	-0.631***	-0.298	-0.751*
Metro Controls				
Baltimore	0.246	0.352	1.205**	0.542
Boston	1.891***	0.894***	2.232***	1.523***
LA	0.491*	0.700*	1.837***	1.074**
NYC	0.515**	-0.055	1.753***	0.593
Household Characteristics				
Vehicle Access	-0.780***	-0.105	-0.291	-0.205
Income	0.000***	0.000	-0.000	-0.000
Age of HH head	0.012*	0.035***	0.058***	0.029
HH head Black	-0.118	0.274	0.006	-0.480
HH head Hispanic	0.247	0.422*	-0.426	-0.900
HH head female	-0.106	0.001	0.248	-0.248
HH head married	0.142	-0.280	-0.090	0.619
# children in HH	0.000	0.014	0.005	-0.051
HH head has high school degree	-0.062	-0.039	0.526**	0.245
HH head employed	-0.155	0.059	-0.511	0.278
Neighborhood Characteristics				
Poverty rate	3.538***	-0.442	0.512	1.678
% White	-0.889*	-1.391***	0.357	-0.420
Distance to central city (mile)	0.033	-0.146**	-0.066**	0.029
% Rental units with the rent below the FMR	-1.502*	-1.151	0.812	-1.164
Social services jobs per 100 persons	-0.000	-0.000	0.002	0.002
Social Networks				
Friend(s) living in a baseline neighborhood	0.177	-0.031	0.426*	0.336
Family member(s) living in a baseline neighborhood	0.324**	0.375**	1.063***	0.444
Social resources in a baseline neighborhood	-0.048	0.611	0.752	0.236

Duration of residency in a second neighborhood	-	-	-0.519***	0.220
constant	-3.494***	-2.767**	-6.519***	-4.059***
Number of observations	3,532		1,087	
Wald chi-square	276.13***		140.86***	
Pseudo R2	0.073		0.128	

Holding other variables constant, the presence of family members in the baseline neighborhood is highly associated with the likelihoods of moving within a baseline neighborhood, moving to an adjacent neighborhood to the baseline neighborhood, and moving from a second neighborhood to the baseline neighborhood, compared to the likelihood of moving to another neighborhood. This association is stronger than all other social networks covariates. The influence of the presence of friends is also significant in the second move model. Those with friends living in the baseline neighborhood are more likely to move back to the baseline neighborhood rather moving to another neighborhood. Consistent with logit results, a shorter duration of residency in a second neighborhood is associated with the likelihood of moving back to the baseline neighborhood.

Table 27 and Table 28 present multinomial logit results from the separate models estimated for each MTO treatment group and for households by race and ethnicity. Note that the Hispanic models failed to achieve convergence, due to low variation in the metropolitan control variables in the Hispanic sample. Since these variables were not crucial to my analysis, a decision was made to drop these variable from the model so that the remaining coefficients could be estimated. Similar to the logit results, findings from these models suggest that the sign and impact of neighborhood characteristics and social networks vary by treatment group and between black and Hispanic families. In the first move model, those in the experimental group and control group who lived in higher poverty neighborhoods are more likely to move within a baseline neighborhood compared to moving to another

neighborhood. In the second move model, those in the Section 8 group and control group who lived closer to a central city are more likely to move back to the baseline neighborhood compared to moving to another neighborhood. In contrast, black and Hispanic households show opposite signs in the impact of poverty rate. While black households in higher poverty neighborhoods and Hispanic households in lower poverty neighborhoods tend to move within the baseline neighborhood in their first moves, black households in lower poverty neighborhoods and Hispanic households in higher poverty neighborhoods tend to move back to the baseline neighborhood in their second moves. With regard to the impact of social networks, those in the experimental group show similar results to the full sample result in the second move model. The magnitude of the impact of the presence of family members in the baseline neighborhood is the highest among those in the experimental group, followed by the control group and Section 8 group. The impact of the presence of friends in the baseline neighborhood is significant and large for those in the experimental group. Similarly, both black and Hispanic households with strong social ties in the baseline neighborhood are more likely to move back to the initial neighborhood, while the impact of the presence of family members is higher for Hispanic households than black households and the impact of the presence of friends is higher for black households than Hispanic households.

Table 27. Multinomial Logit Results of the First Move and Second Move Models by MTO Treatment Group

Variable	First Move, Coefficient						Second Move, Coefficient					
	Experimental		Section 8		Control		Experimental		Section 8		Control	
	Within baseline neighbor hood	Adjacent neighbor hood	Within baseline neighbor hood	Adjacent neighbor hood	Within baseline neighbor hood	Adjacent neighbor hood	Baseline neighbor hood	Adjacent to baseline neighbor hood	Baseline neighbor hood	Adjacent to baseline neighbor hood	Baseline neighbor hood	Adjacent to baseline neighbor hood
Metro Controls												
Baltimore	-0.482	0.576	0.201	0.044	1.108**	-0.030	0.646	0.869	1.956	-0.471	0.888	1.238
Boston	1.544***	0.986	1.798***	0.743	2.632***	0.983*	1.780**	0.808	2.049	2.587**	2.281**	2.365*
LA	0.378	-0.297	-0.435	0.650	1.470***	1.788***	1.562**	0.773	2.724**	0.531	2.373**	2.427**
NYC	-0.068	-0.181	0.159	-0.053	1.675***	-0.064	1.155	0.171	2.532**	-0.225	1.687	2.111
Household Characteristics												
Vehicle Access	-0.613*	0.065	-0.661	0.019	0.959***	-0.252	-0.140	-0.914	-1.108	0.077	-0.176	0.552
Income	0.000***	0.000**	0.000**	0.000	0.000	-0.000	-0.000	0.000	0.000	-0.000**	-0.000	-0.000
Age of HH head	0.004	0.053***	0.014	0.021	0.018	0.036***	0.079***	0.050	0.049**	0.054	0.062**	-0.003
HH head Black	-0.100	1.157***	-0.267	-0.050	-0.203	0.054	-0.107	-1.384	-1.221*	2.259	0.376	-0.844
HH head Hispanic	0.343	1.742***	0.209	-0.348	0.102	0.207	-1.314	-1.255	-1.238*	1.010	0.478	-1.848**
HH head female	-0.060	-0.312	-0.453	0.335	0.048	0.319	0.436	-1.649*	-0.186	15.072** *	0.295	0.370
HH head married	0.480	-0.684	0.003	0.404	-0.085	-0.737	-0.023	-0.318	0.012	2.055**	0.463	1.939**
# children in HH	-0.043	0.087	0.062	0.085	-0.021	-0.048	-0.011	-0.118	0.092	0.240	-0.099	-0.598**
HH head has high school degree	-0.312	-0.075	0.420	-0.088	-0.143	0.098	0.141	0.188	1.110**	0.374	0.564	0.288
HH head employed	-0.113	-0.189	-0.797**	0.234	0.160	0.239	-0.399	0.424	-0.614	-0.202	-0.536	0.460
Neighborhood Characteristics												
Poverty rate	4.391***	-0.233	2.194	-1.862	4.165***	-0.206	2.148	2.820	-0.142	-0.049	-1.054	2.381
% White	-2.615**	-2.217**	-0.918	-0.278	-0.007	-1.535*	1.157	0.047	0.790	1.345	-1.436	-1.928

Distance to central city (mile)	-0.069	-0.172	0.078	-0.039	0.066	-0.317**	-0.001	0.046	-0.144**	0.068	0.338***	-0.034
% Rental units with the rent below the FMR	-2.913**	-2.550*	-1.181	2.749*	-1.355	-1.900	1.450	-0.455	1.535	1.515	-1.472	-5.332**
Social services jobs per 100 persons	0.004*	-0.014	0.003	0.001	-0.005*	0.001	-0.002	-0.002	0.004	-0.208	0.002	0.003
Social Networks												
Friend(s) living in a baseline neighborhood	0.026	0.077	0.391	0.107	0.148	-0.285	1.140**	0.034	0.345	0.795	0.068	0.510
Family member(s) living in a baseline neighborhood	0.213	0.733***	0.364	0.046	0.364*	0.324	1.518***	0.482	0.348	0.058	1.170**	0.453
Social resources in a baseline neighborhood	0.544	0.416	-0.400	1.229	-0.184	0.294	0.998	-0.411	1.308	0.458	0.990	0.239
Duration of residency in a second neighborhood	-	-	-	-	-	-	-0.754**	0.215	-0.981**	0.494	-0.011	0.171
constant	-2.680	-3.948**	-4.179**	6.961***	4.825***	-1.001	9.136***	-3.473	-6.152**	25.620** *	-4.063*	0.404
Number of observations	1,459		1,051		1,022		494		337		256	
Wald chi-square	141.68***		111.13***		100.14***		118.85***		339.45***		81.63***	
Pseudo R2	0.091		0.082		0.078		0.187		0.237		0.208	

Table 28. Multinomial Logit Results of the First Move and Second Move Models by Race and Ethnicity

Variable	First Move, Coefficient				Second Move, Coefficient			
	Black		Hispanic		Black		Hispanic	
	Within baseline neighborhood	Adjacent neighborhood	Within baseline neighborhood	Adjacent neighborhood	Baseline neighborhood	Adjacent to baseline neighborhood	Baseline neighborhood	Adjacent to baseline neighborhood
Treatment Effects								
Experimental group	-0.736***	-0.869***	-0.911***	-0.487*	-0.281	-0.780	-1.132*	-1.014

Section 8 group	-0.999***	-0.788***	-0.972***	-0.557*	-0.374	-0.779*	-0.257	-0.389
Metro Controls								
Baltimore	-0.056	0.575	-	-	1.490***	0.551	-	-
Boston	1.744***	1.009**	-	-	2.152***	1.686**	-	-
LA	0.886	0.665	-	-	2.137***	1.334**	-	-
NYC	0.479	0.064	-	-	1.304**	0.815	-	-
Household Characteristics								
Vehicle Access	-0.815***	-0.518*	-0.810***	0.470	-0.274	-0.846	-0.139	1.808**
Income	0.000	0.000	0.000***	0.000	0.000	-0.000	-0.000	-0.000
Age of HH head	0.003	0.041***	0.011	0.022	0.045***	0.030	0.109***	0.096**
HH head female	-0.196	0.150	-0.149	0.024	-0.544	-1.508**	0.775	-0.376
HH head married	-0.161	-0.563	0.216	-0.043	-0.041	0.482	0.814	0.205
# children in HH	0.053	0.066	-0.028	-0.062	0.049	-0.151	0.033	0.266
HH head has high school degree	-0.025	0.012	-0.103	-0.312	0.702**	-0.066	1.003	0.965
HH head employed	-0.069	0.147	0.014	0.070	-0.324	1.074**	-1.601**	-1.766*
Neighborhood Characteristics								
Poverty rate	3.086***	0.277	-0.085	-2.464*	-0.490	0.911	1.275	-2.417
% White	-1.499*	-2.191***	0.642	-0.844	0.909	-1.616	-2.817	3.493***
Distance to central city (mile)	-0.036	-0.090	0.024	-0.139**	-0.053*	0.018	-0.218**	-0.005
% Rental units with the rent below the FMR	-2.181*	-2.329**	1.084	-1.261	2.051*	-0.533	-2.429	0.368
Social services jobs per 100 persons	-0.001	-0.000	0.004*	-0.001	0.002	-0.002	-0.005	0.005
Social Networks								
Friend(s) living in a baseline neighborhood	0.136	0.057	0.316	-0.194	0.752**	0.311	-0.588	0.293

Family member(s) living in a baseline neighborhood	0.265	0.352*	0.361	0.374	1.025***	0.534	1.700***	0.669
Social resources in a baseline neighborhood	0.314	0.390	-0.324	1.401*	0.769	0.720	0.792	-3.121
Duration of residency in a second neighborhood	-	-	-	-	-0.658***	0.335	-0.267	0.328
constant	-2.448*	-2.313**	-2.848**	-1.062	-6.722***	-3.755**	-3.899	-6.440
Number of observations	2,287		1,059		792		264	
Wald chi-square	177.97***		73.18***		122.53***		108.52***	
Pseudo R2	0.071		0.060		0.156		0.300	

I conducted simulations to identify the joint impact of kinship/friendship and social resources on neighborhood mobility. Table 29 displays the predicted probabilities of moving back to a baseline neighborhood for different levels of social networks using coefficients from the full sample second move model and those estimated for the experimental group and black households. The predictions are based on similarly significant coefficients in all of these models. Values of the presence of friends and family members and the social resources score were allowed to vary, while the other variables were held at their respective means. Due to the insignificance of the social resources score coefficient, the predictions for this group are less precise. When second-time movers make a decision on where to move, the average household with both friends and family members living in the baseline neighborhood is more likely to move back to the baseline neighborhood, followed by the average household with family members only, with friends only, and with neither friends nor family members in the baseline neighborhood. In the full model, those with both friends and family members are approximately four times more likely to move back to the baseline neighborhood than those with neither friends nor family members across all values of social resources scores. In the experimental group sample, on the other hand, those with both friends and family members are about 13 times more likely to move back to the baseline neighborhood than those with neither friends nor family members. Black households also show a five times greater probability of moving back to the original neighborhood with both friends and family members than those without friends or family members do. Nonetheless, the disparity in the probabilities of moving back to the baseline neighborhood increases with a high social resources score (fully dependency on social networks for social services) compared to a low score (zero dependency) in all samples and in all types of social ties, while black households show slightly greater difference in the social resources score.

Table 29. Predicted Probabilities of Moving Back to a Baseline Neighborhood by Kinship/Friendship and Social Resources

Sample	Social resources score	Kinship and Friendship in a baseline neighborhood			
		No friends or family	Friends only	Family only	Friends and family
Full	Low	1.7%	2.5%	4.6%	6.8%
	High	3.5%	5.2%	9.3%	13.3%
Experimental Group	Low	0.4%	1.2%	1.8%	5.3%
	High	1.1%	3.3%	4.7%	13.4%
Black	Low	1.1%	2.4%	3.1%	6.3%
	High	2.4%	4.9%	6.3%	12.4%

4.4. Discussion

Across all measures of neighborhood mobility patterns, randomization into the MTO control group had a strong association with staying in or re-entering a baseline neighborhood, while the experimental group showed the lowest association. Nearly 70 percent of the total MTO households left a baseline neighborhood and never came back to their initial neighborhood or its adjacent neighborhoods. Given that most participants initially lived in public housing projects in central cities (Orr et al. 2003), the MTO experiment contributed to the suburbanization of the poor, both under geographic constraints and without such constraints. The percentage difference in the likelihood of leaving the baseline neighborhood and never coming back between the experimental group and the control group is 14 percent. This is not an unusual finding as both experimental group and section 8 group receive housing vouchers. While receiving housing search assistance, the experimental group face geographic restrictions on the use of housing assistance that required vouchers to be used in a low-

poverty neighborhood with poverty rates less than 10 percent. Since most baseline neighborhoods tend to have poverty rates of higher than 10 percent, it makes these neighborhoods undesirable for those in experimental group to use their vouchers. Experimental households are also required to live in low-poverty neighborhoods for at least a year after initial random assignment, which is why the median experimental household that entered an adjacent neighborhood to the baseline neighborhood spent almost one and a half years in another neighborhood between the baseline neighborhood and its adjacent one. Taking these households into account the probability of moving back or in closer proximity to one's initial neighborhood, more than 25 percent of the total number of experimental households preferred to live in the baseline neighborhood or at least adjacent ones, despite the benefits of voucher use and housing search counseling assistance.

I find that social services density has a significant, negative effect on the likelihood of the move from the first neighborhood, while all other neighborhood characteristics have insignificant effects. Given that those who moved have higher average values in the presence of family members and friends, and a higher social resources score, it may imply that movers attempted either to be closer to their social networks or to distance themselves from their social networks. On the one hand, households in neighborhoods with lower access to social services might move to neighborhoods where relatives or friends lived to depend on social networks for costly services. On the other hand, households who had initially fewer options to get social services and inevitably relied on local social networks might move to neighborhoods in which they exhibit greater access to social services. This finding is consistent with the qualitative finding by Briggs et al. (2010) in that most households moved closer to their social networks to maintain a central role in daily life, while some households moved to a completely new neighborhood by separating themselves from the existing social ties.

I also find that households tend to move back to their initial neighborhoods when they have strong kinship and friendship in these neighborhoods, although they have left to seek better neighborhood-level social services. MTO participants in neighborhoods with less social services jobs were more likely to move out of the first neighborhood, but these movers were more likely to move back to the original neighborhood if they had either family members or friends there. Moving back to the initial neighborhood implies that households failed to find available social services such as childcare in a new neighborhood and returned in order to be closer to their social networks to get practical help. According to the neighborhood opportunity literature, social networks provide households with the metropolitan opportunity set by filtering and assessing resources and information around neighborhoods (Galster and Killen 1995). Even if MTO households moved to neighborhoods with better quality social services, they still might have no access to such opportunities because of an absence of social networks that would introduce such opportunities to the new comers. In other words, relocation to high-opportunity neighborhoods would not substantially increase the perceived opportunity set for the poor unless local social networks connects them with available information and resources. This might be the reason why the impacts of social services density were non-significant in my logit models.

In the separate models estimated for each MTO treatment group, the impact of neighborhood poverty rate is different in the first move and second move models, which captures geographic restrictions in voucher use in the MTO program. Since those in the control group did not have a voucher and were not required to live in a low-poverty neighborhood, neighborhoods with a lower poverty rate provided low-income households with less access to social networks and thus pushed them to make a move from their initial neighborhoods. However, since those in the experimental group were required to use their vouchers in low-poverty neighborhoods only, many of these households were likely to move

from the second neighborhood once they lived in low-poverty neighborhoods at least for one year which is the minimum length of time that they are required to stay. Also, I find that the impacts of social network variables in the second move multinomial logit model were greatest for those in the experimental group compared to those in the Section 8 group. This finding can be also explained in the context of the MTO geographic constraint, which suggests that forced voucher use in low-poverty neighborhoods led households to move back to their initial neighborhoods rather than staying in these neighborhoods or moving to another neighborhood.

Controlling for other determinants of residential mobility, the effects of metropolitan variables likely capture metropolitan differences in rental housing markets and other neighborhood characteristics. I find evidence of considerable heterogeneity in the likelihood of moving by metropolitan area. Those in New York reported the lowest probability moving out of the first neighborhood relative to the omitted metropolitan area (Chicago), followed by Los Angeles. As I find in Chapter 3, these metropolitan areas have suffered severe affordable housing gaps, which might limit voucher households to find a rental unit in a desirable neighborhood as they compete with non-subsidized low-income renters. Consistent rising rents over time might have also constrained MTO participants, particularly those in the experimental group, to move because the applicable FMR might have offer a limited set of affordable housing options in low-poverty neighborhoods.

Chapter 5: Vehicle Access and Locational Attainment

This chapter examines the effect of vehicle access on locational attainment. Moving to Opportunity (MTO) has been studied exhaustively to learn the impacts of living in low-poverty neighborhoods, but its questions on access to automobiles have never been investigated in depth. I explore the dynamics of neighborhood conditions for MTO participants by levels and changes in levels of vehicle access since the baseline survey, and estimate locational attainment models that address a wide range of variables capturing various dimensions of neighborhood opportunity, focusing on the influence of vehicle access on neighborhood outcomes.

5.1. Background

5.1.1. Transportation and Location Choices

Classic models of urban location and development posit that utility-maximizing households make tradeoffs between housing costs and intra-regional accessibility (Alonso 1964; Muth 1969). For example, upper-income households in the United States often value housing consumption over accessibility, so that higher income households choose distant locations to consume a larger housing bundle, while lower income households select smaller housing in more accessible central-city locations. Public transportation further induces centralization of low-income populations, since the costs of owning and operating an automobile are high, and public transportation has been available mainly in centrally locations (LeRoy and Sonstelie 1983; Glaeser et al. 2008). Considerable research confirms the importance of transportation accessibility for housing search and residential location (Abraham and Hunt 1997; Levine 1998; Rodriguez, et al. 2011). Beyond mere accessibility, other transportation-related factors

also matter for people's neighborhood satisfaction, including walkability and land use mix (Yang 2008), proximity to public transportation (Baum et al. 2009), access to walking and biking paths (Kearney 2006; Chapman and Lombard 2006), and general accessibility to jobs and social services (St. John and Clark 1984).

Transportation does not exert the only influence on residential choices and satisfaction, of course. Some studies suggest that at least until the early 1990s, affluent households moved to the suburbs primarily to escape perceived urban social problems including crime, poverty, and poor school quality (Mieszkowski and Mills 1993; Hamilton 1982). These choices were reinforced, especially for homeowners, by high property-tax burdens in central cities (Grubb 1970). Transportation may also be less important today than it was in the 1950s and 1960s in terms of residential choice for a variety of reasons. Giuliano and Small (1993) offer several hypotheses concerning the limited influence of work commute on residential location choices. Commuting may not be as onerous as previously anticipated, particularly for short or infrequent trips. High job turnover combined with high moving costs may induce households to choose a residential location that is accessible to a wide array of potential job locations, with the initial job location playing a less-important role. Two-worker households may be unable to find a location that minimizes the commute distance for both workers in the household. The desire to minimize the cost of non-work travel may be a more important determinant of location decisions. And other housing and neighborhood amenities may be more important than commute lengths in influencing location decisions. By implication, the importance of transportation to location and satisfaction likely varies by household type.

Low-income households are considerably more constrained than upper-income households when deciding where to live. They must compete for a smaller supply of units at lower price ranges, and since most low-income households rent their housing, the supply of

affordable rental housing acts as a further constraint. Low-income households also are disproportionately constituted of people who face non-income constraints in residential choices. They are more likely to be African American or Hispanic than to be white non-Hispanic, which exposes them to discrimination in housing markets (Turner et al. 2013). Low-income households also disproportionately include single parents with children under 18, whose responsibilities for childcare, other household responsibilities, and employment are difficult to balance even in the scarce neighborhoods where they can find an affordable home. Few locations where single low-income parents can live affordably, safely, and responsibly also have excellent amenities or public services.

5.1.2. Neighborhood Outcomes of Housing Voucher Recipients

While housing voucher recipients live in a wider variety of neighborhoods, they still cluster in some of their metropolitan area's most racially segregated and impoverished neighborhoods (See Chapter 2.3). While these neighborhoods are less segregated than those of public housing projects, at least one study—a case study of Chicago—suggests that public-housing residents live in neighborhoods whose walkability and accessibility exceed those of voucher users (Talen and Koschinsky 2011).

Part of the challenge for researchers has been to isolate the influence of the voucher itself on locational outcomes. Since households must apply for vouchers, these households may exhibit unique characteristics that differentiate them from the larger population of potentially-eligible households. As a result, simple comparisons between the residential location outcomes of voucher recipients and other households may suffer from a selection bias problem. Data from the MTO program has allowed researchers to circumvent this hurdle (See Chapter 2.5).

Little systematic research has been conducted on how transportation affects voucher users' location choices, and particularly how having access to one's own car allows families to choose higher-opportunity neighborhoods. But a few studies suggest that voucher users—like everyone else—can move to better neighborhoods when they own or have access to a car. One quantitative study found that access to a car increased the likelihood that MTO program participants successfully secured a lease using their voucher (Shroder 2002). Varady and Walker (2007) find that a major factor determining the location of moves was proximity to friends and relatives and the availability of public transportation. Clampet-Lundquist (2004) studied households relocated from the DuBois HOPE VI project in Philadelphia and finds that many were constrained in their housing search due to their lack of access to an automobile and perception that suburban public transportation opportunities were limited (reviewed in Varady 2010).

Drawing on extensive interviews with MTO participants, Briggs et al. (2010) note: “The finding that different voucher holders are willing to make different trade-offs ... underscores the importance of transportation as a determinant of accessibility. ‘Car vouchers’ and other tools could mitigate the trade-off between living in a safer neighborhood and having the desired level of access to one’s social supports and cherished institutions, such as ‘church homes,’ as well as jobs or education and training programs” (Briggs et al. 2010, pp. 232-233). In a similar vein, Rosenblatt and DeLuca (2012, p. 264) capture the difficulty of finding a high-opportunity neighborhood without a car in an interview with a Baltimore MTO participant who could not lease up in a low-poverty neighborhood:

The buses only run a certain time and then they cuts off. So I don't believe nobody dictating to me that I gotta move here, no transportation even though I have driver license but I don't have a car. If my child gets sick ok you can call an ambulance, but

if I need to get to the store I gotta walk down the road....Like right now my job hours are 1–9 so if I’m out way in the county, and the bus stop running at 5 o’clock that’s not good to me right now.

My review of the literature suggests that while the linkages between transportation access and residential location decisions have been explored in-depth, there is a paucity of studies examining the impact of transportation access on the neighborhood choices of low income households receiving rental housing assistance. Part of the challenge is likely due to the limited number of datasets offering information on car access, housing assistance, and residential location outcomes. In the next section, I discuss a unique dataset from the Moving to Opportunity program which provides robust longitudinal information on each of these outcomes. I rely on these data to address the question, “How does vehicle access influence the types of neighborhoods in which low-income households are able to secure housing following a move to a new neighborhood, controlling for other determinants of location choice?”

5.2. Locational Attainment Models

I rely on data from the MTO program to address two methodological issues. First, the simultaneity between residential and transportation choices complicates efforts to model each decision separately. Recently, a large literature has emerged to address the related question of whether transportation services and other built environment features influence a household’s subsequent travel behavior (see Boarnet and Crane [2001] for a review). Since households may choose whether to own a car, in part, in response to the range of transportation options available to them in their chosen residential location, a simple cross-sectional model of location choice that includes auto ownership as one of the independent variables cannot be

used to distinguish the direction of causality between auto access and locational outcomes. Another methodological challenge is that voucher applicants may exhibit unique unobservable characteristics that distinguish them from the pool of similar households who do not choose to apply for rental housing assistance. As a result, simple controls for voucher recipient status in models of locational outcomes may be insufficient to estimate the magnitude of the voucher treatment effect.

To address potential reverse-causality between auto-access and locational outcomes, I adopt a procedure employed by studies examining the impact of auto access on employment outcomes (Gurley and Bruce 2005; Cervero et al. 2002). As in these studies, I restrict the sample to those who moved to a new neighborhood after random assignment and include controls for the household's lagged level of auto access. Lagged auto access was measured at the time of the interim survey. I also examined models that included measures of lagged auto access at the time of the initial baseline survey but opted for measuring lagged auto access as of the interim period due to the long time lag between the baseline and final surveys (10 to 15 years in most cases). Since it is still possible that a household's level of auto-accessibility changes during the interim and final survey, I also include controls for whether the household gained or lost access to an automobile during the interim and final survey waves. One limitation of this approach is that changes in auto access may have occurred before or after the move to the neighborhood where the household lived at the time of the final survey. As a result, the "change in auto access" measures are potentially biased due to the reverse causality issue mentioned above. I decided to include these measures, however, due to the large change in auto access observed for MTO households between the baseline, interim, and final samples.

To investigate residential location outcomes, I estimate several "locational attainment" models. In models of this sort, the dependent variable is a census tract

characteristic associated with a household's chosen neighborhood, and independent variables include household-level determinants of location choice. A few examples of studies employing versions of this type of empirical approach include Alba and Logan (1992), Bayer et al. (2004), Borjas (1998), Dawkins (2005), Freeman (2008), Ihlanfeldt and Scafidi (2002), Sampson (2008), and Woldoff (2008). Bayer et al. (2004) provide a unique interpretation of the household-level coefficients from such models that is analogous to the exposure index utilized by segregation researchers. According to Bayer et al. (2004), when the dependent variable is a measure of census-tract-level racial composition, the coefficient on a given household-level covariate can be interpreted as the average exposure of a given household type to the racial group residing in the surrounding census tract, conditioning on household-level characteristics.

The dependent variables in my locational attainment models include a wide range of variables capturing various dimensions of neighborhood opportunity. I include measures of various dimensions of sustainability and opportunity, including the neighborhood functional environment, social environment, natural environment, economic vitality, and access to opportunity. Functional environment indicators, which capture the quality of available housing, transportation, and other physical neighborhood infrastructure, include median gross rent, vacancy rates, percent of housing that is owner-occupied, percent of single-family units, and a transit access index, provided by the HUD Fair Housing Equity Assessment (FHEA) database (See HUD [2012] for a more detailed discussion of how the transit index is calculated). The neighborhood social environment refers to both the demographic makeup of residents and the strength and quality of the social networks present in a neighborhood. Indicators of this dimension include poverty rates, median household income, labor force participation rates, the percent of the population from a racial or ethnic minority group, the

percent of households headed by females, and the percent of the adult population with a high school degree or GED.

The natural environment dimension captures the exposure to environmental hazards and presence of natural and built environment characteristics that may impact both residents' health and a neighborhood's desirability. Natural environment indicators include the percent of land that is in open space, population density, and cancer risk per million persons. To proxy for automobile emissions, I use GIS software to measure the percent of the census tract covered by 200 meter buffers surrounding major highways. One mile buffers are also established around major Toxic Release Inventory sites to determine the percent of the tract exposed to toxic hazards. A final natural environment indicator is "average block length," which captures the average length of streets within a census tract. Tracts with longer average block lengths are assumed to exhibit more suburban and less walkable street patterns.

The final two neighborhood dimensions examined are the neighborhood's level of economic vitality and access to opportunity. Indicators of economic vitality include job density and aggregate income density. Access to opportunity is quantified using the HUD Fair Housing Equity Assessment (FHEA) school performance index, calculated as the percent of students proficient in reading and math on state test scores, weighted by total school enrollment (HUD 2012).

These variables are taken from several sources, including the 2009 American Community Survey, the 2011 U.S. Geological Survey National Land Cover database, the 2011 National-Scale Air Toxics Assessment, the 2009 Environmental Protection Agency (EPA) Toxic Release Inventory, the 2010 Census Longitudinal Employer-Household Dynamics, and the HUD FHEA database. In each regression model I include the lagged measure (as of the baseline surveys) of the same neighborhood characteristic used to construct the dependent variable. All variables are derived from the same sources of

dependent variables, including the 2000 U.S. Census, the 2001 U.S. Geological Survey National Land Cover database, the 2002 National-Scale Air Toxics Assessment, and the 2000 EPA Toxic Release Inventory, with the exception of the job density, transit access, and school performance variables due to data unavailability around the year 2000. Table 30 describes the source for each variable and the calculation method.

Table 30. Neighborhood Characteristic Descriptions and Sources for the Linear Regression Analyses

Variable Description	Calculation Method	Source, Year
<u>Functional Environment</u>		
Median Gross Rent	Median gross rent of specified renter-occ. units with rent (\$)	Census 2000 SF3, ACS 2009 5YR
Vacancy Rate	Percent of housing units vacant	Census 2000 SF3, ACS 2009 5YR
% Owner Occupied	Percent of housing units owner-occupied	Census 2000 SF3, ACS 2009 5YR
% Single-Family Units	Percent of single-family (detached and attached) units	Census 2000 SF3, ACS 2009 5YR
FHEA Transit Access Index	FHEA transit access index	HUD FHEA 2012
<u>Social Environment</u>		
Poverty Rate	Percent of persons in poverty	Census 2000 SF3, ACS 2009 5YR
Median Household Income	Median household income last yr (\$)	Census 2000 SF3, ACS 2009 5YR
Labor Force Participation Rate	Labor force participation rate	Census 2000 SF3, ACS 2009 5YR
Unemployment Rate	Unemployment rate	Census 2000 SF3, ACS 2009 5YR
% Minority Population	Percent minority population (not non-Hispanic white alone)	Census 2000 SF3, ACS 2009 5YR
% Female Headed Households	Percent of households that are female-headed households	Census 2000 SF3, ACS 2009 5YR
% 25+ w High School Diploma / GED	Percent of persons 25+ w/ at least a high school diploma or GED	Census 2000 SF3, ACS 2009 5YR
<u>Natural Environment</u>		
% Open Space	Percent of area covered by open space	NLCD 2001 & 2011
Average Block Length	Average block length	Census 2000 & 2010 TIGER/Line Data
Population Density	Population per square mile	Census 2000 SF3, ACS 2009 5YR
% Buffer of Major Highways	Percent of tract covered by 200 m buffers surrounding major highways	Census 2000 & 2010 TIGER/Line Data
Cancer Risk / Million	Cancer risk per 1 million population	NATA 2002 & 2011
% Buffer of TRI Facilities	Percent of tract covered by 1 mi buffers surrounding TRI facilities	EPA TRI 2000 & 2009
<u>Economic Vitality</u>		
Job Density	Total number of jobs per square mile	Census LEHD 2010
Aggregate Income Density	Aggregate income per square mile	Census 2000 SF3, ACS 2009 5YR
<u>Access to Opportunity</u>		
FHEA School Performance Index	FHEA school performance index	HUD FHEA 2012

The independent variables in each model include a variety of household-level factors discussed in the literature that have been shown to be associated with neighborhood choice. To capture various policy impacts, I include measures of the randomly-assigned “treatment” group for each sample, interacted with whether the household has leased-up in their current location using a voucher at the time of the final survey. Including such information makes my estimates comparable to the “intent-to-treat (ITT)” and “treatment-on-treated (TOT)” effects commonly discussed in the MTO literature, as coefficients of dummy variables indicating Experimental and Section 8 groups are equal to the ITT effects and coefficients of interaction terms of treatment groups and lease-up are equal to the TOT effects (see Sanbonmatsu et al. [2011] for a more detailed discussion of these effects). I also include indicators of the household’s metro location, with Chicago omitted as the reference category.

Other household characteristics include income, income squared, and number of children in the household. Characteristics of the household head include age, age squared, race and ethnicity, marital status, gender, education, and employment status. I include three measures of auto access. The first is an indicator variable equal to one if anyone in the household owned a car, van, or truck that runs at the time of the interim survey. I also include two indicator variables that capture whether the household gained or lost access to autos since the interim survey. All of these variables, with the exception of the auto access variables, were measured contemporaneously with the date of the final survey. All models are restricted to those who moved from their baseline neighborhood to a new census tract by the final survey.

5.3. Results

5.3.1. Changes in Neighborhood Characteristics

I begin with an examination of the metro- and household-level characteristics for the MTO sample, displayed in Table 31. The sample is fairly evenly-distributed across metros, with the smallest percentage of households living in Baltimore. Households in the sample have very low incomes (\$21,330 on average), yet 41 percent has access to a vehicle. Consistent with other MTO research, I also find that the sample is disproportionately weighted towards African American households headed by unmarried females.

Table 31. Descriptive Statistics for Variables Used in the Linear Regression Analyses, MTO Final Survey

Descriptive Statistics, Independent Variables			
<i>Variable Description</i>	<i>Obs</i>	<i>Mean</i>	<i>Std Dev</i>
<u>Treatment Effects</u>			
Experimental group	2,718	0.47	0.50
Section 8 group	2,718	0.21	0.41
Lease-up	2,408	0.51	0.50
Lease-up x Exp. group	2,408	0.27	0.44
Lease-up x Sec 8. group	2,408	0.12	0.33
<u>Metro Controls</u>			
Baltimore	2,328	0.18	0.38
Boston	2,328	0.20	0.40
LA	2,328	0.22	0.41
NY	2,328	0.16	0.36
<u>Household Characteristics</u>			
Car access at interim	2,242	0.41	0.49
Car access gained	2,226	0.13	0.34
Car access lost	2,226	0.12	0.32
Income	2,718	21,329.66	22,651.91
Age of HH head	2,718	43.79	8.33

HH head Black	2,668	0.69	0.46
HH head Hispanic	2,689	0.28	0.45
HH head female	2,716	0.98	0.13
HH head married	1,656	0.19	0.39
# children in HH	2,718	1.54	1.55
HH head has high school degree	2,706	0.44	0.50
HH head employed	2,714	0.52	0.50

Table 32 gives an initial picture of the changes in neighborhood conditions for each program participant since the baseline survey, stratified by levels and changes in levels of vehicle access. The major finding displayed in this table is that residential mobility generally resulted in improved neighborhood conditions. By the final survey, MTO households lived in neighborhoods with poverty rates that were about 24 percent lower than the baseline neighborhood poverty rate. Similar trends are observed across a wide range of census tract characteristics, with MTO households moving to census tracts with a lower vacancy rate and unemployment rate as well as higher median rents, percentage of owner-occupied units, percentage of single-family units, median household income, labor force participation rates, exposure to college-educated adults, exposure to open space, aggregate income density, and improved school performance. However, there are tradeoffs; the households' new residences were less accessible to jobs and had poorer transit access and were more exposed to automobile emissions and toxic hazards.

Table 32. Changes in Neighborhood Characteristics, MTO Baseline to Final Survey

	<i>Full Sample</i>	<i>No Car Access at Interim No Car Access at Final</i>	<i>Car Access at Interim No Car Access at Final</i>	<i>No Car Access at Interim Car Access at Final</i>	<i>Car Access at Interim Car Access at Final</i>
<u>Functional Environment</u>					
Median Gross Rent	544.94	512.10	533.27	571.20	573.57
Vacancy Rate	-0.98	-0.65	-2.06	-2.76	-1.69

% Owner Occupied	26.24	22.28	26.96	31.24	31.10
% Single-Family Units	21.64	17.46	19.95	26.94	26.30
FHEA Transit Access Index	-11.34	-5.98	-15.15	-12.77	-17.79
<u>Social Environment</u>					
Poverty Rate	-24.11	-21.52	-24.30	-26.99	-26.34
Median Household Income	22,373.76	19,750.27	21,686.16	25,502.95	25,253.22
Labor Force Participation Rate	14.72	13.40	14.16	15.89	15.78
Unemployment Rate	-11.35	-11.07	-11.89	-11.88	-11.00
% Minority Population	-6.86	-4.26	-6.25	-8.98	-8.90
% Female Headed Households	-8.99	-5.31	-7.95	-11.36	-11.89
% 25+ w High School Diploma / GED	23.08	20.98	23.38	25.25	23.99
<u>Natural Environment</u>					
% Open Space	3.18	2.63	2.82	4.97	3.97
Average Block Length	143.31	-10.14	32.06	208.80	291.33
Population Density	-9,773.23	-7,874.20	-7,852.26	-17,277.70	10,495.08
% Buffer of Major Highways	-7.54	-7.08	-9.40	-7.62	-7.00
Cancer Risk / Million	-13.14	-12.95	-11.75	-14.20	-12.76
% Buffer of TRI Facilities	-21.92	-21.92	-20.93	-20.21	-23.11
<u>Economic Vitality</u>					
Job Density	-3,014.44	-3,025.84	-3,431.92	-4,469.37	-3,103.53
	121,000,00	214,000,00	106,000,00	-	44,000,00
Aggregate Income Density	0	0	0	14,000,000	0
<u>Access to Opportunity</u>					
FHEA School Performance Index	2.57	1.39	1.48	1.37	6.36

Compared to those who never had access to an automobile, households who had cars throughout the analysis period or subsequently gained access to cars saw higher increases in median rents, percentage of owner occupied housing, percentage of single-family units, median household income, labor force participation rates, exposure to college-educated adults, and exposure to open space, while at the same time experiencing greater reductions in neighborhood vacancy rates, poverty rates, and percentage of female headed households. The table also points to tradeoffs made as a result of mobility, with those with car access generally experiencing a larger decline in population density and increased exposure to less walkable environments. Curiously, while those with consistent access to a car saw considerable improvements in school performance, those who gained an automobile since the baseline

period saw slightly smaller increases in school quality with those who never had access to an automobile. Furthermore, the table suggests that consistent access to a car has different impacts on job density and aggregate income density than do changes in car access. These latter findings point to the importance of controlling for changes in automobile access over time in the locational attainment regressions.

5.3.2. Linear Regression Results

I now turn to an examination of linear regression models which control for the influence of household-level characteristics on locational outcomes. Table 33 displays these results, using measures of the neighborhood functional environment as dependent variables. The models explain between 18 to 47 percent of the variation in the dependent variables, a low goodness-of-fit, but comparable to other locational attainment models reported in the literature (Bayer et al. (2004) 9 to 21 percent; Borjas (1998) 19 to 32 percent; Dawkins (2005) 25 to 30 percent; Freeman (2008) 10 to 32 percent). All models display significant metropolitan heterogeneity, as evidenced by the magnitude and significance of the metropolitan dummy variables.

Table 33. Linear Regression Results of Locational Attainment, Functional Environment

OLS Linear Regression Results, Functional Environment

<i>Variable</i>	<i>Dependent Variable:</i>	<i>Median Gross Rent</i>	<i>Vacancy Rate</i>	<i>% Owner-Occupied</i>	<i>% Single-Family Units</i>	<i>Transit Access Index</i>
<u>Treatment Effects</u>						
Experimental group		24.341	1.077	3.772**	2.135	-2.627
Section 8 group		-7.593	0.370	2.290	4.105*	-2.842
Lease-up		132.023***	-0.754	7.493***	5.843**	-2.252
Lease-up x Exp. group		18.293	-2.378	0.461	0.172	0.374
Lease-up x Sec 8. group		39.537	-0.436	-1.480	-5.796	3.840
<u>Metro Controls</u>						
Baltimore		50.605**	8.046***	5.762***	30.668***	6.619***
Boston		212.576***	-10.213***	-0.644	-11.576***	8.331***
LA		147.143***	-13.012***	-4.310**	17.195***	-4.020
NY		113.108***	-12.750***	-19.595***	-24.674***	-33.510***
<u>Household Characteristics</u>						
Car access at interim		32.364	-3.581***	5.348***	5.853***	-8.028***
Car access gained		57.718**	-3.324**	5.426***	6.699***	-8.524***
Car access lost		-11.407	1.301	-2.353	-1.338	4.586
Income		0.003***	-0.000	0.000**	0.000	0.000
Income squared		-0.000	0.000	-0.000	-0.000	-0.000
Age of HH head		-0.618	-0.109	-0.787	-1.490**	-0.853
Age of HH head squared		0.008	0.001	0.007	0.014**	0.008
HH head Black		-53.929	0.970	-6.273**	-2.206	6.395
HH head Hispanic		-36.020	-1.033	-7.722***	-5.160	9.501**
HH head female		8.002	-2.044	6.408	13.681**	-2.859
HH head married		-18.777	0.594	-0.242	2.259	-1.670
# children in HH		-3.615	0.148	0.562	0.822	-2.021***
HH head has high school degree		-17.038	-0.472	-1.755	-1.352	-0.058

HH head employed	1.567	-0.801	0.637	1.054	1.983
Baseline Neighborhood Characteristic	-0.210***	0.058	0.007	-0.004	0.046
Constant	754.306***	29.717***	49.410***	54.819***	94.294***
Number of Observations	1,054	1,055	1,055	1,038	1,019
R-squared	0.181	0.339	0.233	0.468	0.236

Household characteristics exhibit varying impacts across models. As expected, income is positively associated with attaining a residential location in areas exhibiting higher median gross rents and a higher percentage of owner-occupied housing. The impacts of age, race, ethnicity, and gender of the household head are statistically significant in some models but not in others. Regarding the influence of access to autos, having auto access at the time of the interim survey and gaining a car during the survey period is associated with residing in neighborhoods with lower vacancy rates, a higher percentage of owner-occupied housing, a higher percentage of single-family units, and lower access to transit service.

The influence of voucher use along with treatment group assignment differs by functional environment measure. Using a voucher at the time of the final survey is associated with residing in neighborhoods exhibiting higher median rents, a higher percentage of owner-occupied housing, and a higher percentage of single-family units. Those assigned to the Experimental group reside in neighborhoods with a higher percentage of owner-occupied housing, whereas those assigned to the Section 8 group reside in neighborhoods with a higher percentage of single-family units.

Table 34 displays the same set of regression results for the models relying on measures of the neighborhood social environment as dependent variables. Here I find that race, and to a lesser extent ethnicity, are significantly associated with a variety of neighborhood outcomes. Specifically, households headed by African Americans and Hispanics reside in neighborhoods with higher poverty rates, lower median household income, lower labor force participation rates, higher unemployment rates, higher minority percentages, higher female-headed household percentages, and a lower percentage of adult high school graduates. Among all household characteristics, initially having access to an auto or subsequently gaining access has the most consistent impact across neighborhood social

environment outcomes, with initial access significantly influencing all outcomes except unemployment rate and a percentage of minority population.

Table 34. Linear Regression Results of Locational Attainment, Social Environment

OLS Linear Regression Results, Social Environment

<i>Variable</i>	<i>Dependent Variable:</i>	<i>Poverty Rate</i>	<i>Median Household Income</i>	<i>Labor Force Participation Rate</i>	<i>Unemployment Rate</i>	<i>% Minority Population</i>	<i>% Female Headed Households</i>	<i>% 25+ w High School Diploma / GED</i>
<u>Treatment Effects</u>								
	Experimental group	-2.356*	2,722.101*	1.224	-0.592	-1.920	-2.460	0.826
	Section 8 group	-1.226	1,631.130	0.626	-0.799	-0.069	-3.510	-0.955
	Lease-up	-6.157***	4,464.098***	3.273***	-1.915**	-0.423	-4.161*	2.060
	Lease-up x Exp. group	-0.305	2,187.475	0.141	-0.329	-2.402	-2.206	2.047
	Lease-up x Sec 8. group	0.806	1,248.180	0.596	-0.416	-2.872	2.836	1.963
<u>Metro Controls</u>								
	Baltimore	-8.159***	6,197.569***	1.572	-6.756***	-12.332***	-4.125*	-3.676***
	Boston	-10.182***	14,311.759***	7.621***	-7.951***	-25.800***	-13.572***	1.896
	LA	-5.300***	5,247.753***	3.516***	-9.496***	-0.263	-28.499***	-20.635***
	NY	-5.709***	5,207.448***	0.334	-8.838***	-6.303***	-9.596***	-5.626***
<u>Household Characteristics</u>								
	Car access at interim	-4.539***	4,214.392***	2.042***	-0.804	-2.324	-3.452*	4.547***
	Car access gained	-5.428***	4,811.417**	2.227**	-0.311	-0.392	-0.900	3.121**
	Car access lost	1.443	-1,751.824	-0.515	0.398	3.135	2.428	-1.855
	Income	-0.000	0.086	0.000***	0.000	0.000	-0.000	0.000
	Income squared	-0.000	0.000	-0.000*	-0.000	-0.000	-0.000	0.000
	Age of HH head	0.405	-77.990	0.136	0.112	-0.708	0.742	-0.224
	Age of HH head squared	-0.004	0.729	-0.001	-0.001	0.007	-0.006	0.003
	HH head Black	5.150***	-7,392.263***	-1.869*	2.676***	17.066***	14.338***	-2.977*
	HH head Hispanic	5.560***	-5,970.892**	-2.363**	2.262**	13.175***	10.239***	-5.128***
	HH head female	0.558	1,003.083	-1.427	-0.296	-3.125	-4.652	0.588
	HH head married	-0.289	-2,079.944*	-0.148	-0.863	-0.193	-0.417	-2.216**

# children in HH	0.562*	-616.161*	-0.420*	0.167	0.463	0.897**	-0.368
HH head has high school degree	0.445	-483.800	0.004	-0.362	-0.721	0.677	-0.113
HH head employed	-0.840	-48.986	0.743	-0.335	0.324	0.111	0.923
Baseline Neighborhood Characteristic	-0.035	-0.147**	-0.053	-0.026	0.017	-0.051	-0.037
Constant	26.228**	34,822.813***	55.053***	17.127**	98.868***	42.108**	80.147***
Number of Observations	1,055	1,055	1,055	1,038	1,055	1,055	1,055
R-squared	0.160	0.166	0.150	0.230	0.273	0.256	0.310

Regarding the influence of various MTO policy effects, households who leased-up reside in neighborhoods with lower poverty rates, higher median household income, higher labor force participation rate, lower unemployment rate, and fewer female-headed households, while those in the Experimental group reside in neighborhoods with lower poverty rates and higher median household income. Comparing the magnitudes of these effects, using a voucher has a much larger impact on these locational attainment outcomes than does assignment to the Experimental group.

Table 35 displays the same set of regression results using natural environment features as dependent variables. In these models, the influence of household characteristics is more variable by outcome measure. The race and ethnicity of the household head are significant in one or more models, but no other household characteristic other than vehicle access exhibits consistently significant impacts. Those with access to vehicles move to neighborhoods with more open space that exhibit lower population densities and more suburban street networks.

Table 35. Linear Regression Results of Locational Attainment, Natural Environment

OLS Linear Regression Results, Natural Environment

<i>Variable</i>	<i>Dependent Variable: % Open Space</i>	<i>Average Block Length</i>	<i>Population Density</i>	<i>% Buffer of Major Highways</i>	<i>Cancer Risk / Million</i>	<i>% Buffer of TRI Facilities</i>
<u>Treatment Effects</u>						
Experimental group	0.233	41.203	2,006.355	-1.800	-0.823	-7.363*
Section 8 group	0.523	166.012	2,396.813	1.905	-3.680*	0.588
Lease-up	2.704***	83.845	-3,412.201*	-2.256	-2.035	-11.038**
Lease-up x Exp. group	0.049	66.051	-3,282.366	-0.115	2.201	6.076
Lease-up x Sec 8. group	-1.510	-177.544	959.071	-4.073	5.839**	7.499
<u>Metro Controls</u>						
Baltimore	13.486***	83.053	-4,709.805***	23.621***	13.449***	-5.962
Boston	0.051	151.834*	4,112.126***	6.693***	7.083***	7.345*
LA	-0.183	560.682***	3,430.225**	0.359	25.164***	1.753
NY	-0.649	124.445	67,932.892***	2.126	27.297***	-5.331
<u>Household Characteristics</u>						
Car access at interim	1.660**	117.940	-4,098.039***	0.631	1.527	-3.796
Car access gained	2.002**	199.325**	-3,607.083*	-3.719*	-0.728	3.382
Car access lost	0.113	-67.844	1,613.446	-2.882	-1.111	3.526
Income	0.000**	0.004	0.061	-0.000	0.000	-0.000
Income squared	-0.000**	-0.000	-0.000**	0.000	-0.000	-0.000
Age of HH head	-0.191	16.157	198.040	-0.211	-0.151	1.488
Age of HH head squared	0.002	-0.128	-3.371	0.002	0.003	-0.013
HH head Black	-1.786	-227.881**	-151.009	2.520	-1.712	-5.120
HH head Hispanic	-1.021	-224.591**	-1,174.314	5.359*	-2.922	-2.382
HH head female	-0.759	36.340	-2,038.655	-5.146	-3.171	-5.710
HH head married	0.468	13.993	1,673.138	1.996	0.266	2.868
# children in HH	-0.175	-24.103	135.954	-0.386	0.153	1.259

HH head has high school degree	-0.336	-88.873	839.777	0.629	1.078	1.927
HH head employed	0.561	89.154	-1,534.930	-1.070	0.225	2.835
Baseline Neighborhood Characteristic	-0.080	0.089**	-0.187**	-0.005	-0.016	0.102***
Constant	6.321	1,284.737**	21,429.379	25.655	44.316***	1.739
Number of Observations	1,055	1,055	1,055	1,055	1,055	1,055
R-squared	0.292	0.105	0.554	0.155	0.294	0.063

Lease-up status is associated with a variety of natural environment outcomes, including higher levels of open space access, lower population density, and lower exposure to toxics. Assignment to the MTO treatment groups is also associated with lower cancer risk and lower exposure to toxics, but neither the experimental nor treatment group significantly influence other natural environment outcomes.

Table 36 reports the results from regressions using measures of economic vitality and access to opportunity as dependent variables. I find that the effects of the two treatment groups and lease-up status are not significant. Some other household characteristics are significant, but significance levels vary substantially across the various outcome measures. Regarding the influence of auto access, initial access and gain in access is associated with living in areas with lower job density. The findings with respect to school performance are particularly interesting. I find that African Americans and Hispanics both exhibit poorer access to high-performing schools. Losing access to a car is associated with residence in a neighborhood with better performing schools.

Table 36. Linear Regression Results of Locational Attainment, Economic Vitality and Access to Opportunity

OLS Linear Regression Results, Economic Vitality and Access to Opportunity

<i>Variable</i>	<i>Dependent Variable:</i>	<i>Job Density</i>	<i>Aggregate Income Density</i>	<i>School Performance Index</i>
<u>Treatment Effects</u>				
Experimental group		1,684.477	90,613,408.591	0.380
Section 8 group		-695.971	49,284,154.491	0.400
Lease-up		1,095.242	-107,547,062.910	1.895
Lease-up x Exp. group		-3,086.770	-104,558,814.099	0.463
Lease-up x Sec 8. group		-1,362.992	344,244.373	-0.532
<u>Metro Controls</u>				
Baltimore		-24.390	-74,587,595.656**	10.709***
Boston		2,489.987	225,076,050.074***	3.698*
LA		192.156	-17,497,946.055	6.413***
NY		10,748.221***	1,350,482,747.315***	27.077***
<u>Household Characteristics</u>				
Car access at interim		-2,652.688*	-64,903,061.439	1.751
Car access gained		-2,989.818*	-71,000,366.245	-0.314
Car access lost		879.575	-2,691,980.395	-5.372***
Income		0.018	2,622.338	-0.000
Income squared		-0.000	-0.043*	0.000
Age of HH head		381.224	19,315,944.793	-0.642
Age of HH head squared		-3.847	-204,409.077	0.006
HH head Black		-8,904.069*	-75,034,017.512	-8.662***
HH head Hispanic		-4,907.116	-38,978,244.991	-7.229***
HH head female		269.860	14,597,572.735	-2.607
HH head married		-2,493.384	-85,774,390.238	2.270
# children in HH		-84.513	-21,952,585.094	-0.182
HH head has high school degree		969.172	-15,584,398.737	1.347

HH head employed	-678.763	-101,154,182.602*	0.370
Baseline Neighborhood Characteristic	0.067	-0.298	0.191***
Constant	2,099.923	49,390,752.223	40.213**
Number of Observations	1,038	1,055	1,019
R-squared	0.069	0.255	0.350

5.4. Discussion

Table 37 provides a summary of the regression coefficients for lease-up status, treatment group assignment, and automobile access across all regressions. These tables report all coefficients significant at the .10 level. Comparing models, I find that lease-up status has more significant impacts on locational attainment than being assigned to either the Experimental or Section 8 group. Part of the explanation for these findings may be attributable to the length of time between the initial random assignment and the final survey, which was 10 to 15 years later in many cases. Even with this length of time, however, initial assignment to the experimental group has effects on locational attainment which persist across several outcomes. Taken together, these findings suggest that the initial exposure to low-poverty neighborhoods has impacts on long-term locational attainment, particularly when combined with successful voucher use.

Table 37. Summary of Linear Regression Coefficients of Locational Attainment Models

Summary of Regression Coefficients								
<i>Variable Description</i>	<i>Experimental group</i>	<i>Section 8 group</i>	<i>Lease-up</i>	<i>Lease-up x Exp. Group</i>	<i>Lease-up x Sec 8. Group</i>	<i>Car access at interim</i>	<i>Car access gained</i>	<i>Car access lost</i>
<u>Functional Environment</u>								
Median Gross Rent	NS	NS	132.023***	NS	NS	NS	57.718**	NS
Vacancy Rate	NS	NS	NS	NS	NS	-3.581***	-3.324**	NS
% Owner Occupied	3.772**	NS	7.493***	NS	NS	5.348***	5.426***	NS
% Single-Family Units	NS	4.105*	5.843**	NS	NS	5.853***	6.699***	NS
FHEA Transit Access Index	NS	NS	NS	NS	NS	-8.028***	-8.524***	NS
<u>Social Environment</u>								
Poverty Rate	-2.356*	NS	-6.157***	NS	NS	-4.539***	-5.428***	NS
Median Household Income	2,722.101*	NS	4,464.098***	NS	NS	4,214.392***	4,811.417**	NS
Labor Force Participation Rate	NS	NS	3.273***	NS	NS	2.042***	2.227**	NS
Unemployment Rate	NS	NS	-1.915**	NS	NS	NS	NS	NS
% Minority Population	NS	NS	NS	NS	NS	NS	NS	NS
% Female Headed Households	NS	NS	-4.161*	NS	NS	-3.452*	NS	NS
% 25+ w High School Diploma / GED	NS	NS	NS	NS	NS	4.547***	3.121**	NS
<u>Natural Environment</u>								
% Open Space	NS	NS	2.704***	NS	NS	1.660**	2.002**	NS
Average Block Length	NS	NS	NS	NS	NS	NS	199.325**	NS
Population Density	NS	NS	-3,412.201*	NS	NS	-4,098.039***	-3,607.083*	NS
% Buffer of Major Highways	NS	NS	NS	NS	NS	NS	-3.719*	NS
Cancer Risk / Million	NS	-3.680*	NS	NS	5.839**	NS	NS	NS
% Buffer of TRI Facilities	-7.363*	NS	-11.038**	NS	NS	NS	NS	NS

<u>Economic Vitality</u>								
Job Density	NS	NS	NS	NS	NS	-2,652.688*	-2,989.818*	NS
Aggregate Income Density	NS	NS	NS	NS	NS	NS	NS	NS
<u>Access to Opportunity</u>								
FHEA School Performance Index	NS	NS	NS	NS	NS	NS	NS	-5.372***

I find that auto access has significant impacts across a large number of locational outcomes, whether access is measured in terms of having a car at an earlier period or gaining access during the survey period. Those with access to cars gain access to neighborhoods with a more highly-valued housing stock, higher owner-occupied housing and single-family unit percentages, lower poverty rates, higher labor force participation rates, and a more educated adult population.

I also find that when it comes to environmental conditions and outcomes associated with access to opportunity and economic vitality, there are tradeoffs associated with having access to a vehicle. While households with vehicles live in areas with more access to open space, having a vehicle also encourages moves to neighborhoods that are less conducive to walking and that are less accessible to jobs and transit. Thus, when it comes to measuring “opportunity,” one must recognize that the spatial distribution of opportunities is heterogeneous. When faced with an uneven distribution of opportunity structures, households must often make tradeoffs and choose those which are valued most highly. Although my approach does not allow me to distinguish between the impact of household preferences versus spatial supply constraints as they influence the residential outcomes observed, I find that auto access has fairly consistent impacts across a range of housing market, social, economic, and environmental outcomes, and that accessing one particular dimension of neighborhood opportunity often comes at the expense of other dimensions of opportunity.

The findings on heterogeneity in reported levels of locational attainment in transit access by metropolitan area are somewhat unexpected, given that transportation infrastructure varies by metropolitan area. MTO participants in New York report the lowest levels of gains in transit access relative to the omitted metropolitan area (Chicago), followed by Los Angeles. New York has a more extensive heavy-rail public transit system, while Chicago has a mix of bus and rail transportation services and a more automobile-dependent transportation

network outside of the core central city. Los Angeles has a more automobile-based transportation system that relies heavily on a bus-based public transportation service. Combining with the effects of metropolitan controls in other models, this finding implies that those in New York and Los Angeles sacrificed transit access the most to achieve locational attainments in other neighborhood attributes such as median gross rent and percentage of owner occupants. This finding accounts for trends in tight rental markets for low-income households in New York and Los Angeles.

Chapter 6: Policy Implications and Conclusions

6.1. Policy Implications

6.1.1. Fair Market Rents and Affordable Housing

My findings obtained from the analysis of segregation of affordable housing provide some important context for current policy initiatives. Although housing vouchers have expanded housing options in comparison to the set of housing choices affordable to extremely low-income households in the market, most voucher households in the Moving to Opportunity metropolitan areas would have more housing options across the metropolitan area below the applicable Small Area Fair Market Rents than the applicable Fair Market Rent. Decomposed into different types of neighborhoods, the segregation of affordable housing would have improved in terms of spatial, economic, and racial aspects with Small Area FMRs. Despite high levels of inequality in low-poverty and high-percentage-white neighborhoods, the new rule would have provided voucher recipients with more evenly distributed affordable units across these neighborhoods, possibly leading to less segregation overall.

In his panel study on urban poverty and housing instability, Desmond (2016) argued that the housing voucher program could be expanded without additional costs by implementing Small Area FMRs. He theorized that such a rule would cause landlords in low-rent zip code areas to lower their rents to the applicable Small Area FMR because they would lose the incentive to overcharge due to the old payment standard. However, its feasibility also depends on the number of voucher recipients in low- and high-rent zip code areas. Assuming no moves, there should be an adequate number of overcharged vouchers in low-rent zip codes so that they can pay off the excess voucher costs in high-rent zip codes. Overcharging would be mainly due to households with more bedrooms than people. The more there are

overcharged vouchers in low-rent zip codes, the greater the budget to subsidize voucher households in high-rent zip codes. Nevertheless, if many voucher households move to high-rent zip codes as the Small Area FMR intended, it would inevitably require more budget or cause fewer households to receive assistance.

Besides its potential feasibility, Small Area FMRs might place a burden on housing voucher recipients who currently live in low-rent zip codes, since many of them would have to pay more under the new rule if they didn't want to move. A reduction in subsidy followed by an increase in rent contribution would challenge them to secure housing stability in existing units. Even if they decide to stay, the housing cost burden remains a serious issue, leaving very little income for families to spend on other essentials, such as food, medical care, transportation expenses, education, and childcare. They might choose to move out, but additional constraints in residential location choices beyond financial barriers, such as discrimination by landlords, portability moves outside the jurisdiction of the housing authority, a lack of access to public transit or vehicle, and strong social ties in the poor, original neighborhoods, would often frustrate mobility decisions. Therefore, the implementation of Small Area FMRs must put cautious effort into addressing these imminent issues.

Although HUD has recently announced a two-year suspension on the Small Area FMR rule, the final rule put cautious effort into addressing imminent issues (U.S. Department of Housing and Urban Development 2016). The final rule includes tenant protections, providing housing authorities with options to temporarily hold voucher contracts from payment standard reductions and gradually reduce housing assistance payment over time. The final rule would have been implemented to certain metropolitan areas meeting several criteria that takes into account the complexity of administration and rental market strength.

6.1.2. Social Networks

My findings on the link between social networks and the pattern of neighborhood mobility have implications for housing search services. I find that more than 25 percent of the MTO experimental households preferred to live in their original neighborhoods or its adjacent neighborhoods while they were required to use a voucher in low-poverty neighborhoods only. Since most of the baseline neighborhood exhibits poverty rates higher than 10 percent, a quarter of these households were likely to give up the opportunity to use a voucher and ended up in neighborhoods which were familiar to them. If such a pattern is affected by the tendency to maintain existing social networks, housing vouchers would be used more effectively if they are combined with more information on available housing options near their current residence or in the same neighborhood in which other individual housing needs are met respectively.

The impact of neighborhood social services is somewhat mixed, but it plays a significant role in making the first move. Allard (2009) found that a low-income household living in a high-poverty neighborhood or a predominantly minority neighborhood has access to far fewer social service opportunities than such a household in an affluent, predominantly white neighborhood. My finding on the negative effect of social services density on the likelihood of moving is consistent with Allard's finding. Nevertheless, it is difficult to determine whether households in neighborhoods with lower access to social services moved to neighborhoods where relatives or friends lived for a further dependency on social resources, or whether households who had initially fewer options to get social services and inevitably relied on local social networks moved to neighborhoods which exhibit a greater access to social services. In either cases, the availability of vouchers may encourage households to move out of neighborhoods with lower access to social services regardless of

the degree of social services at the destination, and even increase the probability of exposure to an abundant quality social services.

Since my finding also suggests that households tend to move back to their initial neighborhoods when they have strong kinship and friendship in these neighborhoods, it would be essential for housing vouchers to offer housing search services, such as information on available social services in voucher recipients' preferable neighborhoods. Voucher households might move back to the baseline neighborhood because they failed to link themselves to local social networks in a new neighborhood which would have provided them with resources and information around the neighborhood. As discussed in Galster and Killen (1995), there would be no improvement in an individual's perceived metropolitan opportunity set without social networks that acts as an outlet to neighborhood opportunities, even if the actual opportunity has increased following a move. In this sense, in order to relocate more low-income households to high-opportunity neighborhoods, housing search services should be expanded to connect voucher households with information and available resources, particularly with respect to social services.

6.1.3. Vehicle Access

My findings on the effect of vehicle access on locational attainment have implications for policies designed to enhance access to opportunity for low income households. I find that while the random assignment to a low-poverty neighborhood had long-term impacts on a few of desirable locational outcomes, these impacts tended to be much smaller and less significant than voucher use alone. Thus, the expansion of the Housing Choice Voucher program supported by expanded housing search services that provide information about the opportunities available in different neighborhoods may have a more significant impact on

poverty de-concentration and access to opportunity over time than residential mobility programs such as MTO which require households to move to low-poverty neighborhoods.

My results also suggest that housing search services should be tailored to the transportation needs of households receiving assistance. Transporting those without access to a car to prospective residential locations along with providing information about the public transportation options available in different neighborhoods may help to improve the number and quality of units inspected prior to a housing search. This policy recommendation is echoed by Shroder (2002), who finds that car ownership and the intensity of housing counseling services both increase the likelihood of lease-up among Moving to Opportunity program participants. He goes on to argue that while providing long-term transportation services may be expensive, combining such assistance with other educational programs may go a long way towards increasing the rate at which mobility program participants successfully lease-up in desirable neighborhoods.

Another implication of my findings is that combining rental vouchers with subsidies for automobile vouchers may be one possible approach to expanding the location choices available to low-income households. Alternatively, the increased availability of short-term car rental services such as ZipCar and Car2Go suggests that rental car use subsidies may be equally as effective at a lower cost. These services may be particularly useful to households with at least one licensed driver but who do not have sufficient assets to own and maintain a car. Coordination of housing voucher assistance with nonprofit car donation services and rideshare services is a third possibility. For example, the Baltimore Housing Mobility Program (BHMP) partnered with a local nonprofit car ownership program, Vehicles for Change, to help their voucher holders purchase a donated used car when moving to an opportunity area outside the city of Baltimore. BHMP also provided funding for state-required driving school tuition. Of course, the tradeoffs of such policies are that additional

auto-based travel will exacerbate the negative externalities associated with auto use, including congestion and air quality degradation. Furthermore, car ownership itself entails costs that accrue directly to owners, which may place undue burdens on low income families. These tradeoffs should be considered with any auto-based mobility strategy.

6.2. Conclusions

Housing policy has struggled for decades not only with the provision of affordable, adequate quality residential units to the most needy but also with the geographic dispersion of those from neighborhoods with concentrated poverty. Housing vouchers are designed to promote more housing options in the private market, but voucher recipients are still constrained in moving to neighborhoods in which opportunities are expanded for low-income households. The growing body of evidence linking neighborhood conditions to the economic and health outcomes of children in poverty points to the need for a better understanding of how housing vouchers increase access to opportunity. While previous studies have explored the impacts of housing vouchers, it still remains unclear what factors prevent voucher recipients from relocating to opportunity neighborhoods.

To fill the gap in the literature, I examined the constraints that housing voucher households face in neighborhood choices by addressing three barriers at the market, program, and individual levels. Drawing upon data from the Moving to Opportunity survey and various tract-level characteristics, I explored trends in affordable housing supply and segregation, analyzed social networks as a determinant of mobility, and estimated the effect of vehicle access on locational attainment. I find that housing vouchers have provided more housing options to low-income households in an era of declining affordable housing stock, but these options are segregated in high-poverty neighborhoods. Small Area Fair Market Rents that vary by zip code would greatly reduce the segregation of affordable housing, particularly in

terms of the difference in affordability levels in low-poverty neighborhoods and high-percentage-white neighborhoods. Social networks also tend to bind voucher recipients to their poor, initial neighborhoods. Although less access to neighborhood-level social services promotes moves out of the first neighborhood, households are likely to move back to their initial neighborhoods when they have strong kinship and friendship there. With regard to vehicle access, having access to a vehicle has impacts that are more significant and more consistently associated with locational outcomes than any other characteristic including lease-up status. While households with vehicles live in areas with more access to open space, having a vehicle also encourages moves to neighborhoods that are less conducive to walking and less accessible to jobs and transit.

Housing vouchers can be improved in such a way that reduces obstacles in residential location choices and expands housing options in high-opportunity neighborhoods. By allowing higher payment standards in expensive markets based on zip code, the implementation of Small Area FMRs would expand housing options and reduce the segregation of affordable housing across low-income neighborhoods and high-percentage-white neighborhoods. Housing search services can be tailored to the particular needs of individual voucher recipients not only by offering a list of available residential units in neighborhoods that are in close proximity to their family members and friends, but also by providing voucher households with information of social resources in high-opportunity neighborhoods. It can be further expanded to consider access to vehicle and access to public transportation. Combining housing vouchers with subsidies for automobile vouchers may be one possible approach to expanding the location choices available to low-income households.

My findings call for a more nuanced reframing of the geography of opportunity debates. An understanding of the neighborhood mobility of MTO participants calls into question whether housing policy itself successfully relocates low-income families to high-

opportunity neighborhoods. Policymakers should address market, program, and individual issues based on an in-depth understanding of underlying factors that affect residential location choices of low-income households with respect to access to opportunity. More importantly, it is crucial to inform voucher recipients of all available housing and neighborhood opportunities through housing assistance. Given that housing vouchers have provided households with a spatially heterogeneous opportunity structure and full information on opportunities without filtering, the goal of “moving to opportunity” may be more usefully rephrased as “moving to the uniquely customized opportunities.”

In addition to contributing to the ongoing debates on the geography of opportunity, my findings are expected to bridge the gap between research and policy with regard to how housing assistance programs could be improved in the context of the federal government’s charge to Affirmatively Further Fair Housing (AFFH). A final AFFH rule places emphasis on enhancements to taking actions that address significant disparities in housing needs and in opportunity accessibility. My focus on barriers of the housing voucher program sheds new light on the role of the federal government in rethinking the program rule and goals and in developing strategies in conjunction with other services and subsidy programs that increase integration and access to opportunity. Empirically, my results on affordable housing inequality and locational attainment adds depth to the online mapping and data-generating tool provided by HUD, the AFFH Data and Mapping tool (AFFH-T), for communities to address significant disparities in housing needs and opportunity accessibility.

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