

The Relationship Between Housing Vouchers and Educational Attainment in Atlanta, GA

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Abstract: This paper studies the impact that possessing a housing voucher versus living in public housing has on the educational attainment of children in the 3rd and 5th grade. To correct for potential endogeneity due to self-selection, I employ an instrumental variable approach. Findings show that children who live in households receiving housing assistance through vouchers have significantly higher standardized test scores than children living in traditional public housing. This result is robust across different model specifications and when controlling for endogeneity.

A thesis submitted in fulfillment
of the requirements for the degree of
Master of Science in Economics



Sciences Po
Department of Economics
2019

Acknowledgements:

I would like to thank my supervisor Professor Ghazala Azmat for her helpful comments and suggestions throughout the process of writing this thesis. I would also like to give a special thank you to Professor Thomas D. Boston of the Georgia Institute of Technology who collected the administrative data used in this thesis from the Atlanta Housing Authority (AHA) and Atlanta Public Schools (APS) and allowed the author access to it through a data sharing agreement. Dr. Boston's mentorship and encouragement have been pivotal in the completion of this work.

I would also like to thank my family and friends for their continual support of me and without whom this would not have been possible.

1 Introduction

Household assistance in the form of rent-subsidy vouchers has received considerable research attention for two primary reasons. The first is that in the United States, housing policy has undergone a massive shift from developing conventional public housing units to assisting low-income families through a rent-subsidy voucher. Unlike conventional public housing whose location is dependent on the development decisions by the local housing authorities, vouchers give families more autonomy over where they live. As this shift has led to the destruction of public housing units throughout the United States, research has been undertaken to evaluate the impact of this evolution of housing policy on the families concerned. The second reason is that housing vouchers provide an opportunity to study the idea of neighborhood effects. One of the primary goals of housing vouchers is poverty deconcentration. This goal arose partially in response to the theory that concentrated poverty and spatial isolation exacerbates negative social and economic outcomes for low-income inner city families. Data from residential mobility programs, such as the Gautreaux Program and the Moving to Opportunity project, that utilize housing vouchers to relocate families, therefore, has been analyzed to test the validity of this theory of neighborhood effects.

Past research has shown that households moving with a voucher have experienced significant improvements in mental health outcomes, but results from experimental and non-experimental studies alike have been much less promising when it comes to outcomes that impact socioeconomic mobility. One reason for this is that the neighborhoods that voucher recipients are reaching do not vary much from their neighborhoods of origin along several dimensions. One such dimension is school quality. In fact, youth whose household has moved on a voucher often attend the exact same school as before the move. Without the move resulting in the family having access to institutions of higher quality, a primary mechanism through which neighborhood effects are posited to operate is stifled.

This study reopens the question of the potential of vouchers to positively impact the lives of households using them. More specifically, it compares the educa-

tional achievement of children in the third and fifth grade living in voucher households to children of the same age living in conventional public housing. This paper brings new perspective to the literature studying the impact of housing vouchers and neighborhood effects by using a highly unique data set that matches each child in the sample to the type of housing assistance received, the neighborhood where the child lives, the school the child attends, and the test scores the child received on a standardized test called the Iowa Test of Basic Skills (ITBS). All data comes from families with children living and going to school in Atlanta, GA. In this way, I am able to study the impacts of having a voucher versus living in public housing on test scores while controlling for household, school, and neighborhood characteristics. Additionally, this research is novel in the sense that the data reveals that children using vouchers are in fact attending schools of significantly higher quality than children living in conventional public housing, as opposed to past studies which have found little variation in school quality between voucher holders and those in public housing. Reasons for why this may be are discussed in Section 7.

This study uses non-experimental research methods and finds that housing vouchers consistently have a significant and positive impact on educational attainment for children across all model specifications. Because I am not able to randomly assign some families to public housing and others to housing vouchers, the results of OLS regression may be potentially biased due to families self-selecting into each program. This bias may arise from the fact that families with certain unobserved characteristics that could positively impact their child's test scores are more likely to participate in the voucher program, for example. If this is the case, then OLS would overestimate the impact that holding a housing voucher would have on educational attainment. In order to correct for this potential endogeneity, I use the census tract level data of poverty rates and median income to instrument for housing voucher use. While the choice of these instruments may seem to run counter to the theory of neighborhood effects which posits a causal relationship running from poverty rates and median income to test scores (thereby invalidating their use as an instrument for voucher use), I have tested for this relationship and found that the instruments are still valid. I present these tests as well as elaborate on the problem of endogeneity in section 5.

The rest of the paper proceeds as follows. Section 2 provides information on the housing voucher program as well as an overview of how housing assistance has developed in Atlanta specifically. Section 3 provides a comprehensive literature review. Section 4 presents the empirical strategy utilized as well as goes into greater depth on the choice and validity of the instruments used. Section 5 presents the data and provides comparative statistics between characteristics of the households, schools, and neighborhoods of those living in conventional public housing versus those using vouchers. Section 6 provides the results of the OLS and IV regression analysis. Section 7 provides a discussion of the results and how they pertain to the future of housing assistance. Section 8 concludes.

2 Background

While there are several programs in the United States with the goal of combating housing affordability and homelessness, this paper focuses on analyzing the outcomes of two in particular: public housing and housing vouchers. Both programs rely on a type of rent-subsidy to assist low-income households, but the options that each provide the household differ. Programs such as these that are based on rent-subsidies are seen as the most generous and reliable forms of aid.[29] Public housing units are physical buildings that are owned and operated by a local public housing agency. These units are heavily subsidized so that tenants only pay about 30% of their income towards rent. Public housing developments, however, are highly concentrated in poor and socially isolated neighborhoods. Such locations tend to exacerbate disadvantage as living in low opportunity neighborhoods is theorized to detrimentally impact future economic and social outcomes. The Housing Voucher Program, therefore, was developed in response to the spatial disadvantage of public housing developments.[7] Households holding a voucher can apply it to any rental unit that they are able to find that is either at or below Fair-Market-Rent (FMR) (a value set by the Department of Housing and Urban Development for each metropolitan area) if the unit passes a standards inspection and if the landlord accepts the tenant. The household then only pays about 30% of income towards rent, with the voucher covering the rest. The goal of the program is to encourage low-income households to reach neighborhoods of higher opportunity than would have otherwise been ac-

cessible to them. Such residential mobility is expected to counteract some of the negative forces plaguing public housing developments.

Atlanta, GA is an appropriate city of focus when it comes to the question of housing assistance as the program not only has very deep roots in the city - it was the site of the first public housing project in the United States - but it has also seen much evolution throughout the years. In fact, the face of public housing in Atlanta, GA changed drastically after the city was chosen to host the 1996 Olympic Games.[21] Prior to the Olympics, housing projects in Atlanta were heavily concentrated in the inner-city and characterized by poorly maintained facilities and high crime rates. Because of their reputations for violence, these communities were largely avoided and residents were socially isolated. The development of public housing in the inner city (which was exacerbated by ordinances which prohibited public housing from being built in the suburbs) led to Atlanta having the second highest level of poverty concentration of any city in the United States and one of the highest concentrations of public housing residents.[21] The high levels of crime and the physical deterioration of the projects became the forefront of concern when preparing the city for the Olympics, especially since certain facilities chosen to host the games were located directly next to some of the worst projects. Atlanta's newfound prioritization of renovating public housing also coincided with the HOPE VI program which was a policy initiative launched in 1993 to provide funds for the demolition and subsequent transformation of public housing developments into mixed-income communities.[29] With the help of HOPE VI funding, the Atlanta Housing Authority developed the Olympic Legacy Program which was designed to replace four projects with mixed-income communities in the hopes of leading to significant poverty deconcentration within the city and ameliorating the housing conditions for low-income households.[21] The majority of residents who had been living in units slated for demolition accepted housing vouchers to relocate. Another large group relocated to other public housing developments. To have an idea of the locational outcomes that this change in housing policy caused, one can look at the concentration of public housing residents after the implementation of the Olympic Legacy Program. As the result of resident relocation from seven public housing sites, publicly assisted households were widely scattered throughout the city with the highest single concentration of residents being 11% in Dekalb

county.[21]

From 1994 until 2004, about 17,000 units of public housing were demolished in Atlanta and replaced with 10 mixed-income communities.[23] Only about 17% of residents living in the public housing developments that were eventually demolished returned to live in the mixed-income communities between 1995 and 2008, with the majority accepting to relocate with a voucher. Data used for this analysis comes from 2004, a time when there were still several public housing developments still located in the city; however, by 2011, Atlanta had demolished all public housing units for families and offered displaced residents housing vouchers to relocate on the private market.[22] The data for this study, therefore, comes at a pivotal time in the history of public housing in Atlanta and offers a comparison between outcomes for families living in conventional public housing versus outcomes for families utilizing housing vouchers. While I can not trace which families in my sample were originally living in public housing slated for demolition and which families entered the Housing Choice Voucher Program directly, it is important to recognize that the dataset studied in this paper includes both cases.

Eligibility requirements to be able to qualify to receive housing assistance are that the household must be low-income, at least one household member must either be a United States' citizen or an eligible immigrant, the applicant must be able to produce certain documentation such as proof of a social security number, and household members must also pass a criminal background check. One additional requirement to participate in the Housing Choice Voucher program as dictated by the Atlanta Housing Authority is a work requirement which states that one non-elderly, non-disabled, adult household member must maintain continuous full-time employment and all other households members eligible for employment must either maintain full time employment or participate in some kind of combination of school and/or job training, though authorities say that this requirement is difficult to monitor and termination from the program for failure to meet it has not occurred.[10] Despite its lack of enforcement, the existence of this work requirement may act as a source of sorting among families into different assistance programs, with those most likely to maintain a job being more likely to apply for the voucher. Such an outcome would support the

idea that comparison between families utilizing vouchers with families in public housing units would be biased due to self-selection bias.

To evaluate this idea of sorting into programs a bit further, it is important to recognize not just who programs of housing assistance serve, but who these programs do not serve. Affordable housing programs are not entitlement programs meaning that one does not automatically receive aid simply by meeting eligibility requirements. As a result, many more families are eligible for assistance than those who receive it. In 2005, just one year after data for this study was pulled, only 24% of households who had housing needs were served by any type of federal assistance program. By 2015, this number had declined to 21%.^[15] Assistance through the Housing Choice Voucher program is very limited and characterized by long waiting lists. The timeline from the moment a household applies for a voucher to the day that it is received can take from a few months to several years due to long waiting lists and low voucher turnover rates. As an example to illustrate just how saturated the program is, as of today, the waiting list to receive a housing voucher in Atlanta is closed indefinitely. In fact, in the past four years, the list has only been reopened for a total of two weeks: once in March 2017 and once in January 2015.^[18] Because of the sheer number of applications to the program, when a voucher becomes available, the Atlanta Housing Authority uses a process of random selection to blindly draw a household from the waiting list, so that each household on the list has an equal chance of receiving assistance with no preferential wait times for households in special circumstances. According to the Department of Housing and Urban Development's Picture of Subsidized Household database, in 2004, the average waiting time to receive a voucher once put on the waiting list was about 15 months (as opposed to 8 for public housing) and the average time spent using the voucher was about 5 years (as opposed to about 8 for public housing). This implies that households applying for housing assistance are constrained by aid availability and may be more likely to accept what is available at the time rather than wait for their preferred program. The difficulty of getting on the waiting list to begin with combined with the uncertainty of the wait time to receive the voucher makes it difficult to make future plans with housing assistance in mind, which in turn will impact the ability of a household to self-select into any given program. Additionally, the potential issue of selectivity bias may be further

mitigated by the number of households who entered the voucher program due to the demolition of their previous assisted residence in Atlanta. While not all residents in buildings slated for demolition chose to accept a housing voucher, being in a condemned unit certainly increased the chances of a household moving from public housing to the voucher program. If the choice of developments being demolished was exogenous to resident characteristics, these demolitions caused a random population of households to move to the voucher program that would have otherwise been living in public housing. These demolitions, therefore, by increasing the probability of a household having a voucher, distort the self-selection process.

3 Literature Review

3.1 Neighborhood Effects

In his work *The Truly Disadvantaged*, William Julius Wilson sets forth a theory of neighborhood effects that analyzes the relationship between spatial disadvantage and economic and social outcomes. Wilson argues that the concentration of low-income, minority households in the inner city exacerbates poverty due to various characteristics of such neighborhoods. For example, the loss of entry-level jobs in the inner city has produced a spatial mismatch between the skills of low-income households and the job opportunities arising in their vicinity. Additionally, Wilson presents the finding that schools heavily attended by low-income, mostly minority children have “radically different internal environments, methods of teaching and attitudes toward students than predominantly white, upper middle class suburban schools” and that “consignment to inner-city schools helps guarantee the future economic subordination of minority students.” [31] Poor inner city neighborhoods, therefore, suffer from concentration effects meaning that the overall social disadvantage of an area will impact the constraints and opportunities that those living in such areas will face. Wilson proposes that the problems of concentrated inner-city poverty would be best alleviated by policy that promotes social, and therefore geographic, mobility. Such geographic mobility, he posits, is also dependent on the elimination of housing policy and zoning laws which concentrate the poor in the most disadvantaged and low-income areas.

Research has attempted to quantify to what extent neighborhoods influence outcomes, with several different mechanisms cited. For example, theories for why advantaged neighborhoods may positively influence outcomes include the role of peer effects, the influence of affluent adult role models, and the impact that neighborhood institutions such as schools have on those utilizing such resources.[13] Other factors such as social networks, exposure to crime and violence, and physical distance and isolation have also been studied.[5] There are several difficulties with studies that attempt to quantify neighborhood effects. One is that of self-selection. Where people choose to live is non-random and therefore the outcomes that may otherwise be attributed to neighborhood effects would be biased, even when controlling for family characteristics. The other issue is that it is difficult to pinpoint the specific mechanism through which neighborhood effects (if they are found to be present) are working as many of the theories predict that the same outcomes could have different causes (i.e. higher grades in school could come from the higher quality school or positive peer effects).

3.2 Residential Mobility Programs

Two of the most notable residential mobility programs in the United States are the Gautreaux Program and the Moving to Opportunity project. They are particularly well-known for the role they have played in contributing to the literature examining the impact of neighborhood effects on low-income families and are described in detail below.

The Gautreaux Program

The Gautreaux program marks a significant shift both in Housing policy and in research on neighborhood effects in the United States. This program arose out of a lawsuit against the Chicago Housing Authority and the Department of Housing and Urban Development on the grounds of deliberate reinforcement of neighborhood segregation and poverty concentration. Two years after the passage of the Housing and Community Development Act by Congress in 1974, which shifted the focus from conventional public housing developments to rental certificates (later to become housing vouchers), the Gautreaux program was

born. This program would rely on rental certificates and the private housing market to eventually relocate 7,100 families throughout 115 communities over a 20 year period.[8]

The Gautreaux program was originally of academic interest because its goal was to place minority, low-income families into majority white, low-poverty communities. This provided scholars with an opportunity to study the impact that living in such communities had on these families. Additionally, because of the emphasis on race, the program provides an opportunity to study the role that the racial composition of a neighborhood plays on the the outcomes of the assisted family moving there. Mendenhall et al. (2006), for example, utilize the quasi-experimental nature of the Gautreaux Program to analyze the impact that relocating to a new neighborhood had on the percent of time that the head of household (which was restricted to only female-headed families who relocated prior to 1990) received AFDC (Aid to Families with Dependent Children) as well as the percent of time she was employed with earnings. The study finds several neighborhood-level variables to be significant. When analyzing time spent on AFDC, they find that neighborhood crime levels, the male unemployment rate, and whether or not the family is living in a neighborhood with a low percentage of black residents are all significant determinants of time spent on AFDC. For neighborhoods with low percentages of black residents and high resources, the heads of households spend about 7% less time on AFDC. Similarly, when using neighborhoods with low percentages of Black residents and high resources as the reference group, heads of households have a significantly longer percentage of time employed with earnings - about 6-9% more time with earnings. [20] While this paper did not find a significant impact of living in the suburb versus the city on time employed with earnings, previous research has found that moving to the suburbs increases the likelihood of employment.[25] Another outcome for which there was a statistically significant difference between those who relocated to the city and those who relocated to the suburb was education. Those who moved to the suburbs fared much better in the areas of completing a high school diploma, being on the college track in high school, attending college, and attending a 4-year college.[26]

The applicability of results of the Gautreaux Program for both the use of vouch-

ers as a housing policy tool and for research on neighborhood effects have been called into question. Because the program was created in response to a lawsuit demanding that housing be more racially integrated, the goal of the program was to place low-income, black families into majority white neighborhoods using free market housing. Since it was a difficult task finding units in majority white neighborhoods that met the rent criteria as well as finding landlords willing to accept tenants participating in the program, a council was formed to aid the relocation of participants throughout the process. Such individualized support to find leasing opportunities is not available for most voucher holders, which calls into question the housing opportunities that the participants would have been able to find without help. Additionally, this council conducted extensive screening of potential participants in order to flout the quality of Gautreaux tenants to landlords with the goal of encouraging participation. The screening process involved interviews and home visits. Such a high level of selectivity is not only not found in the Housing Choice Voucher Program, but also questions the generality of findings to a less select sample. Additionally, in order to increase the success rates of relocating families through the program, the council also limited participation to families who had access to a car and who had no more than two or three children, since moving to the suburbs posed problems for families relying on public transportation only available within the city and locating apartments larger than two-bedrooms but still within rent limits proved too difficult a task.[8] This level of selectivity resulted in a sample of families that had very particular characteristics, so that research on the outcomes for this group can not necessarily be applied to those who did not pass the screening process, or who represent the more general situation of families moving through the voucher program. The selection process used in the Gautreaux Program not only casts doubt on the applicability of its outcomes, but also on the relevance of the program when it comes to evaluation of the use of vouchers as a method to address affordable housing needs. Throughout the placement process, the qualifications for potential tenant characteristics changed due to constraints of finding housing on the free market. If only families with less than 3 children and who have access to a car can reach better neighborhoods using a voucher program, then such a program will not be successful over a broader sample in relocating families.

To further illustrate this, it is helpful to briefly consider the Gautreaux Two housing mobility program which was launched in 2002. Gautreaux Two was more limited in scope, with only 1,120 families initially registered and only 450 of these families completing all the steps necessary to participate. These families did not have the same level of counsel that families participating in the first wave of the program had. In Gautreaux Two, families were expected to locate housing and meet landlords on their own, resulting in only 36% of families successfully moving. In a qualitative study of outcomes, families cited impediments to moving such as an unwillingness of landlords either to accept a voucher or to make the necessary repairs in order for the unit to be up to standard; lack of moving assistance; overall housing market constraints; and personal obstacles such as a lack of time to search for housing.[24] Further studies of this program suggest that families faced certain problems such as a lack of transportation in suburban areas as well as fewer programs and activities targeted toward low-income children.[33] While such constraints may not outweigh the benefits of moving to a quieter, safer area, they are important to address as they will impact the long run success and integration of the family in a given neighborhood, which are important factors when evaluating neighborhood effects.

Moving to Opportunity

The Moving to Opportunity (MTO) project was developed by the Department of Housing and Urban Development. Families who were both eligible and interested in participating (eligibility criteria included already receiving housing assistance, having children in the household, and residing in a census tract with a poverty rate of 40% or more) were selected and then placed into one of three groups: the Section 8 group, the Experimental group, and the Control group. The Section 8 group most closely mirrors the conditions of families participating in the Housing Choice Voucher Program as it is usually conducted in the sense that they were given a geographically unrestricted housing voucher and no counseling assistance. The Experimental group also received a housing voucher but could only use it to move to an area with a poverty rate of less than 10% and received assistance from a nonprofit to locate units. The Control group did not receive housing vouchers, but retained the type of housing assistance that they had before the implementation of the program.[14] Because families were

randomly assigned across groups, MTO is free from the self-selection bias that may occur when families are able to select into treatment groups. In this sense, the experiment is viewed as a reliable measure of the potential neighborhood effects that participating families might experience.

Early analysis of the MTO program analyzed outcomes along three main dimensions: children's human capital development, adult economic self-sufficiency, and various factors affecting family quality of life. Results show that there are declining behavioral problems for male youth in both treatment groups and not statistically significant effects on behavior for female youth from either group. There are no significant differences between groups when analyzing rates of welfare receipt, neither are there significant differences between groups in employment rates. Members of the Experimental group felt significantly safer in their new neighborhoods, while this judgment of safety was not significant for the Section 8 group. Adult mental health improved for both treatment groups relative to the Control group.[14]

Follow-up analysis shows that results are consistently strongest in the area of mental health, that there are overall beneficial outcomes for teenage girls but negative outcomes for teenage boys, and that there are no statistically significant impacts on adult earnings or employment.[16] The most recent research of MTO takes into account the impact of time exposure to certain neighborhoods when analyzing outcomes. It once again finds no impact on adult economic outcomes, but finds impacts on children that vary across time. There are positive impacts for younger children who move to better neighborhoods, these benefits fade as they enter adolescence, and then they reemerge as the children enter adulthood as shown by measures such as earnings and college attainment.[1]

The MTO experiment and its findings raise important questions regarding the impact and magnitude of neighborhood effects. While there were certain benefits for treatment groups in the areas of mental health and youth behavior for example, there were not as convincing of results in areas correlated with long-term economic success. MTO is a successful experiment in the sense that it utilized a randomized design to control for self-selection of participants and that it placed participants in neighborhoods that varied along dimensions such

as socioeconomic composition and levels of safety.[19] Findings from this experiment, however, raise certain questions regarding the mechanisms through which neighborhood effects are to work. For example, the children in the treatment group of the MTO experiment did not necessarily attend schools that varied in quality from the ones they were attending before moving. In fact, analyzing the movement of MTO participants to neighborhoods in Chicago, findings show that treatment and control groups moved to the exact same communities in terms of spatial disadvantage. This means that even if MTO treatment groups are moving to lower-poverty census tracts, these tracts are entrenched in high-poverty areas suggesting that they still may be highly resource deprived.[28] The question of defining what opportunity means for a certain area therefore is important to address. If the primary difference between neighborhood attainment in the MTO experiment is in the area of crime rates and overall feelings of safety, then it is not surprising that the strongest effects were seen in the area of mental health. If the neighborhoods, however, are not measurably different when it comes to resources or access to opportunities, it is also not surprising that outcomes do not differ between groups in areas such as economic success.

3.3 Education and Assisted Housing

While the quasi-experimental and experimental residential mobility programs described above were utilized to measure several dimensions of neighborhood effects, there is also a body of non-experimental research that analyzes the relationship between household assistance and educational attainment specifically. As it is non-experimental, these studies must rely on regression techniques in order to correct for the potential endogeneity that may be present between participating in a certain housing assistance program and educational outcomes.

Currie and Yelowitz (2000) conducted a study to determine how living in public housing versus living in low-rent housing available on the free-market impacted children's outcomes. It is important to notice that Currie and Yelowitz are not comparing those living in public housing to those participating in the voucher program as is the focus of the current paper, but rather they are comparing outcomes for families living in public housing versus comparable families navigating the free housing market unassisted. In order to correct for potential self-selection bias, Currie and Yelowitz develop an instrumental variable approach, utilizing

the sex composition of children as an exogenous predictor of living in public housing versus looking for free-market alternatives. This IV is justified on the grounds that the sex-composition of children impacts the number of rooms that the family is eligible for and therefore increases the subsidy/incentive to live in assisted housing, but otherwise has no impact on educational outcomes. Using OLS regression techniques that control for observable characteristics, there are no significant differences between children living in projects and other children in school ratings, extra-curricular activities, and grade retention. When using an IV regression in order to correct for potential endogeneity, findings show that children in public housing are less likely to be held back. What's more, the study also finds that families living in public housing are in units of better quality than what they would have had access to on the private market unassisted.[2]

Another study conducted by Jacob (2004) compares educational outcomes for children living in public housing to children whose households are using a voucher. The goal of the study is to determine the impact of high rise public housing on student achievement. In Chicago in the 90s, several public housing complexes were demolished. This study draws from data on building demolitions in cases where the building was condemned for reasons arguably uncorrelated with resident characteristics. Families living in condemned public housing were offered the option of transferring to another public housing complex, transferring to another unit within their development, or use a Section 8 voucher to relocate. As living in a building that was to be demolished significantly decreased the probability that the family would continue living in public housing (i.e. about 30% of the families chose to take the voucher instead of relocating to another public housing unit), the author uses buildings slated for demolition as an instrument for a family using a housing voucher. What makes this study different from research gathered in both the Gautreaux Program as well as MTO is that families who relocated did not volunteer to be a part of the program, but were forced to move because of the impending demolitions. These families also did not receive residential counseling services nor did they have any geographical restrictions or suggestions of where to move. The treatment group, therefore, is the families living in buildings slated for demolition while the control group is comprised of comparable families in buildings not slated for demolition. Findings show that demolitions had a marginally negative effect on

the educational attainment of children 14 years or older, and no significant impact on younger children. There are two proposed reasons for this small effect. The first is due to the relatively small take up rate of the Section 8 voucher. The second, and the one particularly important since it is an outcome consistent in both experimental and non-experimental studies alike is that children who moved out of public housing complexes with vouchers experienced only marginal changes in neighborhood characteristics. Three years after the building closures were announced, children in the treatment group attended schools that were almost identical in measures of peer achievement to those attended by children in the control group.[12]

3.4 Locational Outcomes of Assisted Households

Given the theory of neighborhood effects and the positive impact that moving to a neighborhood of higher opportunity is posited to have on low-income families relocating there, it is surprising that results for the impact of holding a voucher on educational attainment are not stronger. One recurring finding in studies on the issue, however, is that the relocation of the family does not lead to the child attending a school much different than the one he or she would have been attending if the move had not occurred. This calls into question what defines neighborhoods of better opportunity and what is the potential of a voucher user to access such neighborhoods.

Ellen et al. (2016) asked this question of why voucher holders do not relocate to areas with better schools. The study compares the locational outcome of voucher holders to comparable low-income households who are not using vouchers. As the voucher provides a significant rental subsidy, families who are recipients should be using the relative extra income gained from the voucher to move to a higher opportunity neighborhood with a higher performing school. Results of the study find that voucher holders for whom schooling matters the most, i.e. who have a child who is just about to meet the age cutoff for kindergarten, are more likely to move to areas with better schools. In fact, households with children of any age are more likely to move closer to a higher performing school than households without children. Families with older children, however, are less likely to move to higher performing schools, potentially because of an unwillingness to disrupt the child's education once he or she has been

attending a particular school for several years. Their research also suggests that constraints on movement impact household's relocation decisions. Families with better quality schools nearby before the move are more likely to relocate nearer to these schools, suggesting either that proximity matters for informational purposes or that families are unwilling to disrupt established networks by moving farther from their original location. They also find a marginal impact of housing market constraints such as the availability of Fair-Market-Rent units on locational outcome, but it is not immediately evident that the lack of FMR units near better schools is a significant constraint for families.[4]

Wang (2016) measured whether or not voucher holders were able to locate to their neighborhood of choice based on preferences of neighborhood characteristics. Unlike other papers which take poverty rates as a proxy for neighborhood quality, this one analyzes locational outcomes along several dimensions. The first set of dimensions are constructed to capture the level of opportunity prevalent within the neighborhood and include poverty rates, racial diversity, low crime rates, and high-quality schools and building conditions. The second set are used to determine the relative ease of transportation from the dwelling place to destinations such as employment, schools, shopping, and recreation. The goal of this paper, therefore, is to determine to what extent families using vouchers have a choice in where they end up living as determined by their neighborhood preferences. In other words, are locational outcomes driven more by household preferences or by market constraints? Overall, voucher holders in this study place the highest preference on unit quality. The next highest preference category is opportunity, making accessibility the least important on average. Interestingly, within the dimensions measuring neighborhood quality, safety was the most important. The physical condition of the neighborhood and school quality were ranked the next highest while poverty rate and racial diversity were ranked much lower and not important criteria for families. 58% of households in this study indicate that after relocating, their new neighborhood did not meet even a single criteria indicated as high preference in either the opportunity category or the accessibility category. In fact, only 4% of families indicate that they were able to access a neighborhood that met a high-preference criteria in both opportunity and accessibility. According to the study, barriers to accessing neighborhoods that fulfill preferences include lack of information

on available units, difficulty in finding eligible units (mostly because the rent was too high), and a refusal of landlords to accept vouchers.[30]

4 Empirical Strategy

4.1 Overview

The greatest difficulty in estimating the relationship between the Housing Choice Voucher program and student test scores is the potential for bias due to self-selection. The source of endogeneity between voucher use and test scores can be demonstrated by the following scenario: (1) household heads who place a high value on school quality may select in to the voucher program in order to utilize the residential mobility afforded by the voucher to move to a neighborhood with a school of better quality, (2) due to their value placed on schooling, these same household heads may invest more in their child's education outside of the classroom, for example, through ensuring the child completed his or her homework each day. The higher school quality and the outside investment in schooling would both act to increase child test scores, meaning that through the OLS estimate alone, it is impossible to tell if the equation is estimating the impact of holding a voucher on test scores or the impact of the unobserved family characteristics on test scores. This means that the OLS estimation of the value of holding a housing voucher in terms of test scores is biased if in fact endogeneity exists in the equation.

In order to address the potential of self-selection bias in my data set, I will be applying a simultaneous equation model mirroring that which was developed in Evans, Oates, and Schwab (1992).[6] The equations are as follows:

$$y = \beta_1 \mathbf{X}_f + \beta_2 \mathbf{X}_s + \beta_3 D + \epsilon_1$$
$$D = \gamma_1 \mathbf{X}_f + \gamma_2 \mathbf{X}_s + \gamma_3 \mathbf{X}_{ex} + \epsilon_2$$

The first equation represents the OLS linear estimation of the impact of holding a housing voucher on educational outcomes. The dependent variable of interest,

y is a child’s standardized test score. The explanatory variables are controls for family characteristics represented by \mathbf{X}_f , controls for school characteristics represented by \mathbf{X}_s , and a dummy variable D indicating whether the household is using a housing voucher or is living in a conventional public housing unit. This equation is potentially biased due to the expected endogeneity between housing voucher usage and testing outcomes - both may be stochastically related to an unobserved component of the error term ϵ_1 .

The second equation corrects for the self-selection present in the first by predicting housing voucher usage using exogenous variables that are independent of ϵ_1 , thereby effectively ridding the housing dummy variable of the component which was endogenous to y . These predicted values of housing voucher usage are then substituted for actual housing voucher usage in the first equation to estimate the impact of vouchers on test score outcomes. These explanatory variables are depicted by \mathbf{X}_{ex} . In order to successfully correct for endogeneity, \mathbf{X}_{ex} must be sufficiently strong predictors of holding a housing voucher but otherwise be unrelated to the outcome variable of interest y . In other words, the only causality link between \mathbf{X}_{ex} and y should come indirectly through the impact of \mathbf{X}_{ex} on D . The aforementioned paper by Evans, Oates, and Schwabb addresses the relationship between peer groups and teenage pregnancy, and uses this simultaneous equations design to control for the endogeneity present between a teen’s peer group and unobserved family characteristics, as peer groups are largely impacted by both the residential decisions made by parents and the unobserved steps a family may take to lower the probability of teenage pregnancy. The exogenous variables that they use to correct for this are the metropolitan level characteristics of unemployment rate, median family income, poverty rate, and the percentage of adults who completed college, arguing that such variables are a good indication of school quality (and therefore indicative of potential peer group composition) but do not themselves impact teenage pregnancy outcomes.

Similarly, I use census-tract level variables as exogenous predictors of housing voucher use. I have included the poverty rate and the log transformed median income level within \mathbf{X}_{ex} . These variables are all predetermined characteristics of neighborhoods and are correlated with neighborhood traits that voucher recipients would observe and utilize in their choice of where to relocate, but

are otherwise independent of voucher use, i.e. the relative number of voucher users moving to any given neighborhood is not enough to influence its census-tract level characteristics. These variables are also very likely associated with areas having schools of higher quality. Since school quality is an often cited component of the relocation decision of families with children, these variables are potentially strong predictors of housing voucher usage within a given area. These chosen exogenous predictors also have no endogenous relationship with the unobserved family characteristics in the first equation - a household's unobserved level of value of education will not influence the poverty rate of the neighborhood that they are moving to and vis-versa. Additionally, given the nature of housing assistance, it should primarily be voucher users reaching these more desirable neighborhoods and not those assisted through conventional public housing, since conventional public housing does not afford the same level of locational choice.

4.2 Validity of Instruments

In order for these variables to be valid instruments, they must have adequate explanatory power over housing voucher usage but not be correlated with a child's test score. These conditions can be analyzed empirically and using the literature. The first condition can be tested by analyzing the first stage equation that predicts housing voucher usage using the control variables from the original equation and the instruments. This regression has an adjusted R-squared value of just over .50, indicating that the predicted values of housing voucher usage are not so highly correlated with the original values as to still possess their endogeneity with test scores, neither is this value so low as to render this first stage regression meaningless.[11] Poverty rate and log transformed median income are both statistically significant at $p < 0.001$. The results of this regression are summarized in Table 1. When putting these instruments into the equation explaining child test scores, however, neither are statistically significant and their inclusion adds very little explanatory power to the model (R-squared value increases from 0.5637 to .05686). Results of this regression can be found in the Appendix. Empirically, this means that our instruments are strong predictors of the endogenous variable, but not of the dependent variable. This is promising

evidence of the validity of the instruments.

	<i>Dependent variable:</i>
	Housing Voucher Dummy
Total Household Income	0.000003* (0.000002)
Number of People in Household	-0.02054*** (0.00565)
Employment Dummy	0.04674* (0.02455)
Married Dummy	-0.07600 (0.08957)
HOH Age to Child	-0.00052 (0.00596)
HOH Age to Child Squared	-0.00002 (0.00010)
Number of Fulltime Teachers	0.00633*** (0.00110)
Student to Teacher Ratio	0.01217** (0.00476)
Percent of Free or Reduced Lunch Students	-0.08537 (0.05268)
Gender Dummy	-0.02194 (0.01754)
Poverty Rate	-0.02967*** (0.00137)
Log of Median Income	-0.46070*** (0.04653)
Constant	6.10313*** (0.52780)
Observations	1,553
R ²	0.51298
Adjusted R ²	0.50919
Residual Std. Error	0.34402 (df = 1540)
F Statistic	135.17560*** (df = 12; 1540)
<i>Note:</i>	*p<0.1; **p<0.05; ***p<0.01

Table 1: First Stage Regression

I now turn from an empirical analysis to an analysis of past research in order to further examine the validity of the instruments. Once again, a relevant study to look to when trying to examine the relationship that neighborhood characteristics such as poverty rate and median income may have on educational attainment is the Moving to Opportunity experiment described in Section 3. As previously described, participants using vouchers belong to one of two groups: the Experimental or the Section 8. Members of the Experimental group received mobility counseling and were required to move to an area with a poverty rate of less than 10% during at least the first year of holding the voucher, while the Section 8 group faced no such restrictions. Looking at the density distribution of the two groups across poverty rates shows that nearly 60% of the Experimental group lived in neighborhoods with poverty rates of less than 20%.^[16] While Section 8 compliers also move to lower poverty neighborhoods when compared to the Control group, the shift in density is not as drastic. Empirically, the poverty rate distribution of the Section 8 group more closely resembles that which is attained by the households using vouchers in this present study than does the distribution of the Experimental group (in the current study, only about 20% of households using a voucher live in a census tracts with a poverty rate below 20%). A density rate of the poverty rates of neighborhoods within this study by type of housing assistance received can be found in the Appendix. Because households using housing vouchers in this study demonstrate a closer resemblance to the Section 8 group, I use outcomes for the Section 8 group as the relevant results to analyze when determining the relationship between neighborhood characteristics and educational outcomes. Another reason that results from the Section 8 group are desirable when analyzing this question is that while poverty rates differ between the Section 8 and Control group, the difference in school quality between the two groups is low and not statistically significant. The authors explain that “the small changes (in school quality) for the Section 8 group are not surprising since many of the households remain in the city of Boston with many of their children staying in their original schools.”^[14] This means that results from the MTO experiment can provide a good indication of the direct impact of poverty rates on educational attainment, isolated from the impact of school quality.

Katz et al. (2007) measure educational outcomes using a composite index com-

posed of measures such as whether or not a student is still in school as well as results from standardized reading and test scores. For the Section 8 group, there is no statistically significant impact of moving to a lower poverty neighborhood on educational outcomes. The only groups for which the impact on education is significant at the 5% level is for female and male youth belonging to the Experimental group (0.136 and -0.235 respectively), which, as stated above, has a poverty rate density much lower than the sample used in this analysis, implying that there may be a threshold for which poverty rates begin to impact education. However, since the data in this study more closely resembles the Section 8 distribution than the Experimental, this potential threshold is likely not met.

The idea that there may be a threshold of poverty rates that must be crossed before they will have an impact on educational outcomes is consistent given the results of other papers studying the issue. Jacob (2004), who analyzes the impact that demolitions of public housing complexes in Chicago have on educational outcomes, shows that when families move to slightly better neighborhoods as defined by poverty rates, but do not attend schools of higher quality, there is not significant impact on educational outcomes of children under 14.[12] In contrast, Wodtke et al. (2011) find that sustained exposure to disadvantaged neighborhoods has a large and significant impact on educational outcome as measured by high school drop out rates.[32] This paper, however, compares those exposed to the most disadvantaged neighborhoods to the least. In the least disadvantaged quintile, less than 5% of residents are classified as poor. Such a neighborhood is not a realistic standard of comparison to data in this study as only 1% of households in the sample live in a neighborhood with a poverty rate of less than 5%.

Given the results of the empirical analysis as well as surveying past literature, it is reasonable to conclude that for the current study, the neighborhood level characteristics of poverty rates and median level income have a negligible impact on educational outcomes. The use of these variables as instruments for housing voucher usage, therefore, remains valid.

5 Data

The analysis focuses on the city of Atlanta, GA. The data is comprised of a compilation of observations taken from the Atlanta Public Housing Administration matched with data from Atlanta Public Schools. Children who are either in the third or fifth grade whose households are receiving housing assistance are identified. Each child was matched to his or her elementary school as well as his or her exact standardized test score. Using information from the Georgia Department of Education as well as performing a GPS overlay, each student's school and neighborhood characteristics are also matched to the data. The dataset, therefore, contains information on the child's school, household, and neighborhood characteristics as well as his or her academic performance. In total, there are just over 1,500 students represented whose household is either in conventional public housing or the voucher program. All observations are taken from the year 2004.

The explanatory variable of interest is whether a child belongs to a household using voucher assistance or a household living in conventional public housing. The dependent variable is a child's ITBS test score. This score serves as a proxy for educational attainment. The Iowa Test of Basic Skills (ITBS) is a standardized test to measure student performance designed for students in grades kindergarten through 8. Using elementary level test score data is recommended by the literature to analyze education attainment for publicly assisted households for two main reasons. One is that research has emphasized the importance of early childhood education in long term educational success. The second is that residential location is a strong determinant of elementary school access but becomes slightly less relevant for middle and high school access.[3] The question of school access is important because ultimately, vouchers allow households to change neighborhoods, implying that voucher holders will send their children to different schools. If the move, however, has no impact on the school that the child is attending, then a primary mechanism through which student performance is influenced (i.e. school quality) is stifled as the tie between location and school access deteriorates.

Below, I have included a table that describes the list of variables used in the

regression analysis as well as provides the group of reference for all dummy variables.

Table 2: Variable Definitions.

Variable Name	Definition
Housing Voucher Dummy	0-1 dummy variable that equals 1 if the household is using a housing voucher
Child ITBS	The individual ITBS test score of an assisted child in the 3rd or 5th grade
Number of People in Household	The number of individuals living in a particular household
Employment Dummy	0-1 dummy variable that equals 1 if the head of household is employed
Married Dummy	0-1 dummy variable that equals 1 if the head of household is married
HOH Age to Child	The difference in age between the individual classified as the head of household and the child observed
Number of Fulltime Teachers	The number of fulltime teachers working at the school
Percent of Free/Reduced Lunch	Percent of student body that receives a free or reduced lunch
Gender Dummy	0-1 dummy variable that equals 1 if the child is male

Continuation of Table 2	
Variable Name	Definition
Poverty Rate	The poverty rate of the census tract where the child lives
Median Income	The median income of the census tract where the child lives

5.1 Assisted Households

The dataset has 6,717 total observations representing 1,467 distinct households. Of the households in which a student either in the 3rd or 5th grade has been identified, 1,340 households remain, yielding a sample that contains 1,717 student observations. Despite the number of households represented, the characteristics of the identified heads of household are relatively uniform throughout the sample. Just over 98% are women, and an almost identical percentage identify as not being married. Over 99% of households are black. About 61% have an annual income of less than \$10,000 per year, about 27% make between \$10,000 and \$20,000 per year, and the remaining 11% make above \$20,000 per year. About 90% of households are classified as below poverty within the sample. For both types of assistance received, a majority has a head of household classified as not working, although this majority is greater for those in conventional public housing than for those receiving voucher assistance (78.9% vs 59.9%). This result is interesting given Atlanta's work requirement attached to holding a voucher, but not necessarily surprising as the requirement is rarely enforced.[10]

Table 3 breaks down household characteristics by type of housing assistance received.

Table 3: Household Characteristics by Type of Housing Assistance²

	Public Housing	Vouchers	p-stat
Household Income Category:			<0.001
\$0 to \$9,999	2,050 (73.6%)	2,057 (52.3%)	
\$10,000 to \$19,999	554 (19.9%)	1,281 (32.6%)	
\$20,000 and Greater	181 (6.50%)	594 (15.1%)	
Total Household Income	7,638 (7193)	10,992 (8130)	<0.001
Household Poverty Status:			<0.001
Above Poverty	142 (5.10%)	589 (15.0%)	
Below Poverty	2,643 (94.9%)	3,343 (85.0%)	
Monthly Rent Paid by Household	134 (136)	230 (190)	<0.001
Number of People in Household	5.49 (1.84)	4.95 (1.65)	<0.001
Number of Bedrooms in Household	3.52 (0.93)	3.08 (0.90)	<0.001
Employment Status of Individual:			<0.001
Employed - Work Eligible Adult	145 (21.1%)	410 (40.1%)	
Not Employed - Work Eligible	543 (78.9%)	612 (59.9%)	
Race of Individual:			0.004
White	13 (0.47%)	12 (0.31%)	
Black	2,763 (99.2%)	3919 (99.7%)	
Asian/Other	9 (0.32%)	1 (0.03%)	
Married Status of Individual:			<0.001
Not Married	572 (20.5%)	991 (25.2%)	
Married	19 (0.68%)	22 (0.56%)	
Other, Youth, etc	2,194 (78.8%)	2,919 (74.2%)	

As the table above shows, households in conventional public housing versus households participating in the Housing Choice Voucher program have significantly different means in most categories except for the race composition of individuals. Voucher holders have a higher total household income, slightly less people per household, but also slightly less rooms per household. As one of the

²Source: Atlanta Housing Authority and Atlanta Public Schools, Administrative Data, 2007. Access granted through a special data sharing agreement

goals of the voucher program is to alleviate overcrowding, it is important to look at statistics that are indicative of overcrowding; however, the difference in rooms per person seems to be marginal between the two types of housing assistance programs. It is also interesting to note that despite the fact that voucher households have higher incomes on average, these are still very low incomes compared to the rest of the population. 85% of voucher holders still qualify as being below poverty, meaning that these families are still facing disadvantage. Voucher holders are also shown as paying higher rent on average, but this is due to the higher income on average. As a goal of housing assistance in general, no household pays more than 30% of their income on rent.

The fact that a higher percentage of voucher holders are employed and that they have higher incomes on average could be caused by two forces working either independently or together. The first goes back to the initial cause of potential bias in this study which is that more motivated families who are more likely to be successful in any situation are the ones self-selecting into the voucher program. The other force is that where voucher holders are moving has a positive impact on their economic trajectory. This would be due to the opportunities that these areas may afford such as better access to jobs.

5.2 Neighborhoods

The following table explores the difference in locational outcomes between those in public housing and those using vouchers by comparing several neighborhood level characteristics.

Table 4: Neighborhood Characteristics by Type of Housing Assistance⁴

	Public Housing	Vouchers	p-stat
Median Income	17,072 (9,589)	28,409 (11,470)	<0.001
Percent Married	28.5 (7.02)	34.7 (8.37)	<0.001
Percent Black	89.7 (14.4)	87.7 (16.3)	0.012
Emp. to Pop. Rate	0.42 (0.11)	0.50 (0.09)	<0.001
Poverty Rate	52.1 (13.8)	28.3 (12.6)	<0.001
Total Crimes	879 (326)	822 (333)	0.001
Unemployment Rate	22.1 (10.2)	13.3 (6.03)	<0.001

It appears that voucher holders are moving to better neighborhoods as demonstrated by the higher median income of the census tract they are moving to, the lower poverty rate, and the lower unemployment rate. Voucher holders also are moving to census tracts with slightly less crime. The difference in racial composition of the census tract occupied by households in public housing versus households using vouchers is non-existent. Both live in census tracts with high minority populations, which is consistent with past literature analyzing location outcomes of households using vouchers.

5.3 Schools

I now turn to analyzing the differences between the types of schools that children from households in conventional public housing and that children from households using vouchers are attending. Variables measuring different aspects of school quality are shown in the table below.

⁴Source: Atlanta Housing Authority and Atlanta Public Schools, Administrative Data, 2007. Access granted through a special data sharing agreement

Table 5: School Characteristics by Type of Housing Assistance⁵

	Public Housing	Vouchers	p-stat
School ITBS Score	32.6 (11.2)	40.5 (13.0)	<0.001
School ITBS Math	34.9 (13.1)	43.2 (14.0)	<0.001
School ITBS Reading	33.5 (10.2)	40.9 (12.8)	<0.001
Child ITBS Score	28.7 (19.1)	34.8 (21.8)	<0.001
Total Absences	7.63 (7.76)	6.09 (6.31)	<0.001
Percent Free/Reduced Lunch	0.96 (0.10)	0.89 (0.22)	<0.001
Student Teacher Ratio	13.8 (1.89)	14.3 (2.54)	<0.001
Fulltime Teachers	27.7 (8.36)	32.5 (8.91)	<0.001

The first four rows all measure performance on the Iowa Test of Basic Skills (ITBS). On average, schools that children on housing vouchers are attending score about 8 percentage points higher on the ITBS overall than schools children in public housing are attending. Schools that housing voucher children are attending also seem to fare better in other potential measures of school performance. The percentage of children on free or reduced lunch, a variable used in the literature to estimate the disadvantage prevalent within a school and often a proxy for school quality, is slightly lower in voucher schools than in public housing schools. The number of fulltime teachers as well as the student to teacher ratio is greater in voucher schools indicating a higher student population. Less teachers per student is usually associated with a lower quality school as smaller class sizes have been shown to be beneficial to student performance; however, the difference between the two groups is not large in magnitude.[17] Individually, housing voucher children score about 6 percentage points better on the ITBS than public housing children. They also have slightly less absences (a difference that, while small in magnitude, is still statistically significant). Less absences could be a sign of better mental/physical health or having better access to getting to school.

⁵Source: Atlanta Housing Authority and Atlanta Public Schools, Administrative Data, 2007. Access granted through a special data sharing agreement

6 Results

I will first present the results of the OLS estimation without accounting for the potential self-selection bias. I will then present the results for the IV regression using poverty rate and the log transformed median income level as exogenous predictors of housing voucher usage and compare these results to the OLS estimation. Finally, I will analyze the impact of neighborhood characteristics on test scores.

6.1 OLS Estimation

In order to analyze the relationship between holding a housing voucher as opposed to living in conventional public housing on test scores, I first conduct an OLS regression. As previously discussed, if self-selection of families is present, this estimator will be biased. Table 6 shows the results of four different OLS models. The first is the regression of a child's ITBS percentile score on the housing voucher dummy with no other controls in the model. The second model includes only school-related controls, the third only household related controls, and the fourth includes all controls.

The housing dummy variable is an estimate of the difference in test score that would be expected from a child who comes from a household participating in the Housing Choice Voucher program versus a child living in traditional public housing. Across all models, this estimate is positive and significant at the .01 level. The lowest estimate of the impact of a housing voucher is a 4.755 percentile increase in score and the highest is a 7.199 percentile increase in score. This is equivalent to an increase ranging between 23% of a standard deviation in test scores to about a 35% increase. Interestingly, the coefficient of the housing dummy in the model with no controls is fairly close in magnitude to the coefficient on this variable in the model with all controls (6.089 vs 5.971). The housing dummy is a robust and strong predictor of a child's ITBS score.

Another interesting observation is that the variables which are significant, remain significant across the various models that they appear in. For example, the number of fulltime teachers and the student to teacher ratio is a significant predictor of test scores in the model with only school-related controls as well as

in the model with all controls present. Total household income and the number of people within a household also remain statistically significant from the model with only household-level controls to the model with all controls included.

The dummy indicating whether or not a household head is employed and whether or not a household head is married are not statistically significant. It is not surprising that the dummy indicating marriage status is not significant as such a small proportion of the sample is married (less than 1% for both groups). Another variable that does not show up as being a statistically significant predictor of a child's ITBS test score is the difference in age of the head of household to the oldest child. The sign of the coefficient on the age and the age squared variable, however, are consistent with the predicted direction of these relationships. The age difference is a positive predictor of test performance up to a certain point, after which this relationship turns negative. This may be because the head of household is not necessarily the parent of the child, but may in fact be a grandparent. In the case where the grandparent is the head of household, this may indicate that the parent of the child is actually closer to the child's age, which predicts a negative relationship with the child's test score.

Interestingly, the gender dummy is negative and statistically significant across all models. It also changes very little in magnitude despite the controls being used indicating that its value is robust to changes in model specifications. The gender dummy indicates that male students perform worse than female students by a little under 3 percentile points. This finding is also consistent with past research on the topic of assisted households and educational attainment where males perform worse than females.

	<i>Dependent variable:</i>			
	Child Percentile Score ITBS			
	(1)	(2)	(3)	(4)
Housing Voucher Dummy	6.089*** (1.118)	7.199*** (1.164)	4.755*** (1.158)	5.971*** (1.196)
Number of Fulltime Teachers		-0.352*** (0.070)		-0.373*** (0.071)
Student to Teacher Ratio		0.940*** (0.298)		0.856*** (0.297)
Percent of Free or Reduced Lunch Students		-4.625 (3.320)		-4.518 (3.313)
Total Household Income			0.0002* (0.0001)	0.0002** (0.0001)
Number of People in Household			-1.288*** (0.350)	-1.341*** (0.348)
Employment Dummy			-0.290 (1.541)	-0.757 (1.532)
Married Dummy			4.230 (5.550)	3.412 (5.496)
HOH Age to Child			0.184 (0.366)	0.288 (0.362)
HOH Age to Child Squared			-0.005 (0.006)	-0.006 (0.006)
Gender Dummy		-2.690** (1.089)	-2.930*** (1.095)	-2.825*** (1.086)
Constant	28.719*** (0.859)	31.239*** (5.793)	34.132*** (5.553)	35.574*** (7.936)
Observations	1,422	1,416	1,422	1,416
R ²	0.020	0.049	0.039	0.064
Adjusted R ²	0.020	0.046	0.033	0.056

Note:

*p<0.1; **p<0.05; ***p<0.01

Table 6: OLS Test Scores

6.2 IV Estimation

The table below reports the results for the regression when the housing voucher dummy is being instrumented by the poverty rate in a given census tract and the log transformed median income of the same tract. For ease of comparison, the OLS results from the model with no controls and the model with all controls are placed alongside the IV results for the models with the same specifications.

Comparing the four regressions, the standard errors on the housing dummy variable do not change much between models - they remain between 1.118 and 1.845 - and the estimate remains significant at the .01 level. Holding a voucher as opposed to living in traditional public housing yields an increase in test scores of about 7 percentile points. The IV estimates are slightly higher than the OLS estimates, but only by about 1 percentile point and given that the standard deviation for test scores is about 21 percentile points, this is not a very large difference, suggesting that the problem of self-selection may not be as big of an issue as initially predicted.

The model is robust across specifications and methods of regression. Between the OLS and IV model, all of the same variables are significant and almost all are significant at the .01 level. The only variable that differs in level of significance is total household income which decreases slightly in significance between the OLS and IV model with all controls. Once again, the variables with the greatest explanatory power are the number of people in the household, the number of fulltime teachers in the school, the student to teacher ratio, as well as the gender of the student. The housing dummy has the greatest impact on test scores by far when comparing the magnitude of the coefficient on each statistically significant variable.

	<i>Dependent variable:</i>			
	Child Percentile Score ITBS			
	<i>OLS</i>		<i>instrumental</i>	
			<i>variable</i>	
	(1)	(2)	(3)	(4)
Housing Voucher Dummy	6.089*** (1.118)	5.971*** (1.196)	7.067*** (1.625)	7.100*** (1.845)
Total Household Income		0.0002** (0.0001)		0.0002* (0.0001)
Number of People in Household		-1.341*** (0.348)		-1.295*** (0.353)
Employment Dummy		-0.757 (1.532)		-0.796 (1.533)
Married Dummy		3.412 (5.496)		3.440 (5.498)
HOH Age to Child		0.288 (0.362)		0.284 (0.363)
HOH Age to Child Squared		-0.006 (0.006)		-0.006 (0.006)
Number of Fulltime Teachers		-0.373*** (0.071)		-0.386*** (0.073)
Student to Teacher Ratio		0.856*** (0.297)		0.831*** (0.298)
Percent of Free or Reduced Lunch Students		-4.518 (3.313)		-4.239 (3.332)
Gender Dummy		-2.825*** (1.086)		-2.817*** (1.086)
Constant	28.719*** (0.859)	35.574*** (7.936)	28.141*** (1.106)	35.326*** (7.944)
Observations	1,422	1,416	1,422	1,416
R ²	0.020	0.064	0.020	0.063
Adjusted R ²	0.020	0.056	0.019	0.056

Note:

*p<0.1; **p<0.05; ***p<0.01

Table 7: OLS/IV Test Scores

In order to further analyze the robustness of the estimate on the housing dummy variable, I have included the results of additional regressions with different control variables. As in the analysis of the OLS regression, model 1 is the model with no controls, model 2 includes only school-related controls, model 3 includes only household-related controls, and model 4 includes the full list of controls. These results are shown in Table 8. Once again, the housing dummy is still significant across all model at the .01 level. The smallest estimate for the impact that holding a housing voucher versus living in conventional public housing has on test scores is 5.744 and the highest is 8.475. For each model, the IV estimates are slightly higher than the corresponding OLS estimates. The IV estimations prove to be very robust across different specifications. Once again, the housing dummy variable has the largest magnitude impact on test scores followed by the gender of the child.

	<i>Dependent variable:</i>			
	Child Percentile Score ITBS			
	(1)	(2)	(3)	(4)
Housing Voucher Dummy	7.067*** (1.625)	8.475*** (1.753)	5.744*** (1.731)	7.100*** (1.845)
Number of Fulltime Teachers		-0.369*** (0.073)		-0.386*** (0.073)
Student to Teacher Ratio		0.906*** (0.300)		0.831*** (0.298)
Percent of Free or Reduced Lunch Students		-4.268 (3.342)		-4.239 (3.332)
Total Household Income			0.0002 (0.0001)	0.0002* (0.0001)
Number of People in Household			-1.238*** (0.356)	-1.295*** (0.353)
Employment Dummy			-0.331 (1.543)	-0.796 (1.533)
Married Dummy			4.228 (5.551)	3.440 (5.498)
HOH Age to Child			0.177 (0.366)	0.284 (0.363)
HOH Age to Child Squared			-0.005 (0.006)	-0.006 (0.006)
Gender Dummy		-2.687** (1.090)	-2.925*** (1.096)	-2.817*** (1.086)
Constant	28.141*** (1.106)	31.159*** (5.796)	33.500*** (5.615)	35.326*** (7.944)
Observations	1,422	1,416	1,422	1,416
R ²	0.020	0.048	0.038	0.063
Adjusted R ²	0.019	0.045	0.033	0.056

Note:

*p<0.1; **p<0.05; ***p<0.01

Table 8: IV Test Scores

6.3 Exploring Neighborhood Variables

Model specifications up to this point have only included controls for household and school characteristics. I now add several variables to the model in an attempt to explore how neighborhood characteristics may influence test scores. Table 9 shows the results of two OLS regressions and the parallel IV regressions. Variables included to capture relevant neighborhood characteristics are: the percentage of black households within the census tract, the percentage of married households within the census tract, and the total number of crimes committed in the census tract in the year that the data was compiled. As was the case in previous regressions, the IV equivalent of the OLS regression predicts higher coefficients for the impact of holding a housing voucher on a child's test score.

Models 1 and 3 show the OLS regression results and IV regression results using only neighborhood-level characteristics as controls respectively. Models 2 and 4 show the OLS and IV regression results containing all controls respectively. The percentage of black households within the census tract is never a significant determinant of test scores in any model. The total number of crimes committed is significant in models with only neighborhood-level controls, but becomes insignificant when household and school-related controls are added. The percentage of married households within the census tract is also a significant variable across all models; however, the sign on its coefficient is negative meaning that as the percentage of married households increases, the impact on the child's test score actually decreases. On the one hand, this is a surprising result given that there is often a positive correlation between married households and income, so that living in a neighborhood where a greater percentage of households are married would suggest living in a neighborhood of greater affluence. As theory predicts, such a neighborhood could have positive effects via the influence of role models. Conversely, it may be the case that a greater percentage of married households could have a negative impact on the child if, for example, the relative affluence of the neighborhood meant that there were less childcare services targeted towards single parents that would benefit the child. This negative relationship underlines the complexities of predicting and unraveling neighborhood effects.

	<i>Dependent variable:</i>			
	Child Percentile Score ITBS			
	<i>OLS</i>	<i>instrumental variable</i>		
	(1)	(2)	(3)	(4)
Housing Voucher	7.052*** (1.224)	6.988*** (1.300)	9.844*** (1.932)	10.030*** (2.161)
Percentage of Black Households	0.019 (0.044)	-0.001 (0.044)	0.010 (0.045)	-0.015 (0.045)
Percentage of Married Households	-0.174** (0.088)	-0.203** (0.088)	-0.237** (0.095)	-0.264*** (0.095)
Total Crimes in 2004	0.004** (0.002)	0.002 (0.002)	0.005*** (0.002)	0.002 (0.002)
Total Household Income		0.0002* (0.0001)		0.0002 (0.0001)
Number of People in Household		-1.135*** (0.364)		-1.015*** (0.371)
Employment Dummy		-0.703 (1.621)		-0.837 (1.626)
Married Dummy		4.613 (5.761)		4.394 (5.774)
HOH Age to Child		0.171 (0.379)		0.159 (0.379)
HOH Age to Child Squared		-0.004 (0.006)		-0.004 (0.006)
Number of Fulltime Teachers		-0.331*** (0.075)		-0.362*** (0.077)
Student to Teacher Ratio		1.072*** (0.320)		1.018*** (0.322)
Percent of Free or Reduced Lunch Students		-2.229 (3.533)		-1.324 (3.577)
Gender Dummy		-2.428** (1.141)		-2.427** (1.144)
Constant	28.245*** (5.715)	33.752*** (10.162)	29.112*** (5.745)	35.559*** (10.235)
Observations	1,308	1,303	1,308	1,303
R ²	39 0.028	0.067	0.024	0.063
Adjusted R ²	0.025	0.057	0.021	0.053

Note:

*p<0.1; **p<0.05; ***p<0.01

Table 9: IV/OLS Neighborhood Effects

7 Discussion

The results of this analysis consistently show that holding a housing voucher has a statistically significant positive impact on the educational attainment of children as measured by standardized test scores. Not only is this variable consistently statistically significant across all model specifications at $p < 0.01$, but it has the greatest coefficient of all statistically significant variables. Other variables which have a statistically significant positive impact on test scores are the student to teacher ratio and total household income. Variables which have a consistently negative statistically significant impact on test scores are the number of people in the household, the number of teachers, and if the child is male. When controlling for endogeneity using IV regression, the impact of holding a voucher actually increases across all models. The direction of the bias is not what was initially predicted; however, there could be several reasons for a downward bias - one of which is the conditions under which many families were entering the voucher program in 2004. This study draws data from a time when demolitions of public housing projects were prevalent throughout the city of Atlanta. This could imply that families choosing to take a voucher were experiencing particularly difficult circumstances due to being moved from communities that they had grown attached to.

Regardless of the direction of the bias, both regressions predict that having a housing voucher as opposed to living in conventional public housing leads to statistically significant increases in a child's test score, even when controlling for potential self-selection bias. This result differs from past studies which have not found such significant effects on educational outcomes for children within the voucher program. One of the reasons for this difference is that children in this study are moving to schools with significantly higher average test scores than those who are in public housing, as opposed to moving to either a similar or even remaining in the same school. This result underscores one conclusion drawn from the MTO program which states that "one lesson may be that census-tract mobility that doesn't lead to above average schools has little benefit on educational outcomes" [27] In past research, poverty rates have been used as a proxy for neighborhood quality and are the primary goal of resident placement in assistance programs; however, poverty rates themselves are not necessarily

indicative of the level of opportunity in a neighborhood, and residents recognize this. The characteristics that matter the most to households are those related to unit quality, opportunity (such as school quality), and accessibility (as pertains to transport), with characteristics such as poverty rates and racial diversity being ranked much lower on the list of neighborhood qualities sought after when moving.[30] This is because poverty rates within of themselves are not a mechanism through which social mobility would occur if low poverty neighborhoods are not accompanied with a real difference in characteristics such as safety and the quality of institutions. It is also important to note that while test scores are higher for children using vouchers than children living in public housing, these scores are still below average. Voucher holders are accessing better quality schools, and experiencing positive results in educational outcomes because of it, but are still not able to access the best neighborhoods.

Given these results, it is interesting to question why it may be the case that voucher holders in this study are accessing better quality schools than has been shown in past research on this topic. One reason may involve the way that Atlanta has developed in reference to transportation infrastructure. One study that examines public transportation as a causal force of the concentration of the poor in the city center and the rich in the suburbs may provide some insight.[9] This study predicts that as the cost of owning a car declines and becomes more accessible to low-income groups, there is likely to be a greater presence of high-income households in the city-center and low-income households in the suburbs. If it is the case that in Atlanta, a city with high time costs of public transportation due to the lack of an extensive subway system, more low-income individuals are likely to have access to a car, then mobility decisions will be less tied to access to transportation which would have otherwise disproportionately tied low-income households to the inner city. This would give low-income families greater access to suburban areas, but such a proposition would need to be tested empirically and is not undertaken in this paper. Another potential reason for the difference in schools attended by voucher holders versus those living in public housing is the age of the children being studied. As the children are in elementary school, they may be less resistant to changing schools than adolescents might be who have established closer links with peers and would be more resistant to “starting over” at a new school. Along these lines, the age

of the children in this study could also explain the reason behind neighborhood level variables not being particularly significant when it comes to explaining test score outcomes. In fact, once family and school-level characteristics are controlled for, almost all neighborhood-level variables lose their significance. This could be due to the fact that younger children typically have less unsupervised time outside of the household in comparison with teens, for example. Since they have less exposure to their neighborhoods, children may not yet be as significantly impacted by environmental characteristics as adolescents may have been. This is not to say that neighborhood effects won't show up later in life, but rather that families may be able to better shelter younger children from negative environmental impacts such as crime in order to dilute negative impacts in the present.

Looking to the future of housing assistance, there are several steps that should be taken moving forward. One is that when it comes to neighborhood placement, it is important that families are reaching areas that represent a measurable difference in opportunity as pertains to the safety, quality of institutions/housing, and job access in order to see positive results in outcomes. Wilson, in his work *The Truly Disadvantaged*, recognizes the importance of the mechanisms through which change occurs by continually emphasizing that any plan to counteract poverty must be accompanied by “a far more comprehensive program of economic and social reform than what Americans have usually regarded as appropriate or desired”, emphasizing in particular the need to address the decline in blue-collar employment in the central city.[31] If household heads are not able to find jobs regardless of where they live, it is unlikely that their employment status will change just as it is unlikely a child's test scores will significantly improve with no access to better schools. Along these lines, it is important to recognize that the voucher program was largely designed in response to the forced segregation and poverty concentration that public housing developments were causing. It shifted the problem of affordable housing to the private market without addressing the social and cultural forces that lead to residential sorting. This means that voucher holders are still heavily constrained when it comes to movement on this market, and are even excluded from certain areas entirely, for example, due to the existence of measures such as zoning laws that prohibit the construction of affordable housing. As was found during the Gautreaux

Program, residents were often constrained by a lack of FMR housing, a reliance on public transportation, and an unwillingness of landlords to accept voucher holders as tenants - and these constraints were still present even with extensive mobility counseling and assistance, a service that most voucher households do not have access to. The future of housing assistance must address such barriers.

Another important consideration is that the number of families the housing voucher program serves relative to the number of families that qualify as being in need of housing assistance is small. The voucher program has not necessarily created more housing units when compared to what conventional public housing provided. In fact, it was largely used as a tool to replace units that were demolished throughout the years. This simply means that the scope of the program is small and that a majority of low-income households are severely rent-burdened navigating the private housing market unassisted. Finally, it is important to recognize that while families benefiting from the voucher program may be able to leave the worst neighborhood and school districts behind, these neighborhoods still exist. There is also need to address the existence of such low-resource areas as many families are still living in them, something that is not a goal or in the scope of the housing voucher program as currently structured.

8 Conclusion

In this paper, I have undertaken an evaluation of the impact of the housing voucher program on educational attainment by comparing the results from performance of children in the voucher program on the ITBS exam to the performance of children in conventional public housing on this exam. To do this, I used an OLS regression as well as an IV regression suspecting that the OLS results may be biased due to self-selection within the sample. I found that across all models, possessing a housing voucher leads to significantly higher test scores on the ITBS exam. Using the IV model, I am able to show that this result is not due to unobserved family characteristics that would otherwise impact test scores. In fact, results from the IV regression show that OLS estimates are downward biased. Controlling for family, school, and neighborhood level characteristics, I can conclude that the primary cause of this increase in scores is due to the higher quality schools that voucher holders are able to access. These

results show that, contrary to many past studies, housing vouchers can be an effective strategy when it comes to improving educational outcomes for children; however, such results only occur when the voucher results in families being able to send their children to schools of higher quality.

9 Appendix

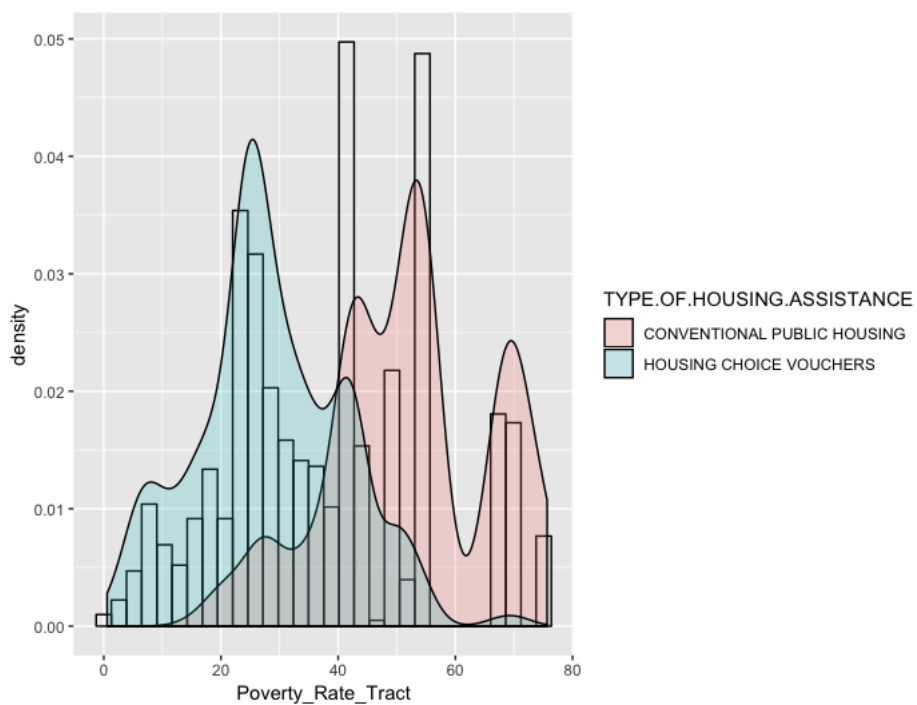
	<i>Dependent variable:</i>
	Child Percentile Score ITBS
Housing Voucher Dummy	5.152*** (1.570)
Total Household Income	0.0002** (0.0001)
Number of People in Household	-1.279*** (0.350)
Employment Dummy	-0.717 (1.532)
Married Dummy	3.472 (5.495)
HOH Age to Child	0.268 (0.362)
HOH Age to Child Squared	-0.006 (0.006)
Number of Fulltime Teachers	-0.369*** (0.071)
Student to Teacher Ratio	0.833*** (0.297)
Percent of Free of Reduced Lunch Students	-4.217 (3.317)
Gender Dummy	-2.908*** (1.087)
Poverty Rate of Census Tract	-0.151 (0.097)
Median Income of Census Tract (log)	-4.853 (2.957)
Constant	89.977*** (33.909)
Observations	1,416
R ²	0.066
Adjusted R ²	0.057

Note:

*p<0.1; **p<0.05; ***p<0.01

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Table 10: Exogeneity of Instruments

Figure 1: Poverty Rate Density Distribution



Source: Atlanta Housing Authority and Atlanta Public Schools, Administrative Data, 2007. Access granted through a special data sharing agreement

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