MANY THE MILES TO SCHOOL: THE ROLE OF RESIDENTIAL AND SCHOOL LOCATION IN CHOOSING AND GOING TO SCHOOL

By

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ABSTRACT

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Over the last 30 years, school choice policies have weakened the link between home residence and school assignment by allowing students to attend schools other than their neighborhood school. In theory, school choice policies can raise student achievement by increasing access to effective schools and by creating competitive pressure for schools to improve their academic quality. However, geographic factors may act as barriers to participating in school choice policies and constrain access to effective schools. To date, little attention has been paid to how geography shapes participation in and effectiveness of school choice policies.

In this dissertation, comprised of three papers, I provide some of the first evidence concerning the roles of distance, residential mobility, school district boundaries, and access to transportation in participation in formal school choice programs and access to effective schools. Also, I estimate the impacts of school transportation—a policy that can mitigate the negative effects of these geographic factors on student outcomes. I examine these relationships in Michigan where students have been able to participate in inter-district and charter school choice for over 25 years. I use student-level enrollment, achievement, and address records for Michigan public school students over seven years to describe geographic inequities in participation in choice use and access to effective schools as well as to estimate the effects of the school bus on student attendance and achievement.

In my first paper, I estimate a set of hazard models to determine the relationships between residential mobility, commute time to school, and exit from school choice programs. I find that

the majority of exits from school choice programs correspond to a residential move. Furthermore, the probability that a student exits charter school and inter-district choice programs increases as the time spent commuting to school past their assigned school increases. These findings establish that participation in school choice policies can be determined by where schools are located in relation to students' residences.

Even where school choice participation is widespread, geographic factors may still constrain access to effective schools. In my second paper, I investigate whether students living in Detroit attend the highest quality schools in their choice sets, as determined by levels of and contributions to achievement, using a set of discrete choice models. I find that students are more likely to attend the higher quality schools in their choice sets when their choice sets are restricted to schools located within Detroit, implying that access to effective schools is constrained by geographic factors.

In addition to influencing access to effective schools, geographic factors can also affect student outcomes. In my final paper, I exploit the walking distance cutoffs that determine transportation eligibility to provide some of the first causal evidence of the effects of school transportation on student attendance and achievement using a regression discontinuity design. I find that transportation eligibility increases attendance rates and decreases the probability of being chronically absent especially for disadvantaged students. However, my results provide no evidence that school transportation affects achievement.

Taken together, the findings of this dissertation provide substantial evidence that where students live in relation to where they go to school affects their educational opportunities and outcomes. I also show that public policy has the potential to mitigate the negative effects of these relationships.

To David.
My shotgun rider on my drive through graduate school.

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INTRODUCTION

Where students live and where they attend school affect their long-term outcomes. Living in neighborhoods with higher incomes and levels of educational attainment increases enrollment in college preparatory courses in high school, college attendance, and adult earnings in addition to decreasing the likelihood of single parenthood (Chetty, Hendren, & Katz, 2016; Chetty & Hendren, 2018; Rosenbaum, 1995). One possible mechanism that can explain neighborhood differences in outcomes is the strength of the schools located within neighborhoods. In fact, Chetty, Hendren, Kline, and Saez (2014) find that areas that contain schools with higher test scores and graduation rates have higher levels of economic mobility. Traditionally, students are assigned to schools by their residence making it difficult to separate the contributions of neighborhoods and schools to student outcomes. However, recent evidence leveraging policies that allow students to attend schools outside of their neighborhoods confirms that both neighborhoods and schools contribute to student achievement. Nonetheless, the effect of schools on achievement is larger (Carlson & Cowen, 2015).

Over the last 30 years, many cities and states have implemented school choice policies that break the traditional link between residence and school assignment by allowing students to attend schools other than their residentially assigned school. In theory, school choice policies can increase access to desirable schools for families unable to afford to live near these schools. They can also increase student achievement if families prefer academic effectiveness, possess accurate information on school quality, and have the ability to physically access effective schools. Evidence concerning the effectiveness of school choice policies is mixed. Research examining the effects of charter schools on achievement in large cities like Boston and New Orleans finds that they positively impact the test scores of historically disadvantaged students (Abdulkadiroglu, Angrist, Dynarski, Kane, & Pathak, 2011; Harris & Larsen, 2016). In contrast, recent studies of statewide voucher programs show that they have negative effects on student achievement (Figlio & Karbownik, 2016; Mills & Wolf, 2018; Waddington & Berends, 2018). Little evidence exists concerning the effects of inter-district choice with a handful of studies showing that those who consistently use these policies have higher test scores (Carlson & Lavertu, 2017; Carlson, Lavery, & Hughes, 2018).

Although some evidence indicates that school choice policies are effective in raising achievement, relationships between residential and school location may constrain widespread participation in school choice programs, its ability to increase access the effective schools as well as its effectiveness improving student outcomes. Families may not take advantage of school choice programs if they value proximity to home when choosing schools and there are few alternatives to their neighborhood option around them. Even if families have strong preferences for school effectiveness, burdensome enrollment policies, lack of sufficient transportation, and residential mobility may constrain students' abilities to attend preferred schools. Furthermore, traveling long distances to school may have deleterious effects on student outcomes independent of choice of school especially if there is no school provided transportation.

In this dissertation, comprised of three papers, I examine how geographic factors, including distance from home to school, residential mobility, district boundaries, and access to transportation promote or restrict participation in school choice programs and constrain access to effective schools. Furthermore, I evaluate a policy that could mitigate the possible negative effects of these factors on student attendance and achievement: school provided transportation. I investigate the relationships between where students live, where they go to school, and their outcomes in Michigan where public school choice programs are prevalent and well-established in all regions of the state. Michigan students can attend their assigned school, other schools in their resident district, schools in other traditional public school districts, and charter schools. Almost a quarter of Michigan public school students participate in formal school choice programs. Additionally, charter school and inter-district choice have existed in Michigan for over twenty-five years, making it a mature and stabilized education market. Furthermore, there exists a substantial amount of variation in the supply of charter schools, the rules that govern inter-district choice, and the provision of transportation across the state, providing an ideal setting to understand how geographic factors interact with policy in a choice-rich environment.

In each of my three papers, I primarily use student-level enrollment, achievement, and address records for all Michigan public school students from the 2012-13 to the 2018-19 school years provided by the Michigan Department of Education (MDE) and Center for Educational Performance and Information (CEPI). I employ a variety of quantitative and quasi-experimental methods including survival analysis, discrete choice models, and a regression discontinuity design to describe the roles of residential and school location in participation in school choice programs and estimate the causal effects of school transportation on student attendance and achievement. I note that each of these papers was prepared as separate articles for publication in peer-reviewed journals. Therefore, each paper has its own literature review, description of the context, and explanation of the data even though many of these aspects are shared across all three papers.

In Paper 1, I describe the roles of residential mobility and distance from home and school in participation in and exit from public school choice programs. First, I provide some of the first evidence concerning differences in residential mobility between students who participate in school choice and those who do not. Second, I estimate the commute times from home to school for all Michigan students and examine differences in commute times for students who use charter school and inter-district choice. These estimated commute times are some of the first descriptions of how long it takes students to travel to school outside of large cities. Finally, I estimate a set of hazard models to investigate the roles of residential mobility and commute time in exit from public school choice programs. I find that most exits from school choice programs are accompanied by residential moves. Furthermore, students have a higher probability of leaving inter-district and charter school choice as the additional commute time to the attended school past the assigned school increases. Taken together, these findings imply that residential stability and proximity to home play large roles in families' abilities to consistently participate in school choice programs.

Geographic factors may not only influence families' decisions to participate in or exit from school choice programs. Also, they could constrain access to effective schools even where school choice participation is widespread. Prior research shows that families in choice-rich cities value proximity to home just as much if not more than academic quality when choosing schools (Denice & Gross, 2016; Glazerman & Dotter, 2017; Harris & Larsen, 2019; Hastings, Kane, & Staiger, 2005; Lincove, Cowen, & Imbrogno, 2018). However, this preference for proximity may represent an inability to attend schools farther from home, especially for disadvantaged students. In Paper 2, I test whether distance to school and district boundaries constrain access to schools with higher levels of and contributions to achievement for students living in Detroit where one in five students attend a school located outside of the city, almost one half attend a charter school, and less than a quarter of students attend their assigned school. First, I show that students living in neighborhoods with lower incomes and rates of car ownership are less likely to participate in public school choice or have access to the highest quality schools using a set of multinomial logistic regressions. Then, I examine whether students in Detroit attend schools with higher levels of and contributions to achievement using discrete choice models. I find that families' preferences for academic quality are stronger when their choice sets are restricted to schools within Detroit. These findings imply that geographic factors likely constrain access to effective schools even where school choice use is prevalent.

In addition to shaping participation in school choice and access to effective schools in choice-rich environments, the relationship between residential and school location may affect student attendance and achievement. In fact, prior research shows that longer commute times have a negative relationship with attendance but little association with achievement (Stein & Grigg, 2019; Blagg, Rosenboom, & Chingos, 2018). One intervention that can mitigate the effects of distance to school on student outcomes is school transportation. By removing the burden of transporting students to and from school from families, the school bus can make it easier for students to get to school, thus increasing their attendance and possibly their achievement. In Paper 3, I provide some of the first causal evidence of the effects of the school bus on student attendance and achievement using a regression discontinuity design that exploits the walking distance cutoffs that determine transportation eligibility. I find that transportation eligibility increases attendance rates and reduces the probability of being chronically absent. These effects are largest for economically disadvantaged students—the students who are least likely to have access to private forms of transportation and most likely to be chronically absent (Urban Institute Student Transportation Working Group, 2018; Balfanz & Byrnes, 2012). My results provide little evidence that transportation eligibility affects achievement. These findings imply that increasing the amount of transportation provided may be an appropriate intervention to reduce chronic absenteeism. However, widespread provision of school transportation may not be the most cost-effective or efficient way to allocate this expensive resource.

Taken together, this body of work shows that school location in relation to residential location is a determinant of participation in school choice programs, access to effective schools, and student outcomes. Also, I show that its influence can be moderated by school transportation policies. Given my findings, future school choice research should account for geographic factors when describing school choice use, determining its effectiveness, and studying the consequences of choice policies. Additionally, more research is needed to understand how elements of school choice policies, in particular enrollment rules and the provision of transportation, promote or restrict access to effective schools, especially those located farther from home. Finally, the next generation of school choice research should consider residential decisions as a form of school choice, study the effects of these decisions on participation in and the effectiveness of school choice programs, and understand how local housing and public transportation policies interact with school choice policies.

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PAPER 1 THE FARTHER YOU GO, THE CLOSER YOU GET: THE ROLES OF RESIDENTIAL MOBILITY AND DISTANCE IN PARTICIPATION IN PUBLIC SCHOOL CHOICE

Introduction

Traditionally, the particular public school that students attend is determined by the particular place in which they live. Over the past thirty years, this inextricable link has been weakened by public school choice polices that allow students to attend schools according to their needs, values, preferences, and goals—including schools outside of residential assignment zones (Levin, 2015). Forty-three states have at least one charter school, and all but three states have policies that govern inter-district and intra-district choice, permitting students to attend schools in other traditional public school (TPS) districts and other schools in their district of residence respectively (David & Hesla, 2018; Wixom & Kelly, 2018). During the 2016-17 school year, over twenty percent of U.S. public school students attended a school other than their residentially assigned school (Wang, Rathburn, & Musu, 2019).

Proponents of school choice argue that these policies create more equitable access to effective schools for families who are unable to afford homes in the most desirable districts and catchment zones (Levin, 2015). Also, they contend that school choice creates competitive pressures on existing schools to meet families' needs and improve productivity since schools must attract students to maintain enrollment (Chubb & Moe, 1990; Friedman, 1962). Therefore, school choice policies have the potential to improve student outcomes if they allow students to attend more effective schools and improve the quality of the supply of schools. Although public school choice policies are well established and widespread, the evidence concerning their effectiveness to raise student achievement for all students who participate in them as well as those who remain in the surrounding TPSs is mixed. On average, disadvantaged students in urban areas experience increases in achievement when they attend charter schools and participate in inter-district choice (Abdulkadiroglu, Angrist, Dynarski, Kane, & Pathak, 2011; Carlson & Lavertu, 2017; Carlson, Lavery, & Hughes, 2018; Harris & Larsen, 2016). Additionally, the majority of evidence concerning competitive effects of charter schools suggests that they do not negatively impact achievement for students in TPS districts (Booker, Gilpatric, Gronberg, & Jansen, 2008; Cordes, 2017; Imberman, 2011; Sass, 2006; Winters, 2012; Zimmer & Buddin, 2009; Zimmer, Gill, Booker, Lavertu, Sass, & Witte, 2009).[1]

Although there exists evidence of positive effects of charter schools and inter-district choice, especially for disadvantaged students, participation in public school choice may be constrained by residential and school location. In order for school choice policies to increase achievement, families must prefer academic effectiveness over other school features and be able to physically access multiple schooling options in addition to having accurate information concerning school quality (Chubb & Moe, 1990; Glazerman & Dotter, 2017). Although parents have strong preferences for academic quality, they value proximity from home just as much, if not more than achievement (Denice & Gross, 2016; Glazerman & Dotter, 2017; Harris & Larsen, 2019; Hastings, Kane, & Staiger, 2005; Lincove, Cowen, & Imbrogno, 2018). Families may also express their preferences for academic quality through residential decisions or may be unable to do so due to residential instability. Furthermore, many students cannot physically access schools outside of their neighborhood. Low income families may not have access to sufficient

[1]Additionally, there exists an extensive literature on the effects of private school voucher programs on student outcomes. In Michigan, the context of this study, there are no voucher programs since the use of public funding for private schools is prohibited by the Michigan State Constitution. Therefore, I focus my review of the literature on evaluations of public school choice policies other than where studies of private school choice are particularly instructive.

transportation to send their students to schools far from home (Urban Institute Student Transportation Working Group, 2018), and rural students may not have more than one accessible school in a reasonable distance from home (Blagg & Chingos, 2017; Catt & Shaw, 2019).

Although distance and residential location could be determinants in participating in public school choice, in addition to influencing its effectiveness, little research has directly examined where students live in relation to where they go to school or its role in participation in school choice programs especially outside of large, choice-rich cities or over time. To my knowledge, little evidence exists concerning the role of residential mobility in participation in public school choice. A handful of studies describe how far students travel to school and its associations with attending higher quality schools and student outcomes in Baltimore, Denver, Detroit, New Orleans, New York, and Washington, D.C. (Blagg, Rosenboom, & Chingos, 2018; Cordes & Schwartz, 2018; Cowen, Edwards, Sattin-Bajaj, & Cosby, 2018; Denice & Gross, 2018; Stein & Grigg, 2019; Urban Institute Student Transportation Working Group, 2018). Studies of parental preferences account for distance as one of many school characteristics parents may value (Denice & Gross, 2016; Glazerman & Dotter, 2017; Harris & Larsen, 2019; Hastings, Kane, & Staiger, 2005; Lincove, Cowen, & Imbrogno, 2018). Additionally, evidence exists concerning the lack of school choice options for students outside of choice-rich cities (Blagg & Chingos, 2017; Catt & Shaw, 2019).

This paper describes the relationships between where students live, where they go to school, and participation in inter-district and charter school choice in Michigan over six years using a rich panel of student level enrollment, achievement, and address data. Specifically, I ask:

1. How often do students participating in formal school choice policies change residences? Are residential moves associated with participation in school choice programs?
2. How far do students travel to school? How does this differ for students participating in formal school choice programs?
3. What are the roles of residential mobility and commute time to school in continued participation in formal school choice policies?

To answer these questions, I first describe the residential mobility patterns of students who participate in formal school choice policies. This is a critical piece largely unaddressed in the student mobility and school choice literatures because families can informally choose schools through residential decisions and could exit school choice due to residential instability unrelated to preferences for effective schools. Next, I estimate commute times for all Michigan students to their attended school and nearest school and examine differences for those who use inter-district and charter school choice. Finally, I explore the roles of residential mobility and commute time in continued participation in school choice using a set of hazard models.

I find that students using public school choice travel farther to school and are more likely to change residences. In addition, students who change residences have a higher probability of leaving school choice programs. In fact, residential moves accompany over half of exits from school choice programs in Michigan. Also, I find that the commute time relative to students' assigned schools may play a role in the use of and duration in choice. Students are more likely to use school choice when the nearest school in the district they live in is farther from home, and many use it to attend schools closer to home. Additionally, students have a higher probability of leaving inter-district and charter school choice when the additional commute time past their nearest school increases. Taken together, these findings imply that residential mobility and distance likely play a role in families' school choice decisions, especially in their decision to remain in formal school choice programs. Future policies and research concerning school choice should account for the roles of residential and school location in influencing the effectiveness of school choice programs to improve access to effective schools and student outcomes.

This paper extends the current literature concerning participation in school choice programs in multiple ways. First, it provides some of the first evidence concerning the roles residential mobility and distance in who participates in and, in particular, who leaves inter-district and charter school choice programs. This paper is one also of the first to describe commute times for public school students outside of choice-rich cities, which have been the focus of nearly all school transportation studies to date. Finally, this is one of the only studies that examines the factors that predict exit from both inter-district and charter school choice within the same context.

This paper proceeds as follows: First, I discuss the prior literature concerning who participates in and exits formal school choice policies. Second, I examine the literature concerning residential mobility, commute to school, and their relationships with school choice participation. Third, I provide context concerning school choice policies in Michigan, the setting of my study. Fourth, I describe my rich panel of student-level data used in my analyses. Next, I explain the methods and results of each of my research questions. Finally, I discuss the implications of my findings for policy and future research.

Background: Determinants of Participation in Public School Choice Programs

Who Chooses?

Understanding who participates in school choice gives some insight into which types of students may have preferences for and access to school choice programs. The earliest studies that describe participation in inter-district choice use district-level data to explore student flows between districts. They show that students from districts with high achieving students and high income families are more likely to leave their districts to attend even more advantaged districts (Carlson, Lavery, & Witte, 2011; Holme & Richards, 2009; Reback, 2008; Welsch, Statz, & Skidmore, 2010). More recent work describing participation in inter-district choice uses student-level data. A study of Colorado students finds that economically advantaged students living in high achieving districts with fewer economically disadvantaged students have a higher probability of participating in inter-district choice (Lavery & Carlson, 2015). Similarly, students that are higher achieving and more advantaged than their peers living in the same district are more likely to leave their district of residence for higher achieving, smaller, and more advantaged districts in Ohio (Carlson & Lavertu, 2017). Findings concerning inter-district choice students in Michigan are more nuanced. A higher percentage of students who begin in inter-district choice in kindergarten are White, economically advantaged, and live farther away from their assigned school (Edwards, 2021). In particular, kindergarteners in Detroit who leave the city to attend school are more likely to be White or Asian and live closer to Detroit's borders (Lenhoff, Singer, Pogodzinski, & Cook, 2020). In contrast, students who begin using inter-district choice after attending a school in their district of residence are more likely to be low achieving, economically disadvantaged, and underrepresented minorities (Cowen, Creed, & Keesler, 2015).

In general, studies of the demographics of charter school students in California, Texas, North Carolina, and Michigan find that a high proportion of charter school students are Black, economically disadvantaged, and low achieving (Bifulco & Ladd, 2006; Booker, Zimmer, & Buddin, 2005; Edwards & Cowen, 2019; Ni, 2012). This is most likely because the majority of charter schools are located in urban areas which have more historically disadvantaged students. As of the 2017-18 school year, 56 percent of charter schools were in cities while only a quarter of traditional public schools were located in urban areas (U.S. Department of Education, National Center for Education Statistics, 2020). Studies that compare the characteristics of students who attend charter schools and those who do not within urban districts find that the comparatively more advantaged students who are assigned to schools or districts with higher levels of disadvantaged students are more likely to attend charter schools (Bifulco, Ladd, & Ross, 2009; Ni, 2012). In sum, the literature shows that, for the most part, students participating in inter-district and charter school choice seem to be more advantaged than their peers.

Who Leaves?

If there is high attrition from inter-district choice and charter schools, the hypothetical benefits of school choice policies may not be realized. The negative effects of student mobility may outweigh any gains in achievement students experience from participating in school choice (Hanushek, Kain, & Rivkin, 2004). Furthermore, neighborhood schools may not respond to competitive pressures to improve if they know or perceive that students will eventually return to their schools (Creed, 2016). In fact, empirical evidence concerning inter-district choice participation and student achievement shows that students who begin in inter-district choice and do not return to their home districts experience increases in achievement, but those who return to their districts of residence experience small declines (Carlson & Lavertu, 2017; Carlson, Lavery,

& Hughes, 2018). Students who begin using inter-district choice after attending a school in their district of residence have no change in achievement on average (Cowen & Creed, 2017).

A handful of studies examine how many and which students leave school choice programs. Overall, disadvantaged students have a higher probability of exiting school choice. In a study of private school choice, Cowen, Fleming, Witte, and Wolf (2012) find that Black students, students with lower achievement, and students attending schools with a higher proportion of voucher students were more likely to exit Milwaukee's private school voucher program and return to public schools. Two papers describe the characteristics of students who leave inter-district choice. In Colorado, four out of five students continued to enroll in a TPS district other than the one they lived in. Students were more likely to exit if they were low income and lived in low-poverty districts (Lavery & Carlson, 2015). In contrast, over 60 percent of students who began in inter-district choice in kindergarten had exited by 5th grade in Michigan. Black, economically disadvantaged, and lower achieving students, especially those who were attending schools with low achieving and high risk students, had a higher probability of exiting (Cowen, Creed, & Keesler, 2015). I directly build on the Michigan study by incorporating commute times and residential mobility into the model and estimating these models for students who begin in charter schools as well.

To my knowledge, few studies directly examine the characteristics of students who exit charter schools. Taken together, they find that non-White, low achieving, and low income students are more likely to exit charter schools (Finch, Lapsley, & Baker-Boudissa, 2009; Ni, 2012). Much of the work concerning who exits charter schools focuses on whether charter schools "push out" difficult to educate students. Students with disabilities and English Learners are no more likely to exit charter schools than their more advantaged counterparts or similar students in surrounding traditional public schools (Winters, 2014; Winters, 2015). The research concerning whether students with low levels of achievement are more likely to exit charter schools is mixed. Evidence form New York City and Denver shows that lower performing students are more likely to exit charter schools while a study of a large Midwestern school district finds no statistically significant difference in achievement levels of those who leave charter schools (Winters, Clayton, & Carpenter, 2017; Zimmer & Guarino, 2013). However, these studies find that there is no difference in exit rates between charter schools and their surrounding traditional public schools (Nichols-Barrer, Gleason, Gill, & Tuttle, 2016; Winters, Clayton, & Carpenter, 2017; Zimmer & Guarino, 2013). Thus, differences in attrition between charter school students likely reflect the characteristics of mobile students within districts.

Residential Mobility

One factor that could influence participation in school choice programs is residential mobility. Most of the work that directly examines the effects of residential mobility focuses on its impact on student performance. The findings of these studies are nuanced, but they show that residential mobility is negatively associated with achievement especially when accompanied by a change in schools. Two studies using nationally representative survey data find that students that move schools and residences experience decreases in achievement on average but moving earlier during high school is associated with increases in test scores (Pribesh & Downey, 1999; Swanson & Schneider, 1999). In an urban district in Tennessee, Voight, Shinn, & Nation (2012) find that residential mobility has a negative relationship with achievement in elementary and middle school. Similarly, students in New York City experience decreases in test scores after they move neighborhoods, but these relationships are attenuated when the residential move is accompanied with a move to a higher quality school (Cordes, Schwartz, Stiefel, & Zabel, 2016).

One study estimates the causal impacts of residential and school mobility. It finds that changing residences has a negative effect on achievement unless the student did not change schools and only moved a short distance (Cordes, Schwartz, & Stiefel, 2019).

Residential Mobility and Participation in School Choice

To my knowledge, little evidence exists concerning the role of residential mobility in participation in formal school choice policies. However, it is likely that residential moves induce entry in and exit from formal school choice programs. Families may make different choices about schools after a residential move since families prefer schools closer to home, report having difficulty transporting their students to school, and are more likely to use school choice when their default option is farther from their residence (Denice & Gross, 2016; Edwards, 2021; Glazerman & Dotter, 2017; Harris & Larsen, 2019; Hastings, Kane, & Staiger, 2005; Jochim, DeArmond, Gross, & Lake, 2014; Lenhoff, Singer, Stokes, & Mahowald, 2021; Lincove, Cowen, & Imbrogno, 2018). Furthermore, residential decisions can be used to informally choose a school since a student's assigned school is determined by residence in the majority of U.S. school districts. To test my hypothesis that many families enter into or exit from formal school choice programs at the time of a residential move, I investigate whether or not changes in residence between school years are associated with changes in use of formal school choice policies. This provides some of the first evidence of the relationship between school choice use and residential mobility.

Distance

In addition to residential mobility, distance to school may also promote or restrict participation in school choice. First, distance to school choice options can serve as a barrier to using formal school choice policies since it is likely that families must travel outside of the their neighborhoods in order to participate in school choice. Studies of parent preferences in choice-rich cities like Denver, New Orleans, and Washington, D.C. show that families rank schools closer to home higher on enrollment applications indicating that they may not be willing or able to leave their neighborhoods to attend more effective schools (Denice & Gross, 2016; Glazerman & Dotter, 2017; Harris & Larsen, 2019; Hastings, Kane, & Staiger, 2005; Lincove, Cowen, & Imbrogno, 2018). These revealed preferences are likely to be function of families' abilities (or inabilities) to transport their children to schools farther from home. Only six states require districts to transport students using inter-district choice and 17 states mandate that charter school students are provided transportation (McShane & Shaw, 2020). In choice-rich cities, most parents report that they drive their children to school and that a lack of reliable transportation is a barrier to sending their children to the desired school and getting them to school regularly (Jochim et al., 2014; Lenhoff et al., 2021). Furthermore, families living in high-poverty neighborhoods, those who are possibly the most likely to benefit from school choice, are less likely to have access to a car, making it difficult to attend schools outside of their neighborhoods (Urban Institute Student Transportation Working Group, 2018).

Distance may be a larger barrier to entry for students in population sparse areas since there are longer distances between schools and towns creating fewer schooling options proximal to home. If inter-district and charter school choice was made universal, about a quarter of rural elementary school students would have access to an additional schooling option within five miles from home. In contrast, almost two-thirds of urban students would have increased access to schools through universal public school choice (Blagg & Chingos, 2017). Furthermore, Catt and Shaw (2019) show that six percent of rural elementary school students and about a quarter of rural high school students in Indiana do not have a magnet, charter, or private school within a thirty minute commute from home.

Although distance from home to school choice options is likely to be a barrier to participating in school choice, long commutes to the assigned school could induce students to use school choice by lowering the opportunity costs of participation. For example, it is likely that the additional distance past the assigned school to attend a school of choice is shorter for students farther away from their assigned school. Some students may even be able to attend schools closer to home through school choice. Therefore, the additional cost in terms of distance of participating in school choice is likely lower for students who live farther away from their assigned school. In fact, the few studies that predict participation in public school choice as a function of distance to assigned school find that students who live farther from their nearest or assigned school are more likely to use inter-district and charter school choice (Bifulco, Ladd, & Ross, 2009; Edwards, 2021; Singer, 2020). In particular, Edwards (2021) finds that commute time to the nearest school plays a larger role in the decision to participate in inter-district choice for rural students with one in five rural students using inter-district choice to attend a school closer to home.

To test my hypothesis that distance to school choice options inhibits participation in choice but long commutes to the assigned school could induce students to use school choice, I compare commute times to the attended school and the nearest school for students who participate in school choice and those who do not. I also calculate the percent of students using school choice to attend a school closer to home.

Prior Evidence Concerning Commutes to School

Recent evidence concerning commute times in from choice-rich cities shows that Black and economically advantaged students travel farther to school, students who travel farther to attend school attend higher quality schools as measured by test scores, types of programs offered, and resources, and students who have longer commute times are more likely to have higher rates of absenteeism (Blagg, Rosenboom, & Chingos, 2018; Cordes & Schwartz, 2018; Cowen et al., 2018; Denice & Gross, 2018; Stein & Grigg, 2019; Urban Institute Student Transportation Working Group, 2018). In particular, Stein, Burdick-Will, & Grigg (2020) predict exit from Baltimore high schools, which operate under an open enrollment system instead of residential assignment, as a function of difficulty of commute. They find that students living farther away from their school in 9th grade are more likely to transfer and attend schools closer to home. As for school choice participation, students who attend charter schools in elementary school have longer commute times on average, but high school students attending traditional public schools travel as far if not farther to school than charter school students (Urban Institute Student Transportation Working Group, 2018). I add to these studies by providing some of the first estimates of commute times to school outside of cities and use them to predict exit from inter-district and charter school choice over time.

Context: Michigan, A Mature School Choice Market

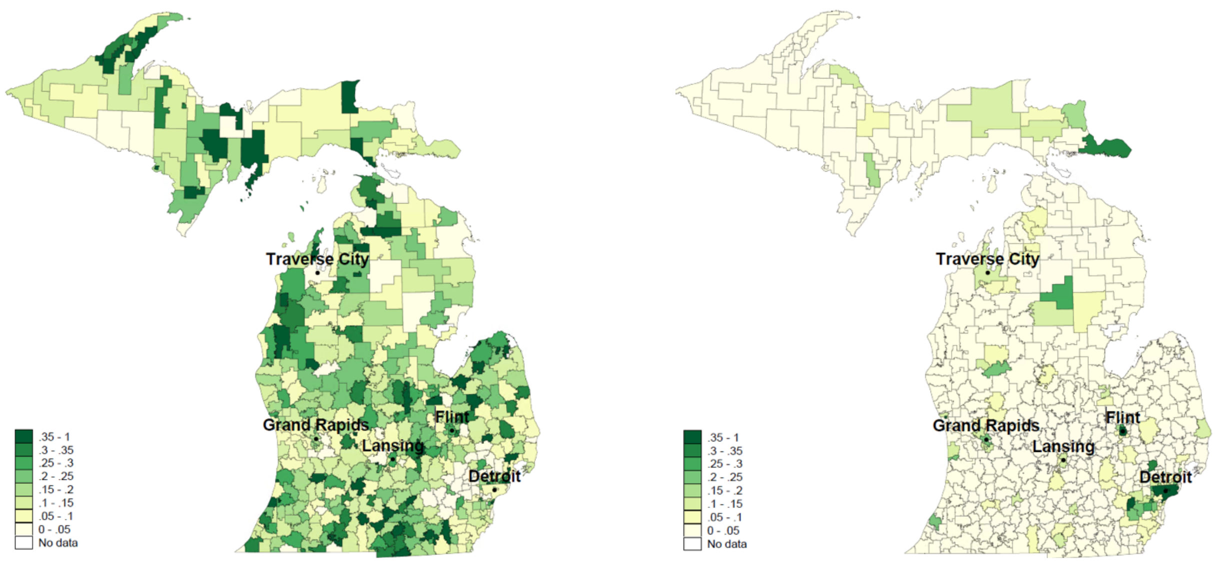
For over twenty years, Michigan students have been able to attend charter schools, other schools in their district of residence, and schools in other traditional public school districts in addition to their assigned school. In 1994, the Michigan State Legislature enacted Part 6A of the Revised School Code which allows community colleges, public universities, intermediate schools districts (ISDs), and TPS districts to authorize charter schools (Michigan Department of

Education, 2017). In contrast with the majority of charter school laws, public post-secondary institutions may authorize charter schools located anywhere in the state without oversight from local governments. Therefore, there is no one body that controls where schools are located, when they open, or when they close. Over 80 percent of Michigan charter schools are authorized by universities or community colleges. Furthermore, each charter school has its own application process. Although Michigan law prohibits charter schools from practicing selective enrollment policies and stipulates that they must hold a lottery to determine admission if they are oversubscribed, filling out multiple applications without a guarantee of enrollment may be prohibitive for entry into the charter sector (Michigan Department of Education, 2017). As of the 2017-18 school year, about one in ten Michigan public school students attended one of its 368 charter schools.

Since 1996, Michigan TPS districts have been able to enroll students from surrounding districts and ISDs. Under Acts 105 and 105c of the Michigan Revised School Code, also known as Michigan's Schools of Choice Program, Michigan districts may accept students from districts in their own ISD or students living in districts in contiguous ISDs respectively. 97 percent of Michigan TPS districts have participated in either 105 or 105c in the last decade with over 80 percent participating in both (Edwards & Cowen, 2020). Districts that decide to participate in Schools of Choice determine how many students they accept, which grades, programs, and schools non-resident students can enroll in, the timeframe they accept applications, and whether or not they offer transportation to non-residents. Under Michigan law, districts cannot select which non-resident students enroll in their district with few exceptions. Districts may refuse enrollment to students who have been suspended or expelled. Additionally, they do not have to accept students from districts outside their ISD with an Individualized Education Program (IEP) if they do not have an agreement with the students' district of residence. Outside of these exceptions, oversubscribed districts must hold a lottery. Districts may also enter into local cooperative agreements with other districts to enroll their students. Unlike Schools of Choice, selective enrollment practices are allowed by these local cooperative agreements (Michigan Department of Education, 2013). During the 2017-18 school year, about 13 percent of Michigan public school students used inter-district choice.

Figure 1. 2017-18 Participation in School Choice by District of Residence

Figure 1A: Inter-District Choice *Figure 1B: Charter School Choice*



Note. The denominator of the proportions in Panels A and B include all residents regardless if they attend a traditional public school or charter school.

Due to its prevalence, longevity, and lack of regulation, Michigan's school choice system is an ideal setting to study the role of location in school choice participation. First, Michigan has a relatively high proportion of Michigan public school students participating in inter-district and charter school choice with substantial use of school choice outside of urban areas. Figures 1A and 1B display participation in inter-district and charter school choice by district of residence. A higher percentage of rural students use inter-district choice than students living in other locales. Although over sixty percent of charter school students live in the Metro Detroit region, charter schools do exist in many rural districts throughout the state. In addition to its widespread use, the maturity of Michigan's school choice programs allows me to examine participation in a stabilized and developed schooling market. Finally, the absence of regulations on the supply of schools in Michigan provides conditions closest to the free market ideal of school choice. Michigan's charter school laws are considered some of the least regulated (Candal, 2018; Ziebarth, 2019). In theory, this allows for unfettered access to effective schools and the opportunity for families' schooling decisions to regulate the market, truly testing whether public school choice policies can increase access to effective schools and improve school productivity.

Data

My main sources of data are student-level enrollment and achievement records from the Michigan Department of Education (MDE) and Center for Educational Performance and Information (CEPI). These data include student demographic information (e.g., race and ethnicity, gender, disability status, English Learner status, and economically disadvantaged status[2]), student test scores on state standardized achievement exams (either the Michigan Educational Assessment Program, MEAP, or the Michigan Student Test of Educational Progress, M-STEP), and student addresses geocoded at the census block level for all Michigan public school students from 2012-13 to 2017-18. Additionally, I use a school-level data made publicly available by MDE, CEPI, and Michigan's Department of Technology, Management, and Budget that includes each district and school's sector, address, and educational settings as well as district boundaries.

To create my full analytic sample, I begin with 8,808,831 student-year observations between the 2012-13 and 2017-18 school years of students attending a traditional public school

[2] In Michigan, students are considered economically disadvantaged if they qualify for free or reduced lunch, receive food (SNAP) or cash assistance (TANF), or they are homeless, migrant, or in foster care.

or a charter school offering a general education setting. First, I exclude less than two percent of observations for the following reasons: 67,352 observations of students attending schools in juvenile detention centers, boarding schools, virtual schools, and other residential schools since these students do not commute to school; 64,680 observations of students who either attend a school that changes districts or live in a census block where the district of residence changes during the panel since these changes could induce them to technically use school choice without switching schools or residences; 12,931 observations for students who do not have a school in their district of residence that offers his or her grade and therefore must participate in school choice by definition; 3,270 observations that I am unable to calculate the distance from the student's residence to either their attended or nearest school; 2,675 student-year observations of students that are reported in a grade higher than the terminal grade of their attended school. Next, I remove 2.4% of observations where a student was held back or skipped a grade since an abnormal grade progression could induce a change in schools for different reasons that most students in the sample. Finally, I exclude of observations for homeless students (2.1% of my sample) since they do not have a stable residence by definition. My final analytic sample consists of 8,331,445 student-year observations representing almost 2.2 million unique students. I draw from this sample for each of my subsequent analyses.

The main focus of my paper are the relationships between use of choice, residence, and school attended. I study two forms of public school choice: charter school and inter-district choice. I consider all other public school students, those attending a school in the district that they live in, their resident district, as not participating in a formal public school choice policy.[3] I determine whether a student attends a TPS or charter school using information about schools

[3] I note that attending a school in the district of residence does not mean that families are not actively choosing a school. It is likely that they chose their residence so they could send their children to their desired school.

made publicly available by MDE and CEPI. I determine a student's district of residence using the coordinates of the population weighted centroid of their resident census block and district boundaries. I consider a student to be a non-resident, one using inter-district choice, if they are attending a TPS in a district other than the one they live in.

Table 1. 2017-18 Student Characteristics by Choice Use

	Full Sample	Resident	Non-Resident	Charter
Number of Students	1,356,085	1,064,568	169,793	121,724
Percent of Sample	100%	78%	13%	9%
Female	49%	49%	50%	50%
White	67%	71%	69%	30%
Black	17%	13%	17%	53%
Hispanic	8%	8%	8%	10%
Asian	4%	4%	2%	4%
Other Race	5%	4%	5%	4%
Econ. Dis.	51%	47%	52%	76%
SWD	13%	13%	13%	12%
EL	7%	7%	4%	12%
City	27%	23%	27%	62%
Suburb	44%	46%	37%	28%
Town	12%	13%	13%	4%
Rural	17%	18%	23%	5%
Avg. Std. Math Score	0.03	0.07	0.00	-0.31
Avg. Std. ELA Score	0.02	0.06	0.02	-0.26

Note. Non-residents are defined as students who attend a traditional public school that is not in their district of residence. Econ. Dis., EL, and SWD stand for Economically Disadvantaged, English Learner and Student with Disability respectively. Locale is determined by the National Center of Education Statistics locale code of the student's district of residence. ELA is an abbreviation for English Language Arts. Math and ELA test scores are from the Michigan Student Test of Educational Progress (M-STEP) and are standardized within grade, subject, and year at the state level. Test scores are available only for students who were in grades 3 through 8 in 2017-18 with valid test scores.

In Table 1, I present the summary statistics for students in the most recent school year of my sample, 2017-18, as well as differences between students attending charter schools, students using inter-district choice, and students attending a school in their district of residence. Overall, a higher percentage of students using formal school choice policies come from disadvantaged backgrounds and have lower average achievement compared to resident students. Differences are smaller between resident and non-resident students. Additionally, a higher percentage of non-resident students live in rural areas compared to resident students. In contrast, the majority of charter school students live in cities and are Black and economically disadvantaged.

RQ 1: How often do students participating in formal school choice policies change residences? Are residential moves associated with participation in school choice programs?

I hypothesize that many families enter into or exit from formal school choice programs at the time of a residential move. To test this hypothesis, I first describe the role of residential mobility in school choice decisions. Students in my analysis are considered to be residentially mobile if they live in a different census block than the previous year regardless of whether the new residence is within the boundaries of the same district.[4] Moving residences, even when it does not change their district of residence, could change the student's assigned school as well as the distance to other schooling options. I determine that students leave their initial choice at time *t* if they no longer using the form of choice they used at time *t-1.* For example, if a student leaves a non-resident school to attend a charter school, they would be leaving their initial choice. In contrast, if a student switches from one charter school to another charter school, they would not be leaving their initial choice. However, if a non-resident student moves into the district they are attending school in and continue to attend school there after they move, they would leave choice although they did not switch schools.

[4] 5.2% of student-year observations have multiple addresses within the same school year. To deduplicate the addresses, I first drop observations with residences in a district that does not match the reported district of residence from MDE when the student has an observation that does match it since that is likely to be the address at the time the school data was collected. Next, I drop excess observations that have commute times that are over an hour to their attended school when the student has one that is closer because it is likely that they lived at the closer address when attending the reported school. Third, I drop observations where a student does not live in the district they attend but has an observation with an address in the district they attend. Finally, I drop the remaining duplicated observations at random since I have no indication of when or how long they lived at a given residence within a school year.

To answer my first research question, I first show the differences in residential mobility rates and exit from students' initial choices by participation in formal school choice policies. Then, I examine how the characteristics of residentially mobile students differ from students who do not switch residences. Finally, I describe the relationships between school attended, moving residences and exit from the students' initial choice. I accomplish this using two different samples drawn from my full analytic sample. First, I examine residential mobility and participation in school choice between two school years for all students. Specifically, this sample includes all students in my main sample that attend a Michigan public school in both 2016-17 and 2017-18. While this sample permits us to describe residential mobility across all grades for the majority of students in Michigan, it does not allow us to examine residential mobility over time or account for a student's initial choice. Thus, I also explore residential mobility and choice use for students who begin kindergarten in the first year of my panel and follow them through 5th grade, the last year of my panel.

Table 2. Residential and Choice Mobility Behaviors by Initial Choice

	Mobility between 2016-17 and 2017-18			**Mobility between Kindergarten and 5th Grade**		
	N	**Changes Residences**	**Exits Initial Choice**	**N**	**Changes Residences**	**Exits Initial Choice**
Resident	953,714	12%	3%	66,493	43%	15%
Non-Resident	143,791	15%	12%	7,977	49%	44%
Charter	111,238	19%	17%	8,546	56%	43%

Note. Non-residents are defined as students who attend a traditional public school that is not in their district of residence. Columns 1-3 include students who are in my full sample during the 2016-17 and 2017-18 school years and a student is considered to change residences if they live in a different census block in 2017-18 than they did in 2016-17. Columns 4-6 contain students who are in kindergarten in the initial year of the sample, 2012-13 and are in my sample all years of the panel. A student is considered to change residences if they live in a different census block than they did in kindergarten at any time before 6th grade. Rows represent choice in the initial year of the sample. I consider students who are no longer using the same choice policy to attend school to exit their initial choice. Students who use the same choice but change schools or district are not considered to exit their initial choices.

In Table 2, I display the percent of students who are residentially mobile and the percent who exit choice for both samples by their initial choice. Across all forms of choice, less than 20 percent of students were residentially mobile between 2016-17 and 2017-18, but almost half of kindergarten students moved residences at least once by 5th grade. In both samples, a slightly higher percentage of students who attended a non-resident or charter school were residentially mobile. Compared to the percent of resident students who move residences, percent of resident students that no longer attend a school in their district of residence is much smaller. However, the percentages of students who change residences and exit their initial choice are similar for students using inter-district and charter school choice. This implies that most exits from formal school choice programs may be accompanied by residential moves.

Next, I compare the characteristics of residentially mobile and immobile students by their initial choice. Table 3 displays these average differences in student demographic characteristics for those who are residentially mobile and those who are not between 2016-17 and 2017-18.[5] Across all initial choices, a higher percentage of residentially mobile students are Black, economically disadvantaged and live in cities compared to other students using the same form of choice. Residentially mobile students also have average test scores prior to moving residences that are 0.2 to 0.3 standard deviations lower than their immobile counterparts. Additionally, residentially mobile students are much more likely to exit their initial choice. For example, only four percent of students who live in the same residence between 2016-17 and 2017-18 and use inter-district choice in 2016-17 no longer use it during the next school year while almost 60 percent of students who move residences exit inter-district choice. However, a smaller percentage of resident students who change residences exit their initial choice compared to students using formal school choice policies. Taken together, the evidence from Tables 2 and 3 show that not only are students participating in school choice are more residentially mobile and

[5] Differences are similar for the kindergarten sample. However, kindergarten students do not have test scores for most of the panel, especially at the time of initial choice. Results are available by request.

that residentially mobile students are more likely to exit their initial choice, but residentially mobile choosers have a higher rate of exit from their initial choice than residentially mobile students attending a school in their district of residence.

Table 3. 2016-17 Student Characteristics by Residential Mobility between 2016-17 and 2017-18

	Resident		Non-Resident		Charter	
	Same Residence	Changes Residence	Same Residence	Changes Residence	Same Residence	Changes Residence
Number of Students	843,583	110,131	122,918	20,873	89,932	21,306
Pct. Exit Initial Choice	1%	19%	4%	59%	11%	40%
Female	49%	49%	50%	51%	50%	50%
White	73%	60%	71%	65%	32%	21%
Black	12%	23%	15%	20%	50%	66%
Hispanic	7%	9%	8%	8%	10%	7%
Asian	4%	2%	2%	1%	4%	2%
Other Race	4%	6%	5%	6%	4%	4%
Econ. Disadvantaged	41%	68%	45%	64%	70%	84%
Student with Disability	12%	15%	13%	14%	12%	12%
English Learner	7%	8%	4%	3%	13%	9%
City	22%	31%	27%	31%	61%	69%
Suburb	48%	40%	37%	37%	30%	24%
Town	13%	14%	13%	13%	4%	3%
Rural	17%	15%	23%	19%	5%	3%
Std. Math Score	0.12	-0.27	0.04	-0.19	-0.28	-0.54
Std. ELA Score.	0.11	-0.26	0.05	-0.15	-0.22	-0.49

Note. Non-residents are defined as students who attend a traditional public school that is not in their district of residence. Columns represent choice in the initial year of the sample, 2016-17. A student is considered to change residences if they live in a different census block in 2017-18 than they did in 2016-17. Students who use the same choice but change schools or district are not considered to exit their initial choices. Locale is determined by the National Center of Education Statistics locale code of the student's district of residence. ELA is an abbreviation for English Language Arts. Math and ELA test scores are from the Michigan Student Test of Educational Progress (M-STEP) and are standardized within grade, subject, and year at the state level. Test scores are available only for students who were in grades 3 through 8 in 2016-17 with valid test scores.

Now that I established that students participating in school choice are more likely to be residentially mobile and exit their initial choice when residentially mobile, I examine the percentage of exits from the initial choice that are accompanied by a residential move. Table 4 describes residential mobility patterns for those who leave their initial choice. Almost two-thirds of students who no longer attend a school in resident district move residences. A similar percentage of students who leave inter-district choice are residentially mobile. About half of charter school students who exit the charter sector move residences. Because students who move residences can attend the same school or district but enter or exit inter-district choice, I also calculate the percent of students who move residences and exit choice separately for those who attend the same school district between years and those who do not. Higher percentages of students who exit their resident district or inter-district choice and move residences during the 2016-17 school year attend a school in the same district the next school year than change districts. Furthermore, one in five students who uses inter-district choice in kindergarten eventually moves into the district that they were using inter-district choice to attend. Overall, the findings of Table 4 show that the majority of students who leave their initial choice also move residences with many who leave their initial choice attending the same school. Taken together, the findings of Tables 2, 3, and 4 suggest that many exits from formal school choice programs may be accompanied by a residential move.

Table 4. Residential Behaviors by Initial Choice for Students who Leave their Initial Choice

	Mobility between 2016-17 and 2017-18			Mobility between Kindergarten and 5th Grade		
	Resident	**Non-Resident**	**Charter**	**Resident**	**Non-Resident**	**Charter**
Number of Students	32,055	17,446	18,783	9,927	3,480	3,662
Same Residence	36%	29%	54%	36%	25%	49%
Changes Residence, New District	26%	29%	46%	27%	28%	51%
Changes Residence, Same District	38%	42%	N/A	37%	47%	N/A

Note. Non-residents are defined as students who attend a traditional public school that is not in their district of residence. Columns 1-3 include students who are in my full sample during the 2016-17 and 2017-18 school years and a student is considered to change residences if they live in a different census block in 2017-18 than they did in 2016-17. Columns 4-6 contain students who are in kindergarten in the initial year of the sample, 2012-13, and are in my sample all years of the panel. A student is considered to change residences if they live in a different census block than they did in kindergarten at any time before 6th grade. I consider students who are no longer using the same choice policy to attend school to exit their initial choice. Students who use the same choice but change schools or district are not considered to exit their initial choices. Changes Residence, New District refers to students who move, but attend a school in a different district than they did the previous year.

RQ 2: How far do students travel to school? How does this differ for students participating in formal school choice programs?

The relationship between where families live and their decisions to use and continue participating in formal school choice policies may not only be shaped by residential mobility but by the distance between schooling options and their residences. Thus, I also examine differences in commute times and distances from home to school between students participating in school choice and those who do not. I calculate commute times (in minutes) and commute distances (in miles) by car using Here Application Program Interface (API) from the population weighted centroid of the student's home census block to their attended school as well as the nearest TPS in their district of residence offering their grade, my proxy for assigned school.[6] Estimating the commute time to students' nearest schools allows me to determine how much farther students are traveling to use school choice options and test my hypothesis that students who live farther from their assigned school are more likely to use school choice. I use the nearest school instead of the assigned school because I do not have data concerning student's assigned schools or catchment zones for all districts in Michigan over time. I determine the student's nearest school by

[6] Although I do not have exact addresses for students, I believe that using the population weighted centroid of the student's resident census block provides reliable estimates for the following reasons. First, over half of U.S. census blocks are smaller than a tenth of a square mile, implying that my calculations should be within 528 feet of the actual address on average (Federal Communications Commission, 2015). To investigate errors associated with addresses coarsened to the block level and disparities in these errors between urban and rural locales in my sample, I calculated the geodetic distance from the population-weighted centroid of each student's census block to the population-weighted centroid of the nearest census block within the same school district. This distance should provide an estimate of the possible size of the measurement error since the population weighted centroid of a student's census block should be closer to their home than the population weighted centroid of the next census block. I find that the median distance between census blocks for students in my full sample is less than a tenth of a mile. Because census blocks are larger in area in rural locales (Federal Communications Commission, 2015), I also examine distance between census blocks in rural districts. I find that the median distance is about three tenths of a mile with less than one percent of rural students living in a census block that has a distance to the center of the next census block over one mile. Because these distances are fairly small, I conclude that using the population weighted centroids of the student's resident census block to estimate commute times should provide fair estimates in cities as well as in rural areas. To account for the differences in the size of the census blocks between rural and urban areas and the larger errors in actual address, I focus my comparisons of travel times between students who use school choice and those who do not within locales. When the centroids do not fall on a road, I use the nearest road to the centroid to calculate drive time.

calculating the geodetic distance to each school offering his or her grade in their district of residence. I consider the school with the shortest distance to be the nearest school.

I calculate commute time and distance by car using the fastest route assuming normal traffic when the student leaves home at 8am on a weekday to best estimate travel conditions during the morning commute to school. Since commutes cannot be calculated for past dates, I estimate commutes times on a weekday at the end April between 2019 and 2021. Although there have been changes to traffic patterns in the years between the beginning of my panel, September 2012, and when I calculated the commute times, I do not believe that these changes are large enough to bias my estimates. Furthermore, these estimates do not account for extreme weather conditions found at other times in the school year in Michigan, allowing them to be comparable with other states. I consider my calculated commute times to be estimates of students' actual commute since I do not know the student's exact address, the mode of transportation students used to get to school, the exact time they leave or arrive to school, accurate weather conditions, or whether there was a significant change in traffic patterns during my panel.

Since the size of, number of, and distance between schools varies across grades, I focus on analyzing commute times and distances for students in kindergarten, 6th grade, and 9th grade, the grades students most commonly change schools, separately. First, I present average commutes times and distances to each student's attended and nearest school for all Michigan public school students by grade for the most recent school year, 2017-18, in Table 5. I choose to focus on the most recent school year in this analysis to more accurately reflect commute times and distances estimated. On average, students travel 8 to 11 minutes (3 to 5 miles) to school. Students in 9th grade travel farther to school than elementary school students. This is likely a function of the number and size of high schools compared to elementary schools. Additionally, students live about 6 to 9 minutes away (2 to 4 miles) from their nearest school offering their grade in their district of residence.

Table 5. 2017-18 Average Commute Times and Distances to Attended and Nearest School by Grade

	Kindergarten	6th Grade	9th Grade
Number of Students	100,279	108,231	109,155
Min. to Attended School	8.6	9.5	10.7
Miles to Attended School	3.7	4.2	4.6
Min. to Nearest School	6.1	7.5	8.8
Miles to Nearest School	2.4	3.1	3.5

Note. Commute times and distances are calculated using HERE API assuming normal traffic at 8 am on a weekday in April between 2019 and 2021. I determine the student's nearest school, my proxy for assigned school, by calculating the geodetic distance to each school offering his or her grade in their district of residence. I consider the school with the shortest distance to be the nearest school.

Reporting state-level averages may mask differences due to access to multiple schooling and choice options. For example, rural students may have to travel farther to school than students living in cities regardless of whether or not they attend their resident school since schools are more spread out in rural areas due to population sparsity. Therefore, I compare commute times to attended school and nearest school within locales to determine how commutes to school differ for students participating in formal school choice programs in Figures 2 and 3. Furthermore, I focus on commute times in my discussion of my results since I contend that time more accurately reflects how individuals experience their commute since they account for traffic patterns, the availability of express ways, and the number of stoplights that may make commutes of the same distance take longer.

In Figure 2, I display commute times to the attended school by grade, locale, and participation in school choice programs. Across all grades and locales, students participating in formal school choice programs travel farther to school on average. In kindergarten, students using inter-district choice travel twice as far to school than students attending a school in their district of residence with slightly smaller differences in 6th and 9th grade. In kindergarten and 6th

Figure 2. Average Commute Time to Attended School by Grade, Locale, and Choice

Figure 2A: Kindergarten

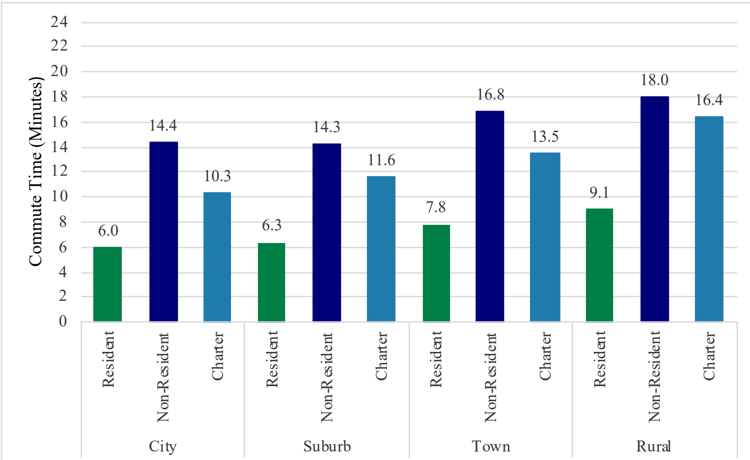


Figure 2B: 6th Grade

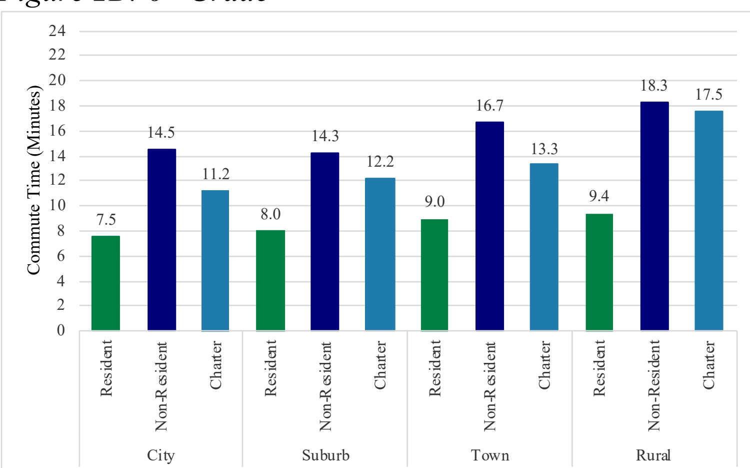
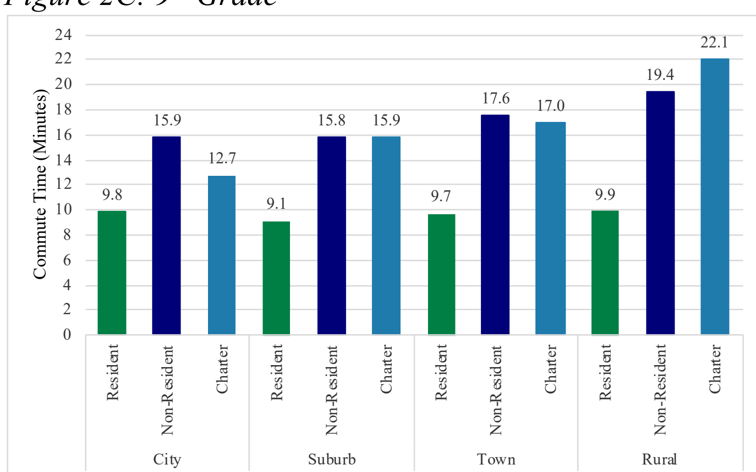


Figure 2C: 9th Grade



Note. Non-residents are defined as students who attend a traditional public school that is not in their district of residence. Locale is determined by the National Center of Education Statistics locale code of the student's district of residence. Commute times and distances are calculated using HERE API assuming normal traffic at 8 am on a weekday in April between 2019 and 2021.

Figure 3. Commute Time to Nearest School By Grade, Locale, and Choice

Figure 3A: Kindergarten

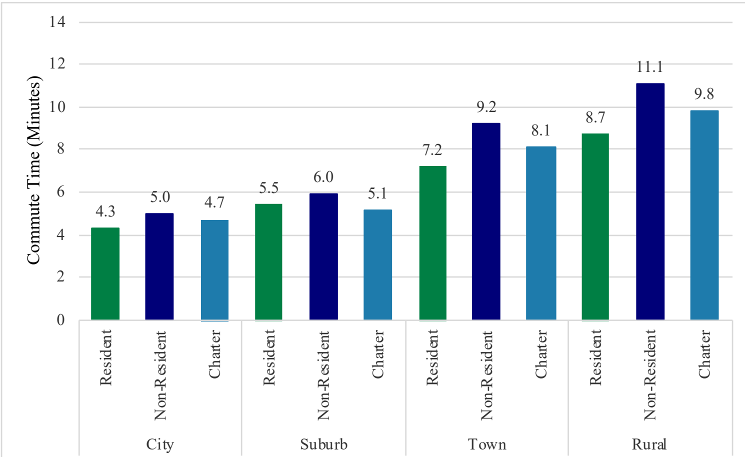


Figure 3B: 6th Grade

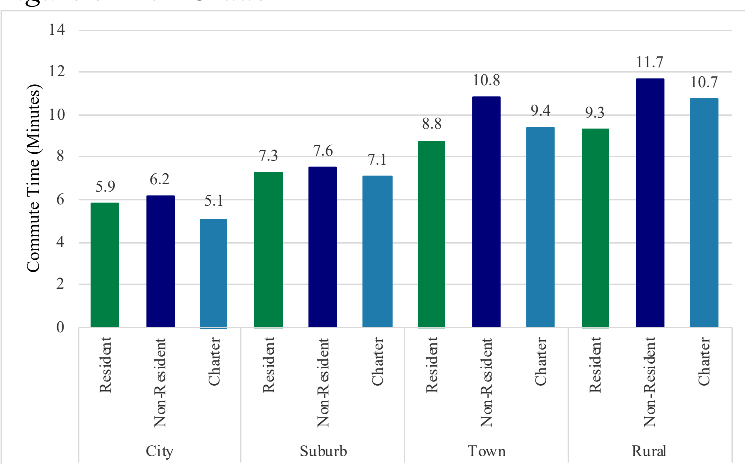
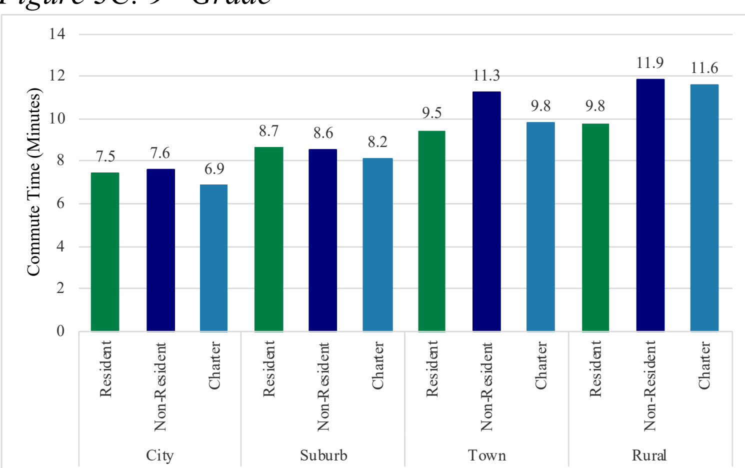


Figure 3C: 9th Grade



Note. Non-residents are defined as students who attend a traditional public school that is not in their district of residence. Locale is determined by the National Center of Education Statistics locale code of the student's district of residence. Commute times and distances are calculated using HERE API assuming normal traffic at 8 am on a weekday in April between 2019 and 2021. I determine the student's nearest school, my proxy for assigned school, by calculating the geodetic distance to each school offering his or her grade in their district of residence. I consider the school with the shortest distance to be the nearest school.

grade, non-resident students travel farther to school than charter school students on average. However, charter school students and students using inter-district choice travel similar distances on average in 9th grade. In Figure 3, I compare commute times to the nearest school between resident, non-resident, and charter school students. Average differences in time to nearest school between students who participate in school choice and those who do not are much smaller than differences in commute time to attended school. In town and rural districts, students who use inter-district choice live farther away from their nearest school than those who attend a school in their resident district. This implies that the opportunity cost of using inter-district choice may be lower for rural students whose nearest school, their likely default option, is farther away from their residence.

Since I show that there are differences in commute times to students' schools as well as nearest schools by choice use, I also explore how much longer students using formal choice policies spend commuting to school than they would if they attended their nearest school in Table 6. The additional minutes or miles a student travels are the differences between the attended school commute and the nearest school commute (attended school commute - nearest school commute). Students with negative additional commute times attend schools closer to home than their nearest school. Non-resident students travel an additional 6 to 10 minutes past their nearest school to their attended school on average. City students have the highest additional drive time. The average additional distance traveled by charter school students ranges from 3 to 9 minutes depending on grade and locale. Some students who use formal school choice policies actually attend a school closer to home than their nearest school. In Table 6, I also report the percent of students attending schools closer to home than their nearest school. Approximately one in five non-resident students living in rural areas and towns attend a school closer to home.

Similarly, over twenty percent of students attending a charter school attend a school closer to home. Taken together, the results I present in Figure 3 and Table 6 show that many students use school choice policies to attend schools closer to home or when their assigned school is far from home. This implies that proximity to home relative to their nearest or assigned school is a likely determinant in participation in formal school choice policies.

Table 6. Additional Distance Traveled Past Nearest School by Grade, Locale, and Choice

	Non-Resident				Charter			
	City	**Suburb**	**Town**	**Rural**	**City**	**Suburb**	**Town**	**Rural**
Kindergarten								
Additional Minutes	9.6	8.4	8.0	7.5	5.9	6.7	4.9	6.9
Additional Miles	5.3	4.6	5.6	4.9	2.9	3.6	3.3	5.0
Pct. Attending Closer to Home	8%	12%	19%	19%	22%	18%	32%	27%
6th Grade								
Additional Minutes	9.0	6.7	6.2	7.0	5.9	5.1	3.3	6.7
Additional Miles	5.2	3.8	4.5	4.6	3.1	3.2	2.1	4.7
Pct. Attending Closer to Home	11%	17%	25%	21%	22%	25%	35%	29%
9th Grade								
Additional Minutes	8.3	7.2	6.4	8.0	4.6	6.8	6.6	8.6
Additional Miles	4.9	4.3	4.9	5.3	2.8	4.5	5.1	6.5
Pct. Attending Closer to Home	14%	18%	26%	20%	28%	19%	28%	27%

Note. Non-residents are defined as students who attend a traditional public school that is not in their district of residence. Locale is determined by the National Center of Education Statistics locale code of the student's district of residence. Additional Minutes and Miles are the difference between the commute to the attended school and the student's nearest school. Commute times and distances are calculated using HERE API assuming normal traffic at 8 am on a weekday in April between 2019 and 2021. I determine the student's nearest school, my proxy for assigned school, by calculating the geodetic distance to each school offering his or her grade in their district of residence. I consider the school with the shortest distance to be the nearest school. I determine the percent of students attending school closer to home using additional commute time in minutes. Negative additional minutes means that the student attends a school closer to home than the nearest school in their district of residence.

RQ3: What are the roles of residential mobility and commute time to school in continued participation in formal school choice policies?

Since I find differences in residential mobility and distance to school between students who participate in formal school choice programs and those who do not, I formally examine whether residential mobility and distance traveled to school are associated with mobility out of inter-district or charter school choice. I accomplish this by estimating a set of hazard models on the students in my full analytic sample who were in kindergarten in 2012-13, participated in either charter school or inter-district choice in kindergarten, and were in my full sample all six years of the panel.[7] I focus on kindergarten, so I know with certainty what the student's initial choice was. I exclude students who leave Michigan public schools during the panel since I cannot account for their residential mobility at the time they leave the panel. Hazard models allow me to account for the relationship between the passage of time and mobility out of schools and have been used in prior studies of mobility and exit out of school choice (Cowen, Creed, & Keesler, 2015; Cowen, Fleming, Witte, & Wolf, 2012; Finch, Lapsley, & Baker-Boudissa, 2009; Lavery & Carlson, 2015). I estimate the hazard of leaving inter-district choice and charter schools separately. I also estimate my models on the sample restricted to students who never move residences since students who move residences are likely to have different choice sets before and after moving and the distance between home and school during the previous school year may be less relevant after changing residences.

Table 7 displays the average student characteristics of the non-resident and charter school students in my sample and compares students who leave their initial choice to those who remain in it through 5th grade. The majority of students who leave either form of choice move residences at some point between kindergarten and 5th grade. Those who switch out of inter-district choice travel farther past their nearest school than students that remain. Additionally, a higher percentage of students who leave inter-district choice are economically disadvantaged.

[7] In my main specifications, I also exclude 2,300 students who attend a school that does not have test scores in at least one year of the panel because a school's average achievement level is a significant predictor of mobility. Many of these schools without test scores only offer grades K-2. Results are similar with the full sample and are available by request.

Table 7. 2012-13 Kindergarten Student and School Characteristics by Mobility and Initial Choice

	Full Sample						Same Residence Sample					
	Non-Resident			*Charter*			*Non-Resident*			*Charter*		
	Full	**Stays**	**Switch**	**Full**	**Stays**	**Switch**	**Full**	**Stays**	**Switch**	**Full**	**Stays**	**Switch**
Student Characteristics												
Number of Students	6,268	3,599	2,669	7,955	4,640	3,315	3,234	2,813	421	3,524	2,604	920
Switches Residences	48%	22%	84%	56%	44%	72%	N/A	N/A	N/A	N/A	N/A	N/A
Min. to Attended Sch.	14.9	14.4	15.5	11.0	11.1	11.0	14.7	14.2	17.9	10.9	10.7	11.4
Min. to Nearest Sch.	7.2	7.6	6.7	5.2	5.4	4.9	7.8	8.0	6.8	5.5	5.6	5.2
Additional Minutes	7.6	6.8	8.7	5.9	5.7	6.1	6.9	6.2	11.1	5.4	5.1	6.3
Female	49%	50%	49%	50%	51%	50%	49%	49%	49%	50%	50%	50%
White	78%	80%	75%	33%	32%	33%	81%	82%	76%	41%	39%	45%
Black	11%	9%	13%	52%	52%	53%	8%	7%	13%	41%	43%	37%
Hispanic	6%	5%	6%	7%	8%	5%	5%	5%	7%	8%	9%	6%
Asian	2%	2%	1%	4%	4%	4%	2%	2%	2%	5%	5%	7%
Other Race	5%	4%	5%	5%	4%	5%	4%	4%	3%	5%	4%	6%
Econ. Dis.	43%	38%	51%	73%	71%	75%	35%	33%	44%	62%	63%	60%
Student with Disability	10%	10%	11%	7%	8%	6%	10%	10%	16%	8%	8%	7%
English Learner	3%	3%	3%	10%	11%	7%	4%	3%	5%	13%	15%	10%
City	22%	21%	24%	61%	62%	60%	19%	19%	19%	55%	58%	47%
Suburb	41%	39%	43%	29%	28%	30%	38%	38%	42%	32%	29%	38%
Town	12%	12%	11%	5%	5%	4%	12%	12%	10%	6%	6%	6%
Rural	25%	28%	22%	5%	5%	5%	31%	31%	29%	7%	7%	8%

Note. The same residence sample only includes students who live at the same residence all years of the panel. Non-residents are defined as students who attend a traditional public school that is not in their district of residence. A student is considered to switch residences if they live in two different census blocks during the panel. Commute times are calculated using HERE API assuming normal traffic at 8 am on a weekday in April between 2019 and 2021. I determine the student's nearest school, my proxy for assigned school, by calculating the geodetic distance to each school offering his or her grade in their resident district. I consider the school with the shortest distance to be the nearest school. Additional Minutes are the difference between the commute to the attended school and the student's nearest school. Econ. Dis. stands for Economically Disadvantaged. Locale is determined by the National Center of Education Statistics locale code of the student's resident district. ELA is an abbreviation for English Language Arts. Math and ELA test scores are from the Michigan Student Test of Educational Progress (M-STEP) and are standardized within grade, subject, and year at the state level.

First, I estimate the unconditional hazard of leaving inter-district or charter school choice and graph the probability of staying in the initial form of choice as Kaplan-Meier survival curves in Figures 4A and 4B respectively. For both non-resident and charter school students, the probability of remaining in their initial choice decreases over time. Next, I plot the Kaplan-Meier curves separately for students who change residence and those who do not in Figure 5. These figures show that residentially mobile students have an increased hazard of exiting their initial choice. In fact, Figure 5A shows that few students who live at the same residence between

Figure 4. Kaplan-Meier Survival Probabilities for All Students (Survival=remain in initial choice). Kindergarten to 5th Grade

Figure 4A: Non-Resident Students

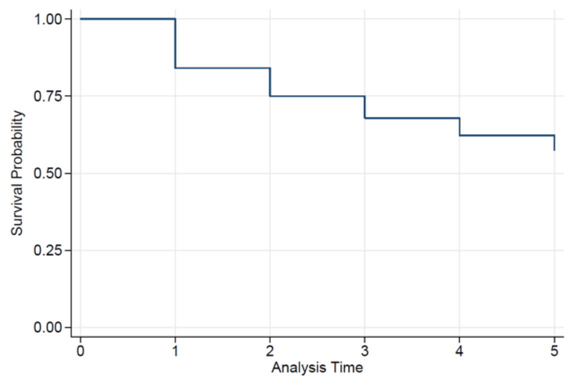
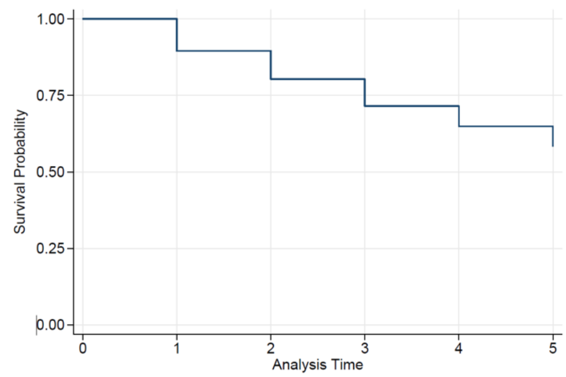


Figure 4B: Charter School Students



Note. Non-residents are defined as students who attend a traditional public school that is not in their resident district. The unit of Analysis Time is years starting with the 2012-13 school year and ending with the 2017-18 school year. Survival probability is the probability of remaining in the same choice between each year.

Figure 5. Kaplan-Meier Survival Probabilities by Residential Mobility (Survival=remain in initial choice). Kindergarten to 5th Grade

Figure 5A: Non-Resident Students

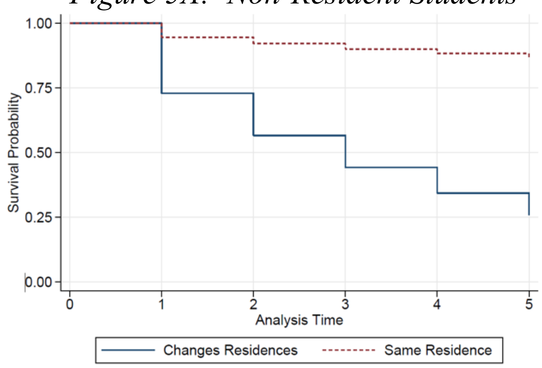
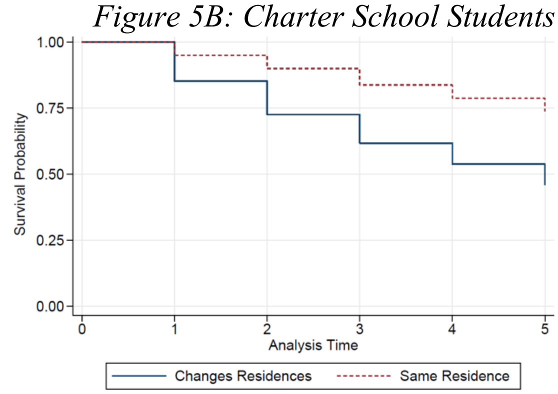


Figure 5B: Charter School Students



Note. Non-residents are defined as students who attend a traditional public school that is not in their resident district. The unit of Analysis Time is years starting with the 2012-13 school year and ending with the 2017-18 school year. Survival probability is the probability of remaining in the same choice between each year. I consider a student to change residences if they do not live in the same census block all years of the panel.

kindergarten and 5th grade leave inter-district choice; exit is driven by residentially mobile students. Figures 6A and 6B examine the unconditional hazards of leaving inter-district choice or charter school choice by quartile of total drive time to school in kindergarten for the full sample.[8] Non-resident students who travel farther to school have an increased hazard of exiting their initial choice while there are small differences by commute time for charter school students. The

[8] Results for the same residence sample can be found in Figure 7 in the Appendix.

differences in hazards by quartiles of additional minutes traveled to school past their nearest school are slightly larger as seen in Figure 8 in the Appendix.

Figure 6. Kaplan-Meier Survival Probabilities by Attended School Driving Time Quartile (Survival=remain in initial choice). Kindergarten to 5th Grade

Figure 6A: Non-Resident Students

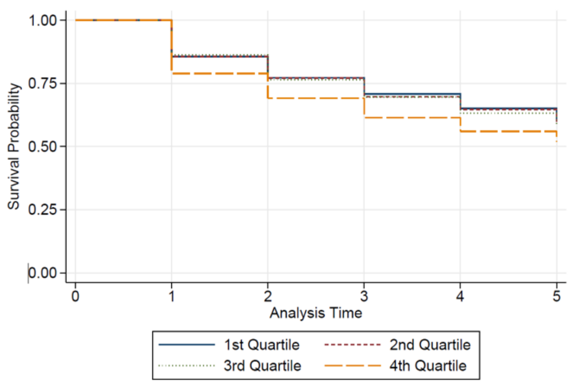
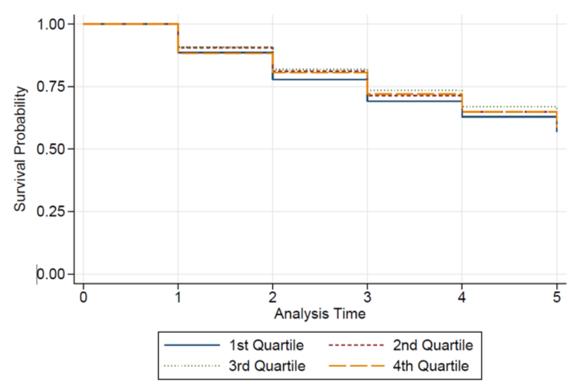


Figure 6B: Charter School Students



Note. Non-residents are defined as students who attend a traditional public school that is not in their resident district. The unit of Analysis Time is years starting with the 2012-13 school year and ending with the 2017-18 school year. Survival probability is the probability of remaining in the same choice between each year. Quartiles are determined using the commute time to attended school in kindergarten. Commute times and distances are calculated using HERE API assuming normal traffic at 8 am on a weekday in April between 2019 and 2021.

Next, I condition the student's probability of leaving their initial choice by residential mobility, distance traveled, and student and school characteristics. Formally, I estimate Equation 1 separately for students who begin in inter-district choice or charter schools:

$$h_i(t) = k(t)\exp\left(Residentmover_{it}\beta_1 + Distance_{i,t-1}\beta_2 + \boldsymbol{\gamma X_{i,t-1}} + \boldsymbol{\delta S_{i,t-1}}\right) \quad (1)$$

Where $h_i(t)$ is the hazard that student *i* fails to continue in their initial choice at time *t.* The baseline hazard function, $k(t)$ is assumed to have a Weibull distribution, as is common in most applications of survival analysis (Manton, Singer, & Woodbury, 1992).[9] $Residentmover_{it}$ equals one when a student lives in a different census block at time *t* than he or she did at time *t-1*. $Distance_{i,t-1}$ is either the overall travel time to the student's attended school, the commute time

[9] I choose a Weibull distribution for the hazard function since the hazard increases over time at a decreasing rate as suggested visually in the Kaplan-Meier curves and by the shape parameter. I also estimate Cox proportional hazard models. The results are similar and available by request.

to their nearest TPS in their district of residence, or the additional travel time to the attended school past the nearest school. I estimate specifications of my main model with linear and quadratic functional forms of each distance measure as well as combinations of overall distance with either nearest or additional distance. $\boldsymbol{X_{i,t-1}}$ is a vector of student characteristics including gender, race, economically disadvantaged, English Learner, and student with disability (SWD) statuses, and locale of the student's district of residence. $\boldsymbol{S_{i,t-1}}$ includes the following school characteristics: total enrollment, the percent of female, Black, Hispanic, Asian, Other Race, economically disadvantaged, and English Learner students, the percent of students with disabilities, and the average standardized math score on state exams.[10] I also include the average drive time to school in the vector of school characteristics to help account for differences in exit rates for schools that are located far from residential areas in general. Because average drive time could be related to the number of students using choice, I also include the percent of non-resident students attending the school in $\boldsymbol{S_{i,t-1}}$ in the inter-district choice models. Standard errors are clustered at the district of residence.

Results

Table 8 Panel A displays the estimates of my coefficients of interest, $Residentmover_{it}$, and the variants of $Distance_{i,t-1}$, on the full sample of non-resident students. Coefficients are displayed as log odds coefficients. Across all of my specifications, moving residences is a large and significant predictor of leaving inter-district choice holding constant other risk factors including economic disadvantaged status, race, and school achievement levels and demographics. In Column 1, I show that having a minute increase in commute time is associated

[10] I also estimate Equation 1 with standardized ELA score instead of math score. Results are similar and available by request.

with a small increase in the probability of exiting inter-district choice. In contrast, students who live farther away from their nearest school in their district of residence are less likely to leave inter-district choice as shown in Column 3. This implies that students who live farther from their assigned school may have a lower opportunity cost to continue participating in inter-district choice. Because of the positive relationship between leaving inter-district choice and actual commute time and the negative relationship between exit and travel time to the nearest school, I also examine the relationship between additional distance traveled to the attended school past their nearest school for non-resident students in Column 5. For every additional minute traveled to the attended school past the nearest school, there is an increase in the hazard of exiting inter-district choice.

To further examine these relationships, I include both the actual commute time and either the commute time to the nearest school or the additional minutes traveled in the model. When both commute times to the attended and nearest school are included in the model as linear terms, their relationships with exit are the same as the models when only one of the distance measures was included. Interestingly, they are similar in magnitude in opposite directions, indicating that if distance to both the attended and nearest school increases, there would be little change in the probability of exiting. To test this, I estimate a model with commute time to the attended school and the additional commute time measure. The coefficient on commute time to the attended school represents the change in the probability of exiting if both the time it takes to get to the nearest and attended school increased. The coefficient on additional minutes represents the change in the probability of exiting if the time it takes to get to the attended school increases, holding the distance to the nearest school constant. Results of this model are displayed in Column 9. There is no significant relationship between overall drive time and exiting

Table 8. Predicting Exit from Initial Choice from Kindergarten to 5th Grade: Full Sample

Panel A: Non-Resident Students

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Resident Mover	2.964***	2.964***	2.973***	2.974***	2.959***	2.958***	2.958***	2.959***	2.958***	2.958***
	(0.054)	(0.054)	(0.054)	(0.054)	(0.054)	(0.054)	(0.054)	(0.054)	(0.054)	(0.054)
Min. to Attended School	0.011***	0.011*					0.011***	0.011*	-0.001	-0.004
	(0.003)	(0.006)					(0.003)	(0.006)	(0.005)	(0.009)
Min. to Nearest School			-0.011***	-0.011			-0.012***	-0.010		
			(0.004)	(0.008)			(0.004)	(0.009)		
Additional Min.					0.0111***	0.012***			0.012***	0.014**
					(0.002)	(0.004)			(0.004)	(0.006)
Min. to Attended School Sq.		-0.000						0.000		0.000
		(0.000)						(0.000)		(0.000)
Min. to Nearest School Sq.				-0.000				-0.000		
				(0.000)				(0.000)		
Additional Min. Sq.						-0.000				-0.000
						(0.000)				(0.000)
Constant	-3.471***	-3.473***	-3.328***	-3.330***	-3.437***	-3.437***	-3.430***	-3.439***	-3.430***	-3.404***
	(0.384)	(0.388)	(0.383)	(0.384)	(0.384)	(0.384)	(0.385)	(0.389)	(0.385)	(0.392)

Table 8 (cont'd)

Panel B: Charter School Students

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Resident Mover	1.613***	1.613***	1.613***	1.612***	1.609***	1.609***	1.610***	1.609***	1.610***	1.611***
	(0.087)	(0.087)	(0.085)	(0.085)	(0.087)	(0.087)	(0.087)	(0.086)	(0.087)	(0.086)
Min. to Attended School	0.004	0.002					0.004	0.003	-0.016**	-0.025***
	(0.004)	(0.005)					(0.004)	(0.005)	(0.007)	(0.009)
Min. to Nearest School			-0.019***	-0.007			-0.020***	-0.008		
			(0.007)	(0.013)			(0.007)	(0.013)		
Additional Min.					0.007**	0.011***			0.020***	0.022***
					(0.003)	(0.004)			(0.007)	(0.007)
Min. to Attended School Sq.		0.000						0.000		0.001***
		(0.000)						(0.000)		(0.000)
Min. to Nearest School Sq.				-0.001				-0.001		
				(0.001)				(0.001)		
Additional Min. Sq.						-0.000*				-0.001***
						(0.000)				(0.000)
Constant	-3.798***	-3.792***	-3.711***	-3.764***	-3.759***	-3.772***	-3.702***	-3.747***	-3.702***	-3.669***
	(0.381)	(0.381)	(0.388)	(0.387)	(0.384)	(0.381)	(0.388)	(0.388)	(0.388)	(0.387)

Note. Total Observations Panel A: 24,397. Panel B: 32,315. Estimated coefficients are display as log odd coefficients. Standard errors clustered at the resident district level in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Student's gender, race, economically disadvantaged, English Learner, and disability statuses, the locale of the student's resident district and the following school characteristics total enrollment, the percent of female, Black, Hispanic, Asian, Other Race, economically disadvantaged, and English Learner students, the percent of students with disabilities, the average standardized math score on state exams, and the average drive time at time t-1 are included as covariates. In Panel A I also include the percent of non-resident students at time t-1 as a covariate. A student is considered be resident mover if they live in a different census block at time t than they did at t-1. Commute times are calculated using HERE API assuming normal traffic at 8 am on a weekday in April between 2019 and 2021. I determine the student's nearest school, my proxy for assigned school, by calculating the geodetic distance to each school offering his or her grade in their resident district. I consider the school with the shortest distance to be the nearest school. Additional Minutes are the difference between the commute to the attended school and the student's nearest school.

inter-district choice, but an increase in the additional travel time is associated with an increased hazard of leaving, indicating that relative distance past the default option, not total time traveled, influences decisions to remain in inter-district choice. The inclusion of the quadratic terms in the models in Columns 2, 4, 6, 8, and 10 does not meaningfully change the relationship between commute time and exit for any of my commute time measures suggesting that the relationship is linear.

Table 8 Panel B presents the analogous models for the sample of charter school students. Similar to non-resident students, charter school students have a higher probability of exiting the charter sector if they move residences between time *t* and *t-1*. While students who have a longer commute to their nearest school are less likely to exit charter schools, there is no significant relationship between commute time to the attended school and exit. There is a small but positive relationship with exiting choice and additional time traveled to the attended school past the nearest school. When both overall commute time to the attended school and the additional time to school are included in the model, an increase in distance to the attended school past the nearest school is associated with an increased hazard of leaving while an increase in both the distance to the nearest and attended schools is associated with a decreased hazard of leaving. This implies that charter school students are more likely to leave the charter sector the farther their attended school is relative to their nearest school, but less likely to exit if both their nearest school and attended school are farther from home.

The commute time from home to school at time *t-1* may not be relevant to school choice decisions at time *t* if students no longer live at the same residence. Therefore, I also estimate a version of Equation 1 on the sample of students who live at the same address between kindergarten and 5th grade without the residential mobility indicator. Results of this specification are presented in Table 9. For non-resident students, the direction of the relationships between all the commute time measures and exiting are in the same direction as the models estimated on the full sample, but their magnitudes are larger. Additionally, there is some evidence that some of these relationships are quadratic in nature. Still, when both overall and additional commute time are in the model, only additional commute time is statistically significant. Similarly, the relationships between commute times and the probability of exit are larger in magnitude and statistically significant for charter school students who do not change residences. In the model with both overall and additional commute time, only additional commute time is statistically significant. These results indicate that the commute time to school relative to the default option may be more important when making school choice decisions than overall distance especially for families whose residence is stable over time.

Discussion

In this paper, I provide some of the first evidence of the differences in residential mobility and commute times for students who use inter-district and charter school choice and their roles in continued participation in formal school choice programs. My findings show that both residential mobility and commute time are likely determinants of participation in school choice. The majority of students who leave their initial choice also move residences, and many who leave their initial choice actually attend the same school but move into or out of the district where they are attending school. As for distance, I find that many families use inter-district or charter school choice to attend schools closer to home or when their assigned school is farther from home. Similarly, students are more likely to exit their initial choice when the commute time to their attended school relative to their nearest school is longer. Taken together, these results

Table 9. Predicting Exit from Initial Choice from Kindergarten to 5th Grade: Same Residence Sample

Panel A: Non-Resident Students

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Min. to Attended School	0.043***	0.103***					0.0427***	0.104***	-0.016	0.044
	(0.006)	(0.016)					(0.007)	(0.016)	(0.014)	(0.033)
Min. to Nearest School			-0.062***	-0.067**			-0.059***	-0.051		
			(0.013)	(0.033)			(0.013)	(0.038)		
Additional Min.					0.044***	0.081***			0.059***	0.060***
					(0.006)	(0.010)			(0.013)	(0.019)
Min. to Attended School Sq.		-0.001***						-0.001***		-0.001
		(0.000)						(0.000)		(0.001)
Min. to Nearest School Sq.				0.000				-0.000		
				(0.001)				(0.002)		
Additional Min. Sq.						-0.001***				0.000
						(0.000)				(0.001)
Constant	-4.242***	-4.800***	-3.358***	-3.342***	-4.055***	-4.262***	-3.961***	-4.583***	-3.961***	-4.560***
	(1.221)	(1.205)	(1.208)	(1.197)	(1.217)	(1.201)	(1.214)	(1.192)	(1.214)	(1.240)

Table 9 (cont'd)

Panel B: Charter School Students

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Min. to Attended School	0.018***	0.023*					0.019***	0.021	-0.012	-0.023
	(0.006)	(0.013)					(0.006)	(0.013)	(0.012)	(0.018)
Min. to Nearest School			-0.030***	0.010			-0.032***	0.005		
			(0.011)	(0.027)			(0.010)	(0.027)		
Additional Min.					0.022***	0.033***			0.032***	0.038***
					(0.005)	(0.007)			(0.010)	(0.011)
Min. to Attended School Sq.		-0.000						-0.000		0.001*
		(0.000)						(0.000)		(0.000)
Min. to Nearest School Sq.				-0.002				-0.002		
				(0.001)				(0.001)		
Additional Min. Sq.						-0.001*				-0.001***
						(0.000)				(0.000)
Constant	-4.996***	-5.019***	-4.864***	-5.070***	-4.938***	-4.950***	-4.898***	-5.078***	-4.898***	-4.838***
	(0.755)	(0.762)	(0.750)	(0.743)	(0.753)	(0.759)	(0.754)	(0.744)	(0.754)	(0.772)

Note. Total Observations Panel A: 15,043. Panel B: 15,768. Estimated coefficients are display as log odd coefficients. Standard errors clustered at the resident district level in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Student's gender, race, economically disadvantaged, English Learner, and disability statuses, the locale of the student's resident district and the following school characteristics total enrollment, the percent of female, Black, Hispanic, Asian, Other Race, economically disadvantaged, and English Learner students, the percent of students with disabilities, the average standardized math score on state exams, and the average drive time at time t-1 are included as covariates. In Panel A I also include the percent of non-resident students at time t-1 as a covariate. Commute times are calculated using HERE API assuming normal traffic at 8 am on a weekday in April between 2019 and 2021. I determine the student's nearest school, my proxy for assigned school, by calculating the geodetic distance to each school offering his or her grade in their resident district. I consider the school with the shortest distance to be the nearest school. Additional Minutes are the difference between the commute to the attended school and the student's nearest school.

imply that families not only consider overall distance but focus on distance to school relative to the distance to the default option when making school choice decisions.

Because of the importance of location in families' school choice decisions, it is unlikely that the existence of school choice policies alone will increase equitable access to effective schools or force schools to compete for students, even if families prefer high quality schools. Families are likely weighing the proximity of the school against the increases in quality their child may experience if he or she attended a school farther away from home. In particular, they may be considering the distance relative to other schooling options just as much if not more than overall distance to school, indicating that they are accounting for other choices when making their decisions.

One possible policy that could mitigate the role of residential location in participation in school choice policies is the provision of transportation. School choice theorists claim that increased access and competition would be limited without an expanded school transportation system (Levin, 2015; Chubb & Moe, 1990). If parents are not personally responsible for transporting their children to and from school every day, they may be more willing and able to send them to schools farther from home. In fact, recent evidence from New York City finds that being eligible for the school bus mitigates the negative effects of distance on choice of school (Trajkovski, Zabel, & Schwartz, 2021). Furthermore, families may be able to continue to participate in choice programs after a residential move if there is guaranteed transportation. However, few states mandate that schools provide transportation for students participating in school choice (McShane & Shaw, 2020). More empirical evidence is needed concerning the effects of transportation on student outcomes and its cost-effectiveness to determine its feasibility as a policy solution.

My results also show that it is imperative that future work describing use of school choice policies or their effectiveness in increasing student outcomes should account for residential mobility and distance. For example, research that describes access to school choice options (i.e., Catt & Shaw, 2019; Blagg, & Chingos, 2017) should consider relative distance to school in addition to overall distance to various school choice options. Additionally, work examining differential exit from choice options should account for different residential mobility patterns between sectors. Finally, the literature concerning the effectiveness of school choice programs must incorporate the role of location and specifically residential mobility in their evaluations. A theory of school choice that does not account for physical access to schooling options, families' preferences for proximity, and their residential choices will not accurately reflect the factors that influence families' decisions.

APPENDIX

Figure 7. Kaplan-Meier Survival Probabilities by Attended School Driving Time Quartile (Survival=remain in initial choice). Kindergarten to 5th Grade for Same Residence Sample

Figure 7A: Non-Resident Students

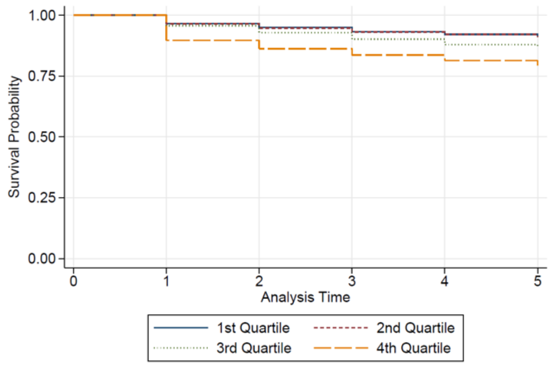
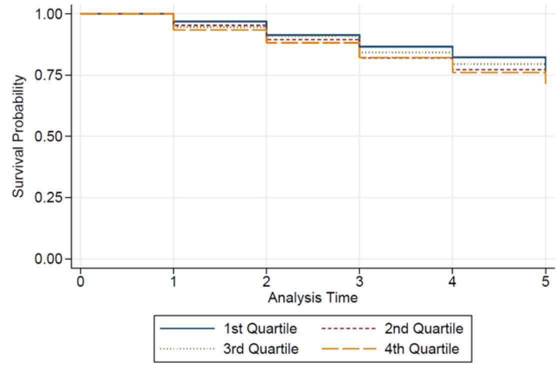


Figure 7B: Charter School Students



Note. Students in the sample live at the same residence all analysis years. Non-residents are defined as students who attend a traditional public school that is not in their resident district. The unit of Analysis Time is years starting with the 2012-13 school year and ending with the 2017-18 school year. Survival probability is the probability of remaining in the same choice between each year. Quartiles are determined using the commute time to attended school in kindergarten. Commute times and distances are calculated using HERE API assuming normal traffic at 8 am on a weekday in April between 2019 and 2021.

Figure 8. Kaplan-Meier Survival Probabilities Additional Driving Time Quartile (Survival=remain in initial choice). Kindergarten to 5th Grade

Figure 8A: Full Sample Non-Resident Students

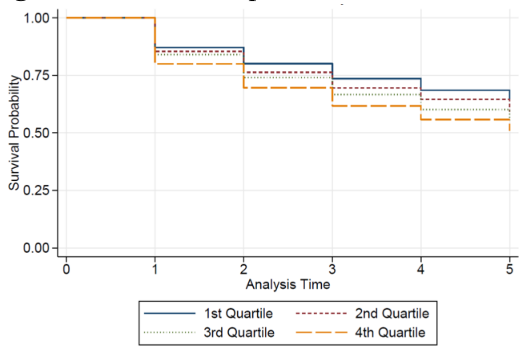


Figure 8B: Full Sample Charter Sch. Students

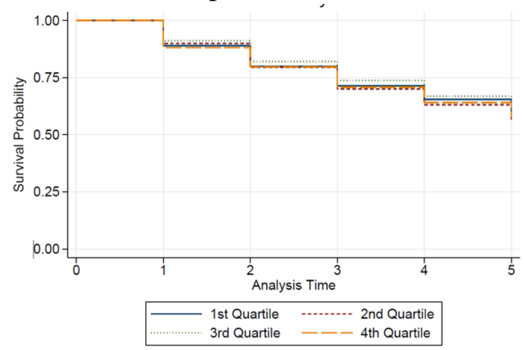


Figure 8C: Same Res. Non-Resident Students

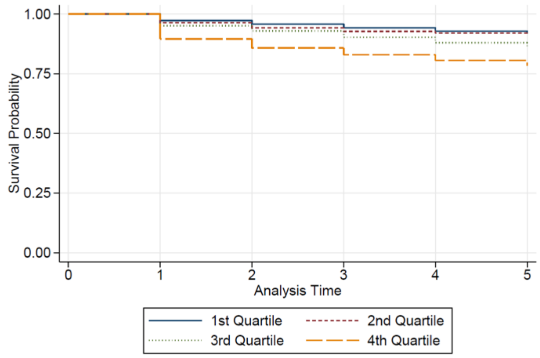
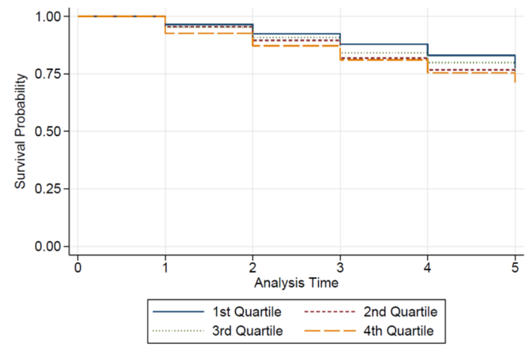


Figure 8D: Same Res. Charter School Students



Note. Students in the same residence sample live at the same residence all analysis years. Non-residents are defined as students who attend a traditional public school that is not in their resident district. The unit of Analysis Time is years starting with the 2012-13 school year and ending with the 2017-18 school year. Survival probability is the probability of remaining in the same choice between each year. Quartiles are determined using the additional commute time to attended school past the nearest school in kindergarten. I determine the student's nearest school, my proxy for assigned school, by calculating the geodetic distance to each school offering his or her grade in their resident district. I consider the school with the shortest distance to be the nearest school. Commute times and distances are calculated using HERE API assuming normal traffic at 8 am on a weekday in April between 2019 and 2021.

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PAPER 2 JUST OUT OF REACH? UNRESTRAINED SUPPLY, CONSTRAINED DEMAND, AND ACCESS TO EFFECTIVE SCHOOLS IN AND AROUND DETROIT

Introduction

Over the last three decades, school choice policies have increased the number and diversity of public schooling options available to students beyond a residential school assignment. Currently, thirty-four states have mandatory open enrollment policies, and forty-four states have charter school laws (Wixom & Keily, 2018; Wixom, 2018). About forty percent of families recognize that they have a choice in public schools, and one in four students in the United States enroll in a school other than the one they were assigned (National Center for Education Statistics, 2018). In cities, the number of students choosing to attend a non-neighborhood school is closer to fifty percent (Jochim, DeArmond, Gross, & Lake, 2014).

Some proponents of school choice argue that it can increase the supply of effective schools in addition to access to these schools. In theory, allowing students to attend schools outside of their neighborhood or even their local district breaks the monopoly that individual schools and districts have on students and thus creates competition for students. This encourages the establishment of many schools with a variety of curriculum, offerings, and management strategies to meet the needs and preferences of students and their families. Under such a system, schools may change their offerings to meet families' preferences in order to attract students. If they fail to attract students, they will shut down. Therefore, competition for students would result in the creation of a more effective supply of schools as long as parents prefer academic performance or school's effectiveness in increasing achievement, have accurate and transparent information concerning school quality, and the ability to overcome barriers associated with attending school outside of their neighborhood (Chubb & Moe, 1990; Friedman, 1962).

Critics of this theory have argued that competition, by itself, cannot regulate the quality of the supply of schools. Since schooling is compulsory, schools will draw students regardless of the school's quality if there is no other options or at least no more effective options. Furthermore, there is little incentive for effective or high performing schools to expand their capacity (Harris, 2017). Therefore, more recent school choice scholars have proposed systems of managed competition or portfolio models where schools are held accountable for their academic performance by districts or authorizers in addition to families (Harris, 2017; Hill, 2006). These proposals also call for cooperation and coordination across schools within an education market in order to regulate not only the quality but the quantity of schools.

Regardless of whether school choice policies increase the supply of effective schools, these policies will only increase access to more effective options if there is demand for effective schools. To accomplish this, families must prefer academic quality over other school characteristics, effective schools must be accessible, and there must exist accurate and transparent information concerning school quality (Harris, 2017; Levin, 2015). Prior work on parent preferences in choice-rich environments finds that families do value academic achievement. However, there are other school characteristics they value similarly. The most prevalent is proximity to home—even in a market where many schools are in principle available (Denice & Gross, 2016; Glazerman & Dotter, 2017; Harris & Larsen, 2019; Hastings, Kane, & Staiger, 2005; Lincove, Cowen, & Imbrogno, 2018). Although much of this literature frames proximity as a preference, distance is likely a constraint on the quantity of schools families' have the ability to attend, particularly for the most disadvantaged students. Families living in high-poverty neighborhoods are less likely to have access to a car (Urban Institute Student Transportation Working Group, 2018). Furthermore, most parents in choice-rich cities report that they drive their students to school with about one third reporting transportation as a barrier to their preferred schools (Jochim et al., 2014).

In this paper, I test whether distance and district boundaries are constraints to accessing high quality and effective schools, as measured by academic performance, for students living in Detroit, Michigan. Detroit provides an ideal context to test whether the supply of effective schools is constrained by geographic barriers for a few reasons. First, Detroit students have many schooling options that are geographically dispersed. They can choose from schools within their own district (intra-district choice), schools in surrounding districts (inter-district choice), and charter schools. Additionally, there is little accountability, coordination, transparency, or accessibility in the Detroit education market. Michigan's charter school law receives high marks from pro-school choice organizations for its lack of regulation on and use of non-district authorizers (Candal, 2018; Ziebarth, 2019). Since universities and colleges can authorize charter schools throughout the state with little oversight from the state or districts and there are no caps on brick and mortar open enrollment charter schools (Michigan Department of Education, 2017), little coordinated oversight of the quantity or quality of schools exists in and around Detroit. Also, there exists no centralized enrollment system or universal transportation policies for Detroit schools unlike other cities with similar levels of choice including New Orleans. Since Detroit has an unrestrained supply of schools with little regulation on their accessibility, it is an ideal case to test whether geography constrains families' ability to attend preferred schools in absence of universal enrollment or transportation policies. Furthermore, this permits the test of the role of the residentially assigned school in school choice decisions as well. In sum, I test whether the mere existence of school choice policies are enough to provide meaningful choice between schools.

To do so, I first describe the role of geography, in terms of district boundaries and distance, in the use of formal school choice policies. I focus on whether students who are disadvantaged in terms of poverty or access to transportation are more or less likely to use school choice. Furthermore, recognizing that in a high-choice environment the decision to enroll in one's default neighborhood school is itself a "school choice," I provide some of the first evidence for the ways in which a student's residentially assigned school may factor into family decision-making. I accomplish this using a set of multinomial logistic regressions that predict sector and location of school attended as a function of student and assigned school characteristics. Then, I test whether Detroit students attend more effective schools, as measured by their contribution to student's test scores, or schools with higher levels of achievement within their choice sets using discrete choice models. More specifically, I ask:

1. What are the roles of poverty, access to transportation, and student's assigned school in use of school choice?
2. Do Detroit students attend the more effective schools and/or the schools with the highest levels of achievement within their choice sets?

I provide evidence that families' choice sets are likely constrained to within city boundaries or within their TPS district. Specifically, disadvantaged students, particularly those living in neighborhoods where families have lower incomes and do not have access to a car are less likely to participate in public school choice, especially the options located outside of city limits. Furthermore, I show that families' preferences for academic quality and school effectiveness are stronger when choice sets are restricted to schools within Detroit or DPSCD and in earlier grades. I conclude by recommending that increasing the accessibility of choice options through transportation and enrollment policies may increase access to effective schools in a choice-rich system.

This study adds to the literature concerning preferences for schools in choice-rich cities in multiple ways. First, it is one of the few studies to frame distance and district boundaries as barriers to attending effective schools instead of a preference, especially for disadvantaged families. Furthermore, I test whether these constraints limit access to academic quality. Also, I describe choice in a deregulated environment that lacks a centralized enrollment system, retains little local control of the supply of schools, and allows students to attend schools outside of district boundaries. In particular, this paper is one of the first to expand students' choice sets to include choices available through inter-district choice—a prevalent but understudied form of choice—where other major forms of choice within multiple public school systems is possible.

Motivation: Supply of, Demand for, and Access to Effective Schools in Choice-Rich Areas

Supply

Although school choice advocates argue that school choice can increase the effectiveness of the supply of schools, little empirical evidence exists that competition, by itself, increases school quality, even when there are preferences for school effectiveness. First, studies of school leaders' perceptions of and responses to competition for students in Milwaukee and New Orleans, two choice-rich cities, find that schools are more likely to increase the marketing of their schools than improve achievement or instruction in response to competitive pressures (Jabbar, 2015; Loeb, Valant, & Kasman, 2011). Furthermore, studies that measure the extent to which competitive pressures from charter and private schools increase achievement of students remaining in traditional public schools find some small positive effects (Booker, Gilpatric, Gronberg, & Jansen, 2008; Cordes, 2017; Figlio & Hart, 2014; Sass, 2006; Winters, 2012) with some studies finding no effect (Zimmer & Buddin, 2009; Zimmer, Gill, Booker, Lavertu, Sass, & Witte, 2009), and one finding some negative effects (Imberman, 2011).

A set of studies of school choice in New Orleans also illustrate that even when there is demand for academic quality, competition, by itself, may not increase the supply of effective schools. In New Orleans, research shows that families have preferences for schools with high levels of academic achievement as measured by school performance ratings (Harris & Larsen, 2019; Lincove, Cowen, & Imbrogno, 2018). Although families listed high performing schools as their preferred option on the common application, less that 40 percent of students attend their first choice schools. Most attend lower quality schools than their first choice due to the limited supply of high performing schools in New Orleans (Lincove, Valant, & Cowen, 2018). Furthermore, a recent study finds that most of the improvements in the effectiveness, as measured by value-added measures, of the supply of schools in New Orleans over time can be attributed to the takeover of low performing schools and the opening of higher quality schools rather than the development of existing schools (Harris, Liu, Gerry, & Arce-Trigatti, 2019). Most of these takeovers and openings were a result of the performance-based charter authorizing process instead of competition by itself (Bross, Harris, & Liu, 2016).

Demand

Taken together, there is inconsistent evidence that shows school choice policies create a more effective supply of schools without external performance accountability. However, these policies can still increase access to effective schools if three conditions are met: families must have strong preferences for academic performance, the ability to overcome barriers associated with attending a school other than the assigned school, and accurate information concerning school quality (Chubb & Moe, 1990; Harris, 2017; Levin, 2015). I discuss the empirical evidence concerning each of these assumptions in turn.

Parental Preferences

When surveyed, parents state that the most important single factor when choosing a school is academic quality. This stated preference is especially strong for low income families (Bell, 2009; Jochim et al., 2014; Schneider & Buckley, 2002; Schneider, Teske, Marshall, & Roch, 1998). Nonetheless, self-reported preferences are subject to social desirability bias. For example, when surveyed, Washington, D.C. parents reported that they prioritize academic quality over other factors in their school search. However, an analysis of their internet searches shows that parents search schools' student demographics and location more often than their test scores (Schneider & Buckley, 2002).

Studies that use parents' rank-ordered (i.e. revealed) preferences on enrollment applications show that parents value higher levels of academic achievement, as measured by the schools' average test scores, accountability ratings, and peer quality (Abdulkadiroglu, Pathak, Schellenberg, & Walters, 2020; Beuermann, Jackson, Navarro-Sola, & Pardo, 2019; Denice & Gross, 2016; Glazerman & Dotter, 2017; Glazerman, 1998; Harris & Larsen, 2019; Hastings, Kane, & Staiger, 2005; Lincove, Cowen, & Imbrogno, 2018). Results concerning preferences for effective schools, as measured by their contribution to student achievement as growth percentiles or value-added measures, are mixed. In New York City and Washington, D.C. there is little evidence that families prefer schools with larger contributions to student achievement (Abdulkadiroglu et al. 2020; Glazerman & Dotter, 2017). In contrast, studies of New Orleans and Trinidad and Tobago find that parents value schools with higher valued added measures on high stakes tests in addition to overall achievement (Beuermann et al., 2019; Harris & Larsen, 2019).

In this study, I use state-calculated accountability ratings and author-constructed school level value-added measures to test whether parents prefer academic quality when choosing schools.

Although parents have strong preferences for academic achievement, they value other qualities as well as achievement. Studies of Washington, D.C. and Minneapolis show that families prefer schools where their child is not a racial minority (Glazerman & Dotter, 2017; Glazerman, 1998). Specifically, Denice and Gross (2016) find that White families in Denver have preferences for schools with few racial minority students. In New Orleans, families have a strong preference for extracurricular activities and childcare (Harris & Larsen, 2019). Additionally, some evidence exists that families prefer district-run schools as well as private schools over charter schools in Denver and New Orleans (Denice & Gross, 2016; Lincove, Cowen, & Imbrogno, 2018).

One of the most valued school characteristics is proximity from home (Abdulkadiroglu et al. 2020; Beuermann et al., 2019; Denice & Gross, 2016; Glazerman & Dotter, 2017; Glazerman, 1998; Harris & Larsen, 2019; Hastings, Kane, & Staiger, 2005; Lincove, Cowen, & Imbrogno, 2018; Singer, 2020). Families prefer schools that are closer to home, have shorter commutes, and are accessible by public transportation. To my knowledge, only one other study examines how student choice sets are constrained by geography. Denice and Gross (2016) find that when choice sets are restricted to a 2 mile radius around a student's home, all families, regardless of race, have strong preferences for high performing schools, implying that distance is a possible constraint to access to effective schools. I add to this literature by providing some of the first empirical evidence that families' choices—especially those of income-disadvantaged families—are meaningfully constrained by distance and geography even with multiple options legally available. Additionally, I examine the role of the student's assigned school in their use of school choice. Then, I use this information to restrict students' choice sets to estimate their underlying preferences for academic quality.

Preferences for school characteristics also vary across race, income, and academic ability. Racial minority, lower income, and lower achieving students have an especially strong preference for proximity that outweighs their preference for academic achievement (Denice & Gross, 2016; Harris & Larsen, 2019; Hastings, Kane, & Staiger, 2005). For example, Hastings, Kane, and Staiger (2005) find that as their child's test score and their income increase, families are more willing to travel farther to access higher quality schools. Differential preferences between advantaged and disadvantaged students could create a two-tiered system where high income and high achieving students attend high performing schools and while low income and low achieving students are stuck in their neighborhood schools (Hastings, Kane, & Staiger, 2005).

Barriers to Access

The difference in stated and revealed preferences, particularly for disadvantaged students, may be driven by constraints on their ability to overcome barriers associated with attending school outside of their neighborhoods. First, the revealed preference for schools closer to home could in fact be due to a lack of access to transportation. Families may be unable, but not unwilling to attend higher quality schools farther from home. Few states require schools to provide transportation to students using choice policies to attend them (McShane & Shaw, 2020). Thus, it tends to be the sole responsibility of the parent to get their child to and from school every day. This may be particularly difficult for low income families who are less likely to have access to a car or other forms of direct transportation (Urban Institute Student Transportation Working Group, 2018). In choice-rich cities, over twenty percent of parents report that transportation is a barrier in sending their child to the school of their choice (Jochim et al., 2014). Furthermore, differences in preferences for academic achievement by race disappear when choice sets are restricted to schools close to home (Denice & Gross, 2016). Therefore, it is likely that students attend schools near their residence out of necessity rather than solely preference.

Another likely set of barriers to access to effective schools is enrollment systems, practices, and policies. Parents, especially disadvantaged parents, cite application deadlines, the number of applications, difficulty with paperwork, and confusion with eligibility requirements as problems when choosing schools (Jochim et al., 2014). Furthermore, unregulated enrollment systems could create unequal access by providing opportunities for schools to select the best students or push out lower achieving students. One solution that can ease the burden on parents and create more equitable opportunities is unified enrollment systems where parents only fill out one application and a third party determines enrollment through a random lottery. At least eight cities have instituted a unified enrollment system over the last decade (Ekmekci & Yenmez, 2019). Parents in Denver report that the common application made the enrollment process more manageable (Gross, DeArmond, & Denice, 2015). Furthermore, causal evidence exists showing that the adoption of the unified enrollment system increased the percent of minority students and English Learners participating in charter school choice in Denver (Winters, 2015).

Accurate and Transparent Information

Families also need accurate information on school quality in order to choose effective schools. Few families have accurate information on the school's contribution to learning or achievement and instead rely on the social connections and the demographics of the student body to determine school quality (Schneider & Buckley, 2002; Schneider et al., 1998). About a quarter of families reported that they were unable to find an adequate amount of information to make the best school choice decision for their child (Jochim et al., 2014). However, information interventions that send school-level achievement information to families have increased the number of students attending effective schools (Hastings & Weinstein, 2008; Valant, 2014). Although many unified enrollment systems also increase the amount of publicly available information concerning school quality and offerings, parents in cities with these systems report wanting more tailored and rich information about schools (Gross, DeArmond, & Denice, 2015).

Background on School Choice in Michigan and Detroit

The amount of choice, and, in particular, the lack of centralized planning concerning the quantity and quality of schools serving Detroit students has been indicated as a contributor to the well-documented financial decline and eventual bankruptcy of Detroit Public Schools (Strauss July 15 2016). Detroit has an option demand choice system where students are assigned to a school within the newly formed Detroit Public Schools Community District (DPSCD) based on their residence but can option to attend other schools if the receiving school has space available similar to Denver and Washington, D.C. (Bell, 2009). For over twenty years, Detroit students have been able to attend charter schools located inside and outside of Detroit, schools in other districts, and other traditional public schools in Detroit instead of their assigned school. The Michigan legislature passed Act 105 of the Revised School Code in 1996 enacting the Schools of Choice Program which oversees inter-district choice in Michigan (Michigan Department of Education, 2013). Under Acts 105 and 105c, Michigan school districts have the option to accept students from other districts in their intermediate school district and surrounding intermediate school districts (ISDs). Districts that choose to receive students through Schools of Choice decide the number of students they enroll, the grades, programs, and buildings non-resident students can enroll in, and the timeframe they accept applications. Thus, sending districts, including Detroit, are not guaranteed to enroll a majority of their resident population. If a district chooses to not participate in Schools of Choice, they still are able to make agreements with specific districts to accept their students or they can accept non-resident students on a case by case basis. Districts are not required to provide transportation to non-resident students, but they can if they choose to do so (Michigan Department of Education, 2013). For example, less than twenty percent of Metro Detroit districts offer any transportation to non-resident students with only two of almost seventy districts reporting that they will cross district boundaries to provide transit. During the 2017-18 school year, Detroit students attended 60 different traditional public school districts within the three surrounding intermediate school districts.

Additionally, Michigan districts can choose to allow students to attend schools other than the one they are assigned to within the district through intra-district choice. Within DPSCD, students are able to choose from their assigned school, other neighborhood schools, and magnet schools. There were 24 magnet schools in DPSCD with 14 having competitive application or examination requirements during of the 2018-19 school year. DPSCD only guarantees transportation to K-8 students who attend their assigned school and live at least three quarters of a mile away from their school. All DPSCD high school students receive bus passes (Urban Institute Student Transportation Working Group, 2018).

Furthermore, Detroit has one of the highest rates of charter school attendance of cities in the United States at almost fifty percent. Only New Orleans and Washington, D.C. have a higher percentage of students attending charter schools (Hesla, White, & Gerstenfeld, 2019). In 1993, Michigan adopted Part 6A of the Revised School Code which allowed districts, intermediate school districts, community colleges, and universities to authorize charter schools. (Michigan Department of Education, 2017). In contrast with the majority of charter school laws in the

United States, authorizers in Michigan may approve applications for charter schools located anywhere in the state without oversight from state or local governments (Wixom, 2018). Thus, there is no one body overseeing where schools open, how many schools open, when schools open or close, and what types of schools exist in Detroit. In contrast, New Orleans only allows the Orleans Parish School Board and the state to authorize charter schools (Wixom, 2018). While charter schools in Michigan cannot practice selective admissions policies, enrollment may be a barrier since each charter school oversees its own application process leaving families to apply to each school individually with no guarantees of enrollment in contrast to Denver, Washington, D.C., and New Orleans that have centralized enrollment systems. Furthermore, charter schools are not required to provide transportation to its students, unlike New Orleans and Washington, D.C. (Urban Institute Student Transportation Working Group, 2018). During the 2018-19 school year, there were 380 charter schools operating in Michigan, with almost one hundred located within the boundaries of DPSCD.

Compared to other choice-rich cities including New Orleans, Denver, and Washington, D.C., Detroit's system of school choice remains one of the least regulated due to its lack of planning concerning school openings and closings, centralized enrollment systems, and universal transportation policies. When the Michigan legislature was crafting the bailout of Detroit Public Schools in 2016, the creation of a non-partisan entity, the Detroit Education Commission, was proposed to oversee the opening and closing of schools, serve as an accountability mechanism, manage a centralized enrollment system, and coordinate transportation needs across all traditional public schools and charter schools in Detroit (Coalition for the Future of Detroit Schoolchildren, 2015). While the state approved the return of an elected school board and the creation of a new debt-free school district, the Detroit Public Schools Community District, no city-wide oversight, enrollment system, or transportation policy was put in place (Gray June 9 2016).

During his 2018 State of the City address, Mayor Duggan announced the Get On and Learn bus loop (GOAL Line) as one of the first efforts of citywide coordination between DPSCD and charter schools. His objective was to decrease the number of Detroit residents attending schools outside of the city since over twenty percent were leaving the city every day to attend school (Levin March 21 2019). Currently, fourteen schools in northwest Detroit, half of which are charter schools, participate in the bus loop where students can get on at any of the schools to travel to any other school on the loop (Community Education Commission, 2019). In addition to transportation to and from school, GOAL Line provides transportation to an after school program. An analysis of ridership and parent surveys finds that GOAL Line is mostly used for its after school program rather than transportation (Edwards, Anderson, & Mohr, 2019).

Data

The main sources of data for this paper are student-level records from 2012-13 to 2017-18 provided by the Michigan Department of Education (MDE) and the Center for Educational Performance and Information (CEPI). These records include student addresses geocoded at the census block level, student demographic information (e.g., race and ethnicity, gender, disability status, English learner status, and economic disadvantaged status[11]), and student test scores on the Michigan Student Test for Educational Progress (M-STEP) for all Michigan public school students. I generate the school-level variables used in my analysis from the student-level data and a variety of publicly available datasets made available by MDE and CEPI. These school-

[11]In Michigan, students are considered economically disadvantaged if they qualify for free or reduced lunch, receive food (SNAP) or cash assistance (TANF), or they are homeless, migrant, or in foster care.

level datasets contain information about all schools in Michigan including the school's sector, address, their accountability rating on Michigan's Overall School Index System, and graduation rates. Additionally, I create a set of variables describing the programs schools offer using the 2018-19 *Detroit Parents' Guide to Schools* which includes application requirements, uniform requirements, transportation, before/after school care, and top activities for all public schools located within the boundaries of DPSCD. Finally, I use 2017-18 catchment zone boundaries provided by DPSCD to determine students' residentially assigned schools.[12]

Measures of Sector and Location

To answer my research questions, I estimate the relationships between student and school characteristics and the use of choice for students living in Detroit. As discussed above, Detroit students can attend their assigned school, other DPSCD schools, traditional public schools (TPS) in other districts, and charter schools located inside and outside of city limits. Therefore, I define use of choice as a categorical variable with five mutually exclusive outcomes determined by the sector and location of the school attended: the student's assigned school, another DPSCD school, a charter school located inside of Detroit, a TPS in another district, and a charter school located outside of Detroit. First, I determine the students' assigned schools using the coordinates of the population weighted centroids of their residences and the 2017-18 DPSCD catchment zones. I

[12] I begin with 112,756 students living within the boundaries of DPSCD during the 2017-18 school year. I use census block to school district conversions curated by the Missouri Census Data Center to determine which students live in Detroit. I exclude 28 students living in 10 census blocks that are split between catchment zones. Next, I restrict the sample to students attending a traditional public school or charter school offering general education in the three intermediate school districts serving the majority of Detroit students, Wayne Regional Education Service Agency (RESA), Oakland Schools, and Macomb Intermediate School District. I exclude 4,372 (3.9%) students attending virtual schools, boarding schools, schools in juvenile detention centers, and other residential schools because they do not commute to school on a daily basis. 18,101 (16.7%) students in my sample attend multiple schools during the 2017-18 school year. For these students, I use the observation associated with the school that determined by MDE and CEPI to be the student's most primary enrollment. For the 5,567 (5.1%) students who have multiple residences while attending their most primary school, I choose a residence to use at random since I am unable to discern which residence was their primary residence throughout the school year. Finally, I exclude 271 observations of students living in census tracts without reported median income. My full sample includes 108,085 students.

consider all other DPSCD schools, regardless if they are neighborhood or magnet schools, as Other DPSCD schools for that particular student. I determine whether or not a charter school and is located inside or outside of Detroit using the school's coordinates and the 2016-17 Michigan school district boundaries from the Michigan Department of Technology, Management, and Budget, the most recent year available at the time of analysis.

I calculate driving times (in minutes) for each student from his or her census block or tract to his or her assigned school for all students in the sample. For distances within a 2-mile radius (as the "crow flies"), drive times are calculated from the center of each students' home census block to the center of each school's census block. For distances more than 2 miles, drive times are calculated from the center from each students' home census tract to the center of the school's census tract. I estimate driving times using the Google Distance Matrix application programming interface (API). Because Google API does not calculate drive times from the past, drive times are calculated using predicted travel conditions for weekdays between September 2017 and April 2020 assuming usual traffic at 8 am. Drive times are calculated for weekdays during the months of the school year where little to no snow would be expected (September through November and March through May).

Measures of Poverty and Access to Transportation

My first research question examines choice use for students who are likely to face difficulty attending schools farther away from home. Two groups of students that are likely to have difficulty overcoming barriers associated with using school choice are impoverished students and students without access to transportation. In addition to the measure of student economic disadvantage provided by MDE and CEPI, I use the median income of the student's resident census tract from the 2017 American Community Survey (ACS) as a measure of poverty. My first measure of transportation access, which is also from the ACS, is the percent of residents that do not own a car in the student's resident census tract. Since Detroit has an inefficient public transportation system compared to other choice rich cities and the majority of Detroit parents report driving their children to school, car ownership is likely necessary to transport students to schools outside of their neighborhoods (Jochim et al., 2014; Urban Institute Student Transportation Working Group, 2018).

Another factor in choice use may be whether the school itself provides transportation. The only school a Detroit student may be guaranteed transportation to is their assigned school. Students attending their assigned school and living more than 0.75 miles walking distance from that school may ride the school bus in elementary and middle school. To account for the role of school provided transportation in decisions to participate in school choice, I create an indicator of transportation eligibility. To determine whether a student is eligible for transportation to their assigned school, I calculate the walking distance from the centroid of the student's resident census block to the school using Here Technologies API assuming average traffic. I consider students who are in kindergarten through eighth grade who live more than 0.75 miles from their assigned school as eligible for transportation to their assigned school.

In Table 10, I provide summary statistics for my full sample as well as differences by sector of school attended. The vast majority of the students in my sample are Black and economically disadvantaged. Students who attend their assigned school have shorter drive times to their assigned school on average than the students attending schools in other sectors. Additionally, students attending schools outside of Detroit live in census tracts with slightly higher rates of car ownership and higher median incomes.

Table 10. Student and Neighborhood Characteristics by Sector of School Attended

	Full Sample	Attends Assigned School	Attends Other DPSCD School	Attends Detroit Charter	Attends Outside TPS	Attends Outside Charter
N	108,085	22,838	27,629	34,029	9,029	14,560
Economically Disadvantaged	90%	90%	86%	93%	87%	92%
Avg. Census Tract Median Inc.	$29,103	$28,410	$29,549	$28,592	$30,291	$29,801
Drive Min. to Assigned Sch.	4.94	4.04	5.31	5.16	5.88	4.58
Avg. Pct. No Car in Tract	23%	23%	23%	24%	21%	20%
Transportation Eligible	40%	32%	37%	50%	28%	47%
Female	49%	48%	49%	50%	49%	50%
Black	82%	81%	84%	82%	84%	79%
White	5%	3%	2%	5%	6%	12%
Hispanic	1%	2%	1%	1%	2%	3%
Asian	11%	14%	13%	12%	5%	4%
Other Race	1%	1%	1%	1%	3%	2%
Student with Disability	14%	14%	18%	12%	9%	11%
English Learner	12%	14%	12%	12%	5%	13%

Note. DPSCD is Detroit Public Schools Community District. TPS is an abbreviation for traditional public school. A student is considered Economically Disadvantaged if he or she receives free or reduced lunch, his or her family receives food (SNAP) or cash (TANF) assistance, or is in foster care, is homeless or migrant. Drives times from the population weighted centroid of the student's home census block to their assigned school were calculated using Google Distance Matrix API assuming usual traffic at 8am on a weekday. Students are considered transportation eligible if they are in grades K-8 and live more than 0.75 miles walking distance from their assigned school.

Academic Quality Measures

The notion of "school quality" is itself a fairly subjective construct, and whether and to what extent schools are held accountable by federal, state, or local jurisdictions for some metric of performance is an enduring debate among education policymakers. This is a particularly important consideration in a study of school choice, which itself is a policy alternative predicated—as I describe above—at least in part on the notion that different families value different aspects of a school's contribution to their children's success. On the other hand, that school ratings on different dimensions are a relevant part of the current policy environment, and school characteristics—regardless of whether schools are in control of them—can and do constitute an important part of parental decision making, especially in high-choice environments (Lincove, Cowen, & Imbrogno 2018).

For these reasons, rather than choose a single metric of academic quality, I focus on three different metrics that capture different aspects of a school's academic performance. The measures are the school's state-generated academic accountability rating, the school's contribution to student test scores as measures by the school's valued added measure, and the school's graduation rate during the 2016-17 school year. I choose to use the year prior to the sample because this is the information parents would have had to use to make their school choice decisions. In particular, I calculate academic quality as follows:

1. School's rating on the Michigan School Index System**.** Index values range from 0 to 100. This is a composite measure made up of six components: student growth on state assessments, student proficiency on state assessments, school quality or student success, graduation rate, English-learner progress, and assessment participation. This measure is highly correlated with the school's average performance on state assessments. I use the school's rating from MDE as a school quality measure because it is made publicly available on a "Parent Dashboard" maintained by the state. I refer to this as a school's accountability rating or ranking because the index is the accountability system for Michigan schools under the Every Student Succeeds Act (ESSA).

2. School Value-added Measure. To measure school's contribution to student learning, I calculate the school's value-added measures, the school's contribution to students' math and English Language Arts (ELA) test scores, for the 2016-17 school year for students in grades K-8. Although value-added measures may be better measures of school quality, they may not be related to family's preferences for high quality schools since Detroit families do not directly observe them. To construct school-level

value-added measures, I follow the procedure described by Koedel, Mihaly, and Rockoff (2015).[13] I choose this procedure since it shrinks the estimated error variance which is preferred when using value-added estimates in secondary analysis since the errors could attenuate the results (Koedel, Mihaly, & Rockoff, 2015). I report the results of the models using the school's value-added to math test scores. Results using the ELA measures are similar and available by request.

3. Graduation Rate. Value-added measures are unavailable for most high schools since students are only administered a state standardized exam once between grades 9 and 12 in Michigan. Therefore, I use four year graduation rates as my secondary academic quality measure for students in grades 9-12. In addition, graduate rates have become a typical alternative to test scores as outcome measures in school choice evaluations (Angrist, Cohodes, Dynarski, Pathak, & Walters, 2016; Wolf, Kisida, Gutmann, Puma, Eissa, & Rizzo, 2013).

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[13] To calculate a school's value-added measures for the 2015-16, 2016-17, and 2017-18 school years, I use student test scores from the M-STEP for the 2014-15 through the 2017-18 school years. I first estimate the following equation: $Outcome_{it} = \rho_0 + \rho_1 math_{it-1} + \rho_2(math_{it-1})^2 + \rho_3(math_{it-1})^3 + \rho_4 ela_{it-1} + \rho_5(ela_{t-1})^2 + \rho_6(ela_{it-1})^3 + \boldsymbol{X_{it}\tau} + \boldsymbol{\delta_{st}\theta} + v_{it}$ where $Outcome_{it}$ is either student *i*'s math or ELA test score at time *t* year standardized within subject, grade, and year at the state level. $math_{it-1}$ and ela_{it-1} are student *i*'s math and ELA test scores respectively for the prior school year. $\boldsymbol{X_{it}}$ is a vector of student characteristics including race, gender, and economically disadvantaged, disability, and English Learner statuses. $\boldsymbol{\delta_{st}}$ is a school by year fixed effect. $\widehat{\boldsymbol{\theta}}$ is recovered as the school value-added measure for year *t*. Next, I shrink these measures towards a Bayesian prior using the following equation: $\widehat{\theta_{st}^{EB}} = a_{st}\widehat{\theta_{st}} + (1 - a_{st})\bar{\theta}$ where $\widehat{\theta_{st}^{EB}}$ is the school by year shrunken value-added estimate, $\widehat{\theta_{st}}$ is the unshrunken, recovered estimate, $\bar{\theta}$ is the school's average valued-added over time, and $a_{st} = \frac{\hat{\sigma}^2}{\hat{\sigma}^2 + \widehat{\lambda_{st}}}$. $\hat{\sigma}^2$ is the estimated variance of the school's valued added measures, and $\widehat{\lambda_{st}}$ estimated error variance for the value-added for school *s* in year *t* (Koedel, Mihaly, & Rockoff, 2015). I use $\widehat{\theta_{st}^{EB}}$, the shrunken value added estimate for school *s* for the 2016-17 school year, in my models. Since I use school by year valued added measures, this allows a school's effectiveness to vary by year. Therefore, a school's value added to a student's test score in 2015-16 should not be reflected in the school's 2016-17 value added estimate.

School Characteristics

To examine other preferences specifically in the Detroit area where this study is focused, I use information on school offerings found in the 2018-19 *Detroit Parents' Guide to Schools* (DPGS), one of the first sources of centralized information on school in Detroit that includes facts on charter schools in addition to DPSCD schools. I use a dataset created from the DPGS that contains information on application requirements, school hours, transportation, before and after school care, uniforms, security, and top activities for all public schools located within Detroit. Additionally, prior research has shown that families have preferences for student demographics. To measure the concentration of students by demographic characteristics, I construct the percent of students who are female, Black, White, Asian, Hispanic, Other Race, and economically disadvantaged as well as the percent of students with disabilities and who are English learners at each school using student-level demographic data.

Table 11 displays the average school characteristics for the student's assigned school by sector of school attended. Students choosing to leave the city have default options with a higher percentage of Black students on average. Students choosing to attend other DPSCD schools and schools outside of Detroit have assigned schools with lower than average accountability ratings.

Table 11. Student Weighted Assigned School Characteristics by Sector of School the Student Attends

Average Assigned School Characteristics	Full Sample	Attends Assigned School	Attends Other DPSCD School	Attends Detroit Charter	Attends Outside TPS	Attends Outside Charter
N	108,085	22,838	27,629	34,029	9,029	14,560
Avg. Pct. Female	53%	52%	53%	53%	53%	52%
Avg. Pct. Black	87%	82%	87%	86%	91%	92%
Avg. Pct. White	2%	3%	2%	2%	1%	2%
Avg. Pct. Hispanic	9%	13%	10%	10%	6%	3%
Avg. Pct. Asian	1%	1%	0%	1%	1%	2%
Avg. Pct. Other Race	1%	1%	1%	1%	1%	1%
Avg. Pct. Economically Disadvantaged	85%	85%	85%	85%	84%	87%
Avg. Pct. English Learner	9%	12%	9%	9%	5%	5%
Avg. Pct. Students with Disabilities	18%	17%	19%	18%	20%	17%
Avg. Total Enrollment	629	695	606	646	588	557
Avg. Accountability Rating	28.79	29.80	27.72	29.63	27.75	27.93
Avg. Math Value-Added	-0.13	-0.13	-0.14	-0.13	-0.13	-0.14
Avg. Graduation Rate	70%	74%	69%	70%	67%	73%
Pct. with After School Care	17%	17%	16%	21%	11%	16%
Pct. Have Sport as Top Activity	39%	43%	37%	42%	29%	37%

Note. Assigned school characteristics are weighted by the number of students in the location and/or sector. DPSCD is Detroit Public Schools Community District. TPS is an abbreviation for traditional public school. A student is considered Economically Disadvantaged if he or she receives free or reduced lunch, his or her family receives food (SNAP) or cash (TANF) assistance, or is in foster care, is homeless or migrant. Average math value-added is the average for students in grades K-8 and average graduation rate is the average in grades 9-12.

Methods

RQ 1: What are the roles of poverty, access to transportation, and student's assigned school in use of school choice?

To examine the differences in school choice take-up among disadvantaged students, I estimate a multinomial logistic regression since my dependent variable is a categorical variable. This model is described in Equation 2:

$$\ln\left(\frac{P_i(m)}{P_i(0)}\right) = \beta_0 + \beta_1 EconDis_i + \beta_2 \log(medianincome)_{ic} + \boldsymbol{Distance_{ij}\delta} + \beta_3 Pct.NoCar_{ic} + \beta_4 BusEligible_{ij} + \boldsymbol{Z_i\alpha} + \delta_g + \varphi_a + \varepsilon_i \quad (2)$$

Where $P_i(m)$ is the probability that student *i* attends a DPSCD school other than his or her assigned school (an Other DPSCD school, a Detroit Charter school, an Outside TPS school or

Outside Charter school) relative to attending his or her assigned school, $P_i(0)$. My variables of interest measure the student's exposure to poverty and access to transportation. $EconDis_i$ is an indicator that equals one when student *i* is considered economically disadvantaged. $\log(medianincome)_{ic}$ and $Pct.NoCar_{ic}$ are the natural logarithm of the median income of and the percent of residents who do not own a car in student *i*'s resident census tract *c* respectively. $\boldsymbol{Distance_{ij}}$ is a vector of indicators for having a drive time between their residence and their assigned school either between five and ten minutes, ten to fifteen minutes, or greater than fifteen minutes. Finally, $BusEligible_{ij}$ is a binary variable than equals one if the student is eligible to ride a school bus to his or her assigned school.

$\boldsymbol{Z_i}$ is a vector of student characteristics including gender, race/ethnicity, and student with disability (SWD), and English Learner (EL) statuses. δ_g and φ_a are grade and assigned school fixed effects respectively. Including assigned school fixed effects allows me to estimate associations between choice use and student characteristics using comparisons between students with the same default option and a similar choice set. However, I also estimate the model represented in Equation 2 using zip code fixed effects, γ_z, instead of assigned school fixed effects as another measure of residential location for a specification check. Results of this model are similar and available by request. Furthermore, I use zip code fixed effects in the models that estimate the relationships between sector attended and assigned school characteristics instead of assigned school fixed effects since they would be perfectly collinear with the assigned school characteristics. This model is represented by Equation 3:

$$\ln\left(\frac{P_i(m)}{P_i(0)}\right) = \beta_0 + \beta_1 EconDis_i + \beta_2 \log(medianincome)_{ic} + \boldsymbol{Distance_{ij}\delta} + \beta_3 Pct.NoCar_{ic} + \beta_4 BusEligible_{ij} + \beta_5 AcademicQuality_j + \boldsymbol{Z_i\alpha} + \boldsymbol{S_j\theta} + \delta_g + \gamma_z + \varepsilon_i \qquad (3)$$

Where $AcademicQuality_j$ is either accountability rating or the school's 2016-17 math value-added measure for elementary and middle school students, and graduation rate for high school students. I estimate the relationships between choice use and academic quality separately for the accountability rating and the other measures since accountability ratings include an achievement growth measure thus, accountability rating and value-added are highly correlated. $\boldsymbol{S_j}$ is a vector of characteristics of assigned school j which includes the percentages of female, White, Asian, Hispanic, Other Race, economically disadvantaged, and English Learner students, the natural logarithm of total enrollment, the percent of students with disabilities, and indicators for whether or not the school offers after school care and has a sport as its top activity.

RQ2: Do Detroit students attend the more effective schools and/or the schools with the highest levels of achievement within their choice sets?

To examine preferences for school sector, proximity from home, academic quality and student demographics, I estimate the relationship between the school characteristics outlined above and the probability that a student attends each school available to them. I accomplish this using a conditional logit model under the framework for alternative specific discrete choice models created by McFadden (1974), which stresses individuals making decisions between a competing set of discrete choices and is also a common approach in the school and college choice literature (e.g., Carlson, Cowen & Fleming 2013; Harris & Larsen, 2019; Long, 2004). Thus, I must construct a choice set for each student in the sample. I begin with the sample of students created for my first research question and restrict it to students in kindergarten, 6^{th} grade, and 9^{th} grade, the grades that students typically choose new schools. This sample includes 8,970 kindergarteners, 8,628 6^{th} graders, and 8,719 9^{th} graders.

Table 12. Sector of Attendance by Grade

	Kindergarten	Grade 6	Grade 9
	8,970	8,628	8,719
Attends Assigned School	24%	20%	17%
Attends Other DPSCD School	24%	23%	32%
Attends Detroit Charter	33%	35%	27%
Attends Outside TPS	4%	6%	15%
Attends Outside Charter	14%	16%	10%

Note. DPSCD is Detroit Public Schools Community District. TPS is an abbreviation for traditional public school.

Table 12 displays the percent of Detroit students attending each sector by grade. Regardless of the grade, less than a quarter of students attend their assigned school, approximately forty percent attend a charter school, and about one in five students leave the city to attend school. In kindergarten, a higher percentage of students attend their assigned school compared to the other grades while more 9th graders attend outside TPS schools and other DPSCD schools.

In Table 13, I report the characteristics of the schools in Detroit students' choice sets by sector separately for each analysis grade. A student's choice set is constructed by creating all pairwise combinations of students and the sample of schools offering his or her grade. For each student, the sample of schools in his or her choice set includes all traditional public schools and charter schools in the three intermediate school districts surrounding Detroit, Wayne Regional Education Service Authority, Oakland Public Schools, and Macomb Intermediate School District that offer general education, and serve at least one Detroit student, making it plausibly accessible to Detroit students. Detroit students attend over 600 different schools located within the boundaries of 69 different traditional public school districts in the tri-county area. There are 361, 278, and 169 schools within the choice sets of kindergarten, 6th grade and 9th grade students respectively. The average demographic characteristics for schools located within Detroit reflect the population of students living in Detroit. Across all grades, schools located outside of the city,

Table 13. School Characteristics by Sector and Grade

Kindergarten	DPSCD	Detroit Charter	Outside TPS	Outside Charter
Number of Schools	71	55	172	63
Avg. Pct. Female	51%	51%	52%	50%
Avg. Pct. Underrepresented Minority	96%	94%	40%	64%
Avg. Pct. Economically Disadvantaged	86%	92%	56%	73%
Avg. Enrollment	494	443	425	553
Avg. Accountability Rating	32.78	47.23	70.04	58.40
Avg. Math Value-Added	-0.11	-0.02	0.01	-0.02
Pct. with Before School Care	3%	47%	N/A	N/A
Pct. with After School Care	24%	62%	N/A	N/A
Pct. Sport Top Activity	39%	64%	N/A	N/A
Pct. Do Not Offer Transportation	1%	47%	N/A	N/A
Pct. Uniform Required	97%	89%	N/A	N/A
Grade 6				
Number of Schools	63	54	105	56
Avg. Pct. Female	52%	51%	52%	50%
Avg. Pct. Underrepresented Minority	97%	92%	38%	64%
Avg. Pct. Economically Disadvantaged	85%	93%	53%	72%
Avg. Enrollment	500	464	652	563
Avg. Accountability Rating	31.35	44.60	62.21	57.14
Avg. Math Value-Added	-0.12	-0.02	0.01	-0.03
Pct. with Before School Care	2%	35%	N/A	N/A
Pct. with After School Care	21%	48%	N/A	N/A
Pct. Sport Top Activity	41%	69%	N/A	N/A
Pct. Do Not Offer Transportation	0%	48%	N/A	N/A
Pct. Uniform Required	97%	81%	N/A	N/A
Grade 9				
Number of Schools	28	27	90	24
Avg. Pct. Female	52%	50%	51%	49%
Avg. Pct. Underrepresented Minority	96%	89%	41%	58%
Avg. Pct. Economically Disadvantaged	80%	91%	50%	73%
Avg. Enrollment	635	445	1076	562
Avg. Accountability Rating	36.99	32.33	65.59	51.44
Avg. Graduation Rate	65%	66%	83%	78%
Pct. with Before School Care	0%	11%	N/A	N/A
Pct. with After School Care	0%	15%	N/A	N/A
Pct. Sport Top Activity	21%	48%	N/A	N/A
Pct. Do Not Offer Transportation	0%	56%	N/A	N/A
Pct. Uniform Required	93%	56%	N/A	N/A

Note. DPSCD is Detroit Public Schools Community District. TPS is an abbreviation for traditional public school. Information concerning Before School Care, After School Care, Transportation, and Uniform Requirements is only available for schools located within the city of Detroit since it comes from the *Detroit Parents' Guide to Schools.* 15 new schools are not included in the average school demographics and school quality ratings since they do not have them for the 2016-17 school year. In addition, 27 elementary and middle schools do not have math value-added measures since they do not have test score in both 2015-16 and 2016-17. 9 schools that were open in 2016-17 do not have a graduation rate.

particularly outside TPS schools, have higher accountability ratings. However, fewer Detroit students attend these schools. Interestingly, Detroit charter schools have higher accountability ratings and value-added measures than DPSCD schools on average in kindergarten and 6th grade, but in 9th grade, DPSCD schools have higher average accountability ratings and similar graduation rates than Detroit charter schools. This change in academic quality may explain the differences in attendance by sector within Detroit between 9th grade and the earlier grades seen in Table 12 if families have preferences for academic achievement.

To examine the attributes of the schools students attend, I estimate a discrete choice model represented by Equations 4 and 5 separately for students in kindergarten, 6th, and 9th grades:

$$\Pr(Y_{ik} = k) = \frac{e^{Z_{ik}\beta}}{\sum_k e^{Z_{ik}\beta}} \tag{4}$$

Where:

$$Z_{ik}\beta = \boldsymbol{Sector_k\delta} + \boldsymbol{Distance_{ik}\delta} + \boldsymbol{S_k\theta} + \beta_1 Quality_k + \mu_i + \varepsilon_{ik} \tag{5}$$

in which Y_{ik} equals one for student *i* if they attend school *k*. Z_{ik} is the predicted utility student *i* receives from attending school *k* based on school *k's* characteristics. $\boldsymbol{Sector_k}$ is a vector of binary variables, $OtherDPSCD_k$, $DetroitCharter_k$, $OutsideCharter_k$, and $OutsideTPS_k$ indicating the sector and location of the school with the reference group being student *i's* assigned school. $OtherDPSCD_k$, equals one if school *k* is a DPSCD school but not the student's assigned school. Similarly, $DetroitCharter_k$, $OutsideCharter_k$, and $OutsideTPS_k$ equal one if the school is in the sector and location delineated by that variable. $\boldsymbol{Distance_{ik}}$ is a vector of indicators for having a drive time (in minutes) from student *i's* home census block to school *k* in the student's choice set either between 10 and 20 minutes, 20 to 30 minutes, 20 to 40 minutes or greater than 40 minutes. Similar to model represented in Equation 2, $Quality_k$ is one of the following academic quality measures: accountability rating, school-level 2016-17 math value-added in kindergarten and 6th grade, and in 9th grade, graduation rate. Again, I estimate the relationships for the quality measures separately due to the high correlation between accountability rating and value-added. $\boldsymbol{S_k}$ is a vector of characteristics of school *k* which includes percent of female students, underrepresented minority students (non-White, non-Asian), and of economically disadvantaged students, and the natural logarithm of total enrollment.[14] Also, I include student fixed effects, μ_i, which accounts for all of the student *i*'s personal characteristics allowing me to make comparisons between schools within student *i*'s choice set.

Results

RQ 1: What are the roles of poverty, access to transportation, and student's assigned school in use of school choice?

Table 14 contains the estimated marginal effects of the models represented by Equations 2 and 3. Columns 1 through 5 present the results of the models represented by Equation 2. The results in Column 1 show that students living in census tracts with high rates of residents without a car and lower median incomes are more likely to attend their assigned school holding all else constant. Additionally, students who live farther from their assigned school and those who are eligible for the school bus to it have a lower probability of attending their assigned school. Since bus eligibility is a function of walking distance to the assigned school, this finding may be driven by distance rather than the opportunity to use school provided transportation. As for other

[14] $\boldsymbol{S_k}$ also includes two missing data indicators. $NewSchool_k$ equals one if the school is in its first year of operation in 2017-18 meaning that it would not have any school characteristics or quality measures from the prior school year. 15 schools in the sample are new schools. Additionally, 27 elementary and middle schools do not have math value-added measures, and 9 high schools do not have graduation rates available for the 2016-17 school year. For schools with missing data, I recode the missing variable for this school to 0 and include indicators for missing value-added and graduation rate data. I also drop one school from the choice sets and the 8 students that attend it because it is missing the accountability rating.

sectors, students who have low rates of car ownership in their resident census tract are less likely to attend schools located outside of Detroit city limits. Furthermore, economically disadvantaged students are more likely to attend charter schools but less likely to attend other DPSCD schools. Overall, these results show that exposure to poverty, access to private transportation, and distance to assigned school play a role in whether or not a student uses school choice, especially to attend schools located outside of the city.

Columns 6 through 15 of Table 14 contain the estimated marginal effects of the model represented by Equation 3 which includes assigned school characteristics as explanatory variables. The probability that a student attends his or her assigned school increases if it has a smaller concentration of economically disadvantaged students, a higher accountability rating, and does not offer after school care. However, there is no significant relationship between assigned school's value-added and choice use. Thus, families may value student demographics and school performance levels, a finding consistent with prior literature. While this may suggest that Detroit families have preferences for these school attributes, it is possible that they are correlated with other unobserved features that families use to determine which school to send their child to.

In contrast, the estimated marginal effects for many of the assigned school characteristics for attending another DPSCD school have the opposite signs than the predicted effects for attending the assigned school. These findings may imply that families substitute other DPSCD schools for their assigned school when the assigned school has fewer desirable characteristics. Furthermore, the estimated marginal effects of assigned school characteristics for attending schools outside of Detroit are small and statistically insignificant in most cases. This suggests that families that choose schools outside of Detroit may not even consider their assigned school

Table 14. Estimated Marginal Effects of Student and Assigned School Characteristics on School Type Attended

	(1) Assigned School	(2) Other DPSCD	(3) Detroit Charter	(4) Outside TPS	(5) Outside Charter	(6) Assigned School	(7) Other DPSCD	(8) Detroit Charter	(9) Outside TPS	(10) Outside Charter	(11) Assigned School	(12) Other DPSCD	(13) Detroit Charter	(14) Outside TPS	(15) Outside Charter
Econ. Dis.	-0.010	-0.098*	0.104*	-0.010	0.014*	-0.012	-0.098*	0.105*	-0.009	0.014*	-0.012	-0.099*	0.105*	-0.009	0.014*
	(0.012)	(0.006)	(0.016)	(0.006)	(0.007)	(0.013)	(0.006)	(0.016)	(0.006)	(0.007)	(0.013)	(0.006)	(0.016)	(0.006)	(0.007)
Log. Med. Income	-0.037*	0.036	0.039*	-0.004	-0.034	-0.045*	0.039*	0.030	-0.009	-0.016	-0.044*	0.038*	0.030*	-0.009	-0.015
	(0.017)	(0.020)	(0.018)	(0.006)	(0.018)	(0.016)	(0.019)	(0.015)	(0.006)	(0.012)	(0.016)	(0.019)	(0.015)	(0.006)	(0.012)
5-10 Min. Drive Time	-0.083*	0.035*	0.037*	0.000	0.011	-0.083*	0.033*	0.049*	-0.002	0.004	-0.082*	0.031*	0.049*	-0.002	0.004
	(0.008)	(0.006)	(0.009)	(0.003)	(0.007)	(0.009)	(0.008)	(0.010)	(0.003)	(0.007)	(0.009)	(0.007)	(0.010)	(0.003)	(0.007)
10-15 Min. Drive Time	-0.180*	0.093*	0.044*	0.019*	0.024	-0.152*	0.054*	0.047*	0.007	0.044*	-0.155*	0.057*	0.049*	0.008	0.040*
	(0.016)	(0.013)	(0.016)	(0.007)	(0.019)	(0.019)	(0.016)	(0.015)	(0.008)	(0.011)	(0.019)	(0.017)	(0.015)	(0.008)	(0.011)
15-20 Min. Drive Time	-0.235	0.134*	0.240*	0.030	-0.168*	-0.244*	0.151*	0.184*	0.031*	-0.122*	-0.254*	0.174*	0.182*	0.033*	-0.136*
	(0.022)	(0.013)	(0.096)	(0.028)	(0.058)	(0.025)	(0.023)	(0.054)	(0.015)	(0.035)	(0.029)	(0.030)	(0.057)	(0.015)	(0.036)
Pct. No Car Ownership	0.001*	0.001*	0.001*	-0.001*	-0.003*	0.001*	0.001	0.001	-0.000*	-0.002*	0.001**	0.001	0.001	-0.000*	-0.002*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.000)	(0.000)
Transportation Eligible	-0.091*	0.028*	0.044*	0.010*	0.009	-0.092*	0.025*	0.044*	0.016*	0.008	-0.092*	0.024*	0.044*	0.015*	0.008
	(0.009)	(0.008)	(0.010)	(0.005)	(0.006)	(0.008)	(0.008)	(0.009)	(0.004)	(0.005)	(0.008)	(0.008)	(0.009)	(0.004)	(0.005)
Sch. Pct. Econ. Dis.						-0.287*	0.367	-0.115	-0.008	0.044	-0.254	0.333	-0.111	-0.018	0.050
						(0.146)	(0.224)	(0.159)	(0.052)	(0.089)	(0.145)	(0.216)	(0.157)	(0.054)	(0.087)
Accountability Rating						0.001*	-0.003*	0.001	0.000	0.000					
						(0.001)	(0.001)	(0.000)	(0.000)	(0.000)					
Math Value-added											0.026	-0.041	0.016	0.016	-0.017
											(0.053)	(0.046)	(0.046)	(0.015)	(0.022)
Graduation Rate											0.002	-0.002*	-0.000	-0.000	0.001*
											(0.002)	(0.001)	(0.00)	(0.000)	(0.000)
Offers Afterschool Care						-0.051*	0.049*	0.003	-0.001	-0.000	-0.046*	0.041	0.006	-0.003	0.002
						(0.016)	(0.020)	(0.017)	(0.007)	(0.008)	(0.017)	(0.021)	(0.019)	(0.008)	(0.008)
Sport Top Activity						0.024	-0.016	-0.024	-0.004	0.020*	0.022	-0.013	-0.024	-0.004	0.019*
						(0.015)	(0.017)	(0.013)	(0.005)	(0.007)	(0.015)	(0.017)	(0.013)	(0.005)	(0.007)
Assigned Sch. Fixed Effects	X	X	X	X	X										
Zip Code Fixed Effects						X	X	X	X	X	X	X	X	X	X
Grade Fixed Effects	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Observations	108,085	108,085	108,085	108,085	108,085	108,085	108,085	108,085	108,085	108,085	108,085	108,085	108,085	108,085	108,085

Note. Standard errors in parentheses. * $p<0.05$. Standard errors are clustered at the level of the geographic fixed effect in the model. Models include student race, gender, English Learner, and disability statuses and school's percent female, White, Asian, Hispanic, Other Race, English Learner, students with disabilities and the natural logarithm of enrollment as covariates. Drive times from the population weighted centroid of the student's home census block to their assigned school were calculated using Google Distance Matrix API assuming usual traffic at 8am on a weekday. DPSCD is Detroit Public Schools Community District. TPS is an abbreviation for traditional public school. A student is considered Econ. Dis. (Economically Disadvantaged) if he or she receives free or reduced lunch, his or her family receives food (SNAP) or cash (TANF) assistance, or is in foster care, is homeless or migrant. Accountability Rating is the school's score on Michigan's School Index System.

as an option. Taken together, these results provide some suggestive evidence that different Detroit families have different and restricted choice sets. Some families may only consider DPSCD schools or schools within Detroit whereas others only look outside of city limits for a school for their child.

RQ2: Do Detroit students attend the more effective schools and/or the schools with the highest levels of achievement within their choice sets?

Table 15 presents the results of the discrete choice model described in Equations 4 and 5 for all students in the sample. As previously described, the models were restricted by grade to ensure than all students in the model had the same choice set. Estimated coefficients are reported as log odds coefficients. All the estimated coefficients for the sector indicators are negative and significant in the main models. This indicates that on average, students are more likely to attend their assigned schools than charter schools, schools outside of Detroit, and other DPSCD schools, even when distance is held constant. The coefficient estimates for all commute time indicators are negative and significant across all specifications indicating a negative relationship between increased distance and attendance. Thus, families are less likely to choose schools farther from home. Also, I find that students have a higher probability of attending schools with higher rates of economically disadvantaged students in the majority of the models. As for academic quality, kindergarten and 6^{th} grade students have a higher probability of attending schools with higher accountability ratings and higher contributions to student achievement as measured by math value-added. As for 9^{th} grade, there is no significant relationship between accountability rating or graduation rate.

Table 15. Conditional Logit Predictions of School Attendance for School Characteristics by Grade

	K		6		9	
	(1)	(2)	(3)	(4)	(5)	(6)
Other DPSCD School	-2.445*	-2.454*	-2.220*	-2.199*	-1.210*	-1.184*
	(0.033)	(0.033)	(0.036)	(0.036)	(0.039)	(0.038)
Detroit Charter	-2.022*	-1.936*	-1.755*	-1.647*	-1.235*	-1.125*
	(0.035)	(0.033)	(0.038)	(0.036)	(0.042)	(0.041)
Outside TPS	-3.200*	-3.223*	-2.260*	-2.195*	-1.421*	-1.425*
	(0.071)	(0.068)	(0.070)	(0.070)	(0.054)	(0.053)
Outside Charter	-1.829*	-1.790*	-1.375*	-1.290*	-0.986*	-0.961*
	(0.040)	(0.040)	(0.042)	(0.041)	(0.054)	(0.051)
10-20 Min. Drive Time	-2.442*	-2.437*	-2.273*	-2.265*	-1.596*	-1.609*
	(0.027)	(0.027)	(0.026)	(0.026)	(0.027)	(0.027)
20-30 Min. Drive Time	-4.052*	-4.055*	-4.051*	-4.039*	-3.029*	-3.040*
	(0.056)	(0.056)	(0.057)	(0.057)	(0.047)	(0.047)
30-40 Min. Drive Time	-6.026*	-6.013*	-5.429*	-5.419*	-4.782*	-4.776*
	(0.238)	(0.238)	(0.168)	(0.168)	(0.155)	(0.155)
40-60 Min. Drive Time	-5.622*	-5.551*	-5.609*	-5.605*	-5.404*	-5.425*
	(0.409)	(0.409)	(0.355)	(0.356)	(0.502)	(0.503)
Pct. Econ. Dis.	0.420*	0.118	0.395*	0.167	0.974*	0.983*
	(0.112)	(0.113)	(0.104)	(0.101)	(0.122)	(0.108)
Accountability Rating	0.009*		0.007*		-0.001	
	(0.001)		(0.001)		(0.001)	
Math Value-Added		0.401*		0.164*		
		(0.067)		(0.073)		
Graduation Rate						-0.001
						(0.001)
Observations	3,238,170	3,238,170	2,398,584	2,398,584	1,473,511	1,473,511

Note. Heteroskedasticity robust standard errors in parentheses. * p<0.05. Estimated relationships are reported as log odds coefficients. Models include school percent female enrollment, percent underrepresented minorities, natural log of enrollment, indicators for being a new school in 2017-18, having missing math value-added or graduation rate data. DPSCD is Detroit Public Schools Community District. TPS is an abbreviation for traditional public school. Drives times from the population weighted centroid of the student's home census block to each school in the student's choice set were calculated using Google Distance Matrix API assuming usual traffic at 8am on a weekday. A student is considered Econ. Dis. (Economically Disadvantaged) if he or she receives free or reduced lunch, his or her family receives food (SNAP) or cash (TANF) assistance, or is in foster care, is homeless or migrant.

Heterogeneity by Location and Sector

Although there exist positive relationships between my measures of academic quality for Michigan schools and the probability of attending a school for kindergarten and 6th grade students, these relationships may differ if the student's choice set is geographically restricted.

Indeed, my findings from the first research question suggest that families' choice sets may be restricted by location and/or sector before considering individual school qualities especially for students with little access to transportation or impoverished students. Specifically, the results indicate that some families are choosing between DPSCD schools, within city limits, or solely outside of the city. To investigate this further, I examine mobility between sectors over time for Detroit students.

Table 16 presents the percent of students who have ever attended another sector between 2012-13 and 2017-18 by sector attended during the year of analysis. Only nine percent of students attending a school inside of Detroit during the 2017-18 school year have ever attended a public school located outside of city limits while living in Detroit. More specifically, about two percent of students who did not attend an outside TPS school in the year of analysis ever attended one. In contrast, about four out of ten students attending an outside Detroit school have attended a Detroit school in the past. Additionally, about a quarter of DPSCD students have attended a non-DPSCD school and a similar amount of non-DPSCD students have attended a DPSCD school.

Table 16. Percent of Students Who Have Ever Attended Another Sector by Sector and Location between 2012-13 and 2017-18

School in 2017-18	N	Ever Assigned School	Ever Other DPSCD School	Ever Detroit Charter	Ever Outside TPS	Ever Outside Charter	Ever Outside Detroit	Ever Inside Detroit	Ever Attends DPSCD	Ever Attends Non-DPSCD
Assigned School	22,808	100%	28%	19%	2%	5%	7%	100%	100%	24%
Other DPSCD School	27,659	29%	100%	23%	2%	7%	8%	100%	100%	29%
Detroit Charter	34,029	16%	15%	100%	2%	9%	10%	100%	27%	100%
Outside TPS	9,029	16%	17%	28%	100%	18%	100%	48%	28%	100%
Outside Charter	14,560	11%	10%	21%	2%	100%	100%	34%	18%	100%
Outside School	23,589	13%	13%	24%	40%	69%	100%	39%	22%	100%
Inside School	84,496	43%	47%	53%	2%	7%	9%	100%	71%	56%
DPSCD School	50,467	61%	68%	21%	2%	6%	8%	100%	100%	27%
Non-DPSCD School	57,618	15%	14%	69%	17%	33%	47%	75%	25%	100%

Note. Sample includes the 108,085 Detroit residents attending public school in 2017-18. Whether a student has ever attended a school in a sector is determined using student enrollment data from the 2012-13 school year through the 2017-18 school year. DPSCD is Detroit Public Schools Community District. TPS is an abbreviation for traditional public school.

Although examining the mobility of all students over time may be informative, this analysis may understate the amount of mobility that happens between sectors since it includes students who did not make active choices in some years. To more accurately explore the movement between sectors of students, I examine the mobility between sectors of students who changed schools between the 2016-17 and 2017-18 school years in Table 17. I consider the mobility patterns of structural movers, students who were in the last or terminal grade of the school they attended in 2016-17, and non-structural movers separately. Almost 90 percent of structural and non-structural movers who attended a Detroit school in 2017-18 also attended one the previous year. However, only a third of non-structural movers attending a school outside of the city during the year of analysis attended one the year before while three quarters of structural movers remained in an outside school between years. About two-thirds of structural and non-structural movers attending a DPSCD school in 2017-18 were in a DPSCD school in 2016-17. Interestingly, 88 percent of structural movers attending a non-DPSCD school attended a non-DPSCD school in both years.

Table 17. Percent of Students Attending a Different Sector Last Year by Sector and Mobility Type

Panel A: Non-Structural Movers

	School in 2016-17								
School in 2017-18	**Assigned**	**Other DPSCD**	**Detroit Charter**	**Outside TPS**	**Outside Charter**	**Outside**	**Inside**	**DPSCD**	**Non-DPSCD**
Assigned School	27%	32%	30%	4%	7%	11%	89%	58%	42%
Other DPSCD School	29%	35%	26%	3%	7%	10%	90%	64%	36%
Detroit Charter	23%	24%	37%	4%	12%	16%	84%	47%	53%
Outside TPS	13%	20%	33%	17%	17%	34%	66%	33%	67%
Outside Charter	18%	16%	33%	5%	28%	34%	66%	34%	66%
Outside School	16%	17%	33%	10%	24%	34%	66%	33%	67%
Inside School	26%	30%	31%	4%	9%	13%	87%	56%	44%
DPSCD School	28%	34%	28%	4%	7%	11%	89%	61%	39%
Non-DPSCD School	20%	21%	35%	7%	17%	23%	77%	42%	58%

Panel B: Structural Movers

	School in 2016-17								
School in 2017-18	**Assigned**	**Other DPSCD**	**Detroit Charter**	**Outside TPS**	**Outside Charter**	**Outside**	**Inside**	**DPSCD**	**Non-DPSCD**
Assigned School	33%	40%	18%	1%	8%	9%	91%	73%	27%
Other DPSCD School	19%	45%	26%	1%	9%	10%	90%	64%	36%
Detroit Charter	6%	7%	72%	1%	14%	15%	85%	13%	87%
Outside TPS	4%	6%	14%	59%	16%	75%	25%	10%	90%
Outside Charter	4%	4%	19%	1%	71%	73%	27%	9%	91%
Outside School	4%	5%	17%	30%	44%	74%	26%	10%	90%
Inside School	17%	28%	43%	1%	11%	12%	88%	45%	55%
DPSCD School	25%	43%	23%	1%	8%	9%	91%	67%	33%
Non-DPSCD School	5%	6%	47%	14%	27%	41%	59%	12%	88%

Note. Main sample includes Detroit residents attending public school in 2017-18 and in 2016-17. Structural Movers are defined as students who were in the terminal grade of their school in 2016-17 meaning that their school did not offer the grade, they would be in in 2017-18. Non-structural movers are all other students who switched schools between the two school years. DPSCD is Detroit Public Schools Community District. TPS is an abbreviation for traditional public school.

When the evidence from Tables 14, 16, and 17 is combined, it seems likely that some families have choice sets restricted to schools within city limits or within DPSCD. Furthermore, the differences in who attends outside schools and the lack of relationship between attending outside schools and assigned school characteristics suggest that those attending outside schools may choose to attend schools outside of the city before considering specific schools. In accordance with these findings, I estimate the model represented in Equations 4 and 5 separately by grade and for students attending: inside Detroit, outside Detroit, a DPSCD school, or a non-DPSCD school. Thus, the schools in the students' choice set are restricted to schools in that location/sector for each analysis. The results of these analysis are presented in Table 18. Panel A displays estimates for the Inside and DPSCD samples and Panel B shows the results for the outside and non-DPSCD samples. Estimates should be interpreted in comparison to other schools within that location or sector.

After restricting the choice sets to schools located inside of Detroit and DPSCD, students still have a lower probability of attending schools farther from home. Additionally, students are less likely to attend Other DPSCD and Detroit charter schools compared to their assigned schools. In contrast with the full sample results, students attend schools with a lower percent of economically disadvantaged students when the sample is restricted to all schools inside Detroit. These contrasting results are explained by the strong positive relationship between the percent of economically disadvantaged students and attendance when the choice set is restricted to schools outside of Detroit as seen in Table 18 Panel B. Taken together, these results imply that students inside Detroit choose schools with fewer economically disadvantaged students but those who attend schools outside are more likely to attend the more impoverished schools within their choice set.

Table 18. Conditional Logit Predictions of School Attendance for School Characteristics by Grade and Location

Panel A: Choice Sets Restricted to Schools Located Inside or Outside of DPSCD Borders

	Inside						DPSCD					
	K		6		9		K		6		9	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Other DPSCD Sch.	-2.417*	-2.418*	-2.212*	-2.189*	-1.406*	-1.341*	-2.486*	-2.453*	-2.256*	-2.213*	-1.588*	-1.526*
	(0.034)	(0.034)	(0.037)	(0.037)	(0.043)	(0.041)	(0.037)	(0.036)	(0.041)	(0.040)	(0.049)	(0.048)
Detroit Charter	-1.964*	-1.910*	-1.635*	-1.552*	-1.059*	-0.746*						
	(0.047)	(0.046)	(0.047)	(0.047)	(0.061)	(0.060)						
10-20 Min. Drive	-2.583*	-2.576*	-2.399*	-2.394*	-1.529*	-1.545*	-2.541*	-2.544*	-2.467*	-2.482*	-1.203*	-1.273*
	(0.032)	(0.032)	(0.031)	(0.031)	(0.032)	(0.032)	(0.050)	(0.049)	(0.050)	(0.050)	(0.046)	(0.046)
20-30 Min. Drive	-4.166*	-4.163*	-4.267*	-4.261*	-2.790*	-2.828*	-3.946*	-3.956*	-4.114*	-4.131*	-2.490*	-2.521*
	(0.086)	(0.086)	(0.098)	(0.098)	(0.067)	(0.066)	(0.118)	(0.118)	(0.137)	(0.136)	(0.089)	(0.090)
30-40 Min. Drive	-6.246*	-6.239*	-6.178*	-6.193*	-3.387*	-3.415*	-17.292*	-18.295*	-5.019*	-5.073*	-15.881*	-15.871*
	(1.000)	(1.000)	(1.001)	(1.001)	(0.585)	(0.585)	(0.047)	(0.047)	(1.002)	(1.002)	(0.098)	(0.101)
Pct. Econ. Dis.	-0.645*	-0.866*	-1.220*	-1.504*	-0.793*	-1.459*	-1.059*	-0.961*	-0.029	-0.344	1.719*	0.282
	(0.188)	(0.188)	(0.179)	(0.179)	(0.208)	(0.195)	(0.294)	(0.304)	(0.308)	(0.331)	(0.316)	(0.297)
Acct. Rating	0.008*		0.007*		0.002*		0.010*		0.013*		0.008*	
	(0.001)		(0.001)		(0.001)		(0.001)		(0.002)		(0.001)	
Math Value-Added		0.346*		0.098				0.698*		0.206		
		(0.071)		(0.079)				(0.125)		(0.154)		
Graduation Rate						-0.003*						-0.000
						(0.001)						(0.001)
Before Care	-0.060	0.050	-0.004	0.059	-1.090*	-0.846*	-0.106	0.347*	-0.086	0.419*		
	(0.044)	(0.044)	(0.047)	(0.046)	(0.171)	(0.181)	(0.155)	(0.144)	(0.151)	(0.136)		
After Care	0.077*	0.046	-0.045	-0.038	0.248	0.251	-0.115*	-0.081	-0.005	0.051		
	(0.036)	(0.035)	(0.037)	(0.037)	(0.142)	(0.146)	(0.056)	(0.054)	(0.060)	(0.060)		
No Transport.	0.295*	0.256*	0.117*	0.142*	-0.064	-0.260*	0.392	0.176				
	(0.040)	(0.040)	(0.040)	(0.041)	(0.049)	(0.050)	(0.249)	(0.250)				
Uniform	0.399*	0.349*	0.354*	0.340*	-0.047	0.090	0.356*	0.394*	0.352*	0.334*	-0.480*	-0.084
	(0.071)	(0.071)	(0.070)	(0.072)	(0.047)	(0.051)	(0.155)	(0.158)	(0.167)	(0.169)	(0.104)	(0.111)
Sport Top Activity	-0.188*	-0.169*	-0.067*	-0.062*	-0.117*	-0.171*	-0.156*	-0.153*	-0.151*	-0.129*	-0.496*	-0.508*
	(0.029)	(0.030)	(0.029)	(0.029)	(0.029)	(0.029)	(0.037)	(0.037)	(0.041)	(0.042)	(0.043)	(0.042)
Observations	922,824	922,824	790,452	790,452	361,185	361,185	308,850	308,850	236,628	236,628	119,084	119,084

Table 18. (cont'd)

Panel B: Choice Sets Restricted DPSCD Schools or No DPSCD Schools

	Outside						No DPSCD					
	K		6		9		K		6		9	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Outside TPS							-1.146*	-1.321*	-0.437*	-0.471*	0.180*	0.166*
							(0.075)	(0.072)	(0.075)	(0.075)	(0.057)	(0.057)
Outside Charter	1.199*	1.260*	0.592*	0.582*	0.058	-0.021	0.135*	0.067	0.269*	0.248*	0.429*	0.335*
	(0.069)	(0.072)	(0.078)	(0.078)	(0.069)	(0.067)	(0.041)	(0.041)	(0.039)	(0.040)	(0.045)	(0.045)
10-20 Min. Drive	-1.922*	-1.949*	-1.803*	-1.803*	-1.651*	-1.648*	-2.380*	-2.380*	-2.169*	-2.166*	-1.906*	-1.925*
	(0.058)	(0.059)	(0.055)	(0.055)	(0.063)	(0.063)	(0.032)	(0.032)	(0.031)	(0.031)	(0.035)	(0.035)
20-30 Min. Drive	-3.523*	-3.565*	-3.416*	-3.413*	-3.030*	-3.020*	-4.005*	-4.017*	-3.934*	-3.923*	-3.283*	-3.270*
	(0.081)	(0.080)	(0.077)	(0.076)	(0.073)	(0.072)	(0.064)	(0.063)	(0.063)	(0.063)	(0.054)	(0.054)
30-40 Min. Drive	-5.443*	-5.421*	-4.767*	-4.755*	-4.649*	-4.553*	-5.883*	-5.869*	-5.256*	-5.224*	-4.899*	-4.821*
	(0.246)	(0.246)	(0.171)	(0.170)	(0.163)	(0.163)	(0.238)	(0.238)	(0.170)	(0.169)	(0.155)	(0.155)
40-60 Min. Drive	-4.730*	-4.645*	-4.579*	-4.540*	-4.781*	-4.691*	-5.440*	-5.349*	-5.349*	-5.285*	-5.380*	-5.280*
	(0.406)	(0.405)	(0.354)	(0.354)	(0.504)	(0.502)	(0.408)	(0.408)	(0.356)	(0.355)	(0.503)	(0.503)
Pct. Econ. Dis.	2.333*	2.073*	1.905*	1.872*	2.059*	3.063*	0.911*	0.611*	0.638*	0.554*	1.322*	1.882*
	(0.206)	(0.216)	(0.176)	(0.161)	(0.237)	(0.191)	(0.141)	(0.144)	(0.123)	(0.120)	(0.154)	(0.138)
Acct. Rating	0.017*		-0.000		-0.022*		0.008*		0.001		-0.008*	
	(0.003)		(0.003)		(0.002)		(0.001)		(0.001)		(0.001)	
Math Value-Added		1.272*		-0.030				0.068		-0.161		
		(0.258)		(0.222)				(0.100)		(0.098)		
Graduation Rate						0.001						0.001
						(0.001)						(0.001)
Observations	308,850	308,850	236,628	236,628	119,084	119,084	1,339,800	1,339,800	1,047,480	1,047,480	629,706	629,706

Note. Heteroskedasticity robust standard errors in parentheses. *p<0.05. Estimated relationships are reported as log odds coefficients. Models include school percent female enrollment, percent underrepresented minorities, natural log of enrollment, indicators for being a new school in 2017-18, having missing math value-added or graduation rate data. School offering variables only included in models that only include students who attend schools within the boundaries of DPSCD. DPSCD is Detroit Public Schools Community District. TPS is an abbreviation for traditional public school. A student is considered Econ. Dis. (Economically Disadvantaged) if he or she receives free or reduced lunch, his or her family receives food (SNAP) or cash (TANF) assistance, or is in foster care, is homeless or migrant.

By restricting the choice set to schools inside Detroit or just to DPSCD schools, I can also include school characteristics from the *Detroit Parents' Guide to Schools* as seen in Table 18 Panel A. Across grades, student have a lower probability of attending schools that list a sport as a top activity. In the earlier grades, students have a higher probability of attending schools that require uniforms and when all Detroit schools are included in the choice set, they are more likely to attend schools that do not offer transportation. Since these characteristics are likely correlated to other unobserved characteristics of schools that families used to determine where they send their child, I do not interpret these as preferences.

As for measures of academic quality, students seem to have a higher probability of attending a school as its accountability rating increases when the choice set is restricted to schools inside of Detroit or DPSCD across all grades. The relationships are larger when the choice set is restricted to DPSCD schools, suggesting that there may be a larger preference for high accountability ratings after accounting for geographic and administrative barriers. Additionally, there is a positive relationship between school value-added and attendance for kindergarteners. The results for the choice sets for students who attend outside or non-DPSCD schools vary by grade. In kindergarten, there is a positive relationship between accountability rating, value-added, and attendance for outside Detroit and non-DPSCD choice sets. However, there is no significant relationship between either of the academic quality measures and attendance for 6th grade students in either of these choice sets. A negative relationship exists between accountability rating and attendance for 9th grade students in both outside and non-DPSCD choice sets. In kindergarten, there is a positive relationship with school valued added and attendance. Therefore, these findings suggest that the possible preferences for academic quality and student demographics may be constrained for students looking to attend school outside of Detroit or DPSCD especially in the later grades.

Discussion

In this paper, I show that students' choice sets are likely geographically constrained, especially for impoverished students and students with little access to private transportation in Detroit, a choice-rich city and region without regulations that promote accessibility or transparency. While I am unable to directly test whether families do not prefer high quality schools since I do not have any record of parent's set of preferred schools, I provide some strong suggestive evidence that families have some preference for higher performing schools when families are choosing between schools located within Detroit and especially within DPSCD. Additionally, I offer some indication that families have limited access to the relatively higher quality schools located outside of the city, constraining their ability to attend schools with their desired characteristics. This contributes to the parental preference literature by framing distance and administrative barriers as constraints to families' preferences instead of as a preference itself and expanding choice sets to include inter-district choice options.

The findings of this study provide a compelling empirical example of the idea that strong preferences for effective schools can exist throughout an education market and, yet students may also have differential access to high quality schools due to where they live and what their historical demographic and current economic circumstances are especially when there is little regulation on where schools locate and what enrollment rules they govern by exists. Thus, it is unlikely that parents and families can regulate the school supply through market transactions even when they have strong preferences for academic quality. This implies that choice-rich cities, regardless of whether they offer intra-district, charter school, or inter-district choice, may need to provide oversight of the schooling market to ensure an adequate supply of effective schools. This oversight likely includes centralized planning of the quantity and location of schools and performance accountability as suggested by Harris (2017).

Furthermore, choice-rich cities may need to ensure that effective schools are accessible to all students. Two policies that could promote or restrict access to effective schools are transportation policies and enrollment policies. Increasing school transportation has the potential to remove the burden from parents of transporting their children to school, making it easier to attend schools located farther from home. However, few states require to provide transportation to students attending charter schools or participating in inter-district choice (McShane & Shaw, 2020). Furthermore, enrollment policies have the potential to promote or restrict access to effective schools. Multiple applications with varying deadlines likely restrict access to effective schools for the most vulnerable populations, possibly explaining why Detroit students have difficulty accessing the highest quality schools, especially in the later grades. A centralized enrollment application could increase access to effective schools through choice since causal evidence exists showing that they are effective in increasing enrollment in charter schools for disadvantaged students (Winters, 2015). To date, however, only a handful of cities have implemented these policies. Extensions of this work and others in this literature should consider in particular the role that enrollment rules play in promoting or restricting access to schools even in a system where choice is widely available.

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PAPER 3 ANOTHER ONE RIDES THE BUS: THE IMPACT OF SCHOOL TRANSPORTATION ON STUDENT OUTCOMES IN MICHIGAN

Introduction

Since 1869, some public school districts have provided students transportation to school to ensure consistent attendance and allow districts to consolidate (McDonald & Howlett, 2007). Today, over 25 million children, about half of U.S. public school students, ride a school bus to and from school. During the 2015-16 school year, school districts spent over $24 billion on student transportation nationally, about $1,000 per student transported—constituting approximately eight percent of average per pupil expenditures (National Center for Education Statistics, 2019). To reduce these high costs of the school bus, districts have cut school bus routes, provided public transit passes, contracted with rideshare companies, halted bus service altogether, and in some states, charged parents for transportation services in recent years (Bergal June 16 2015; Cornwall May 1 2018).

Decreasing the availability of district-provided transportation may be detrimental to student outcomes. School transportation can positively affect school attendance, an increasingly important outcome, by providing a reliable, consistent, and safe mode of transportation. This removes the logistical and financial burdens of school transit from parents, making it easier for students to get to school regularly, increasing how often they attend school. These burdens may be especially prohibitive for low-income families since they are more likely to live in neighborhoods that are unsafe to walk through, have little access to car or any form of direct transportation, and be chronically absent, commonly defined as missing more than ten percent of possible school days (Balfanz & Byrnes, 2012; Sampson, Raudenbush, & Earls, 1997; Urban Institute Student Transportation Working Group, 2018). In addition to increasing attendance, school transportation may raise student achievement since school attendance has a positive effect on student achievement and is positively associated with on-time graduation and socio-emotional outcomes (Aucejo & Romano, 2016; Kirksey, 2019; Gershenson, Jacknowitz, & Brannegan, 2017; Gottfried, 2010, 2011, 2014b Kirksey, 2019).

Although districts have funded school transportation for over 150 years, little research has existed concerning its role in increasing student outcomes until recently. Descriptive evidence shows that riding the school bus, the most prevalent form of school transportation, is positively associated with attendance (Cordes, Leardo, Rick & Schwartz, 2019; Gottfried, 2017). However, these differences in attendance between students who ride the bus and those who do not can be explained by student and school characteristics, implying that students who use the bus do so to attend better schools (Cordes et al., 2019). To my knowledge, no evidence exists concerning the direct effects of school bus transportation on student achievement.

In this paper, I provide some of the first causal evidence concerning the effects of school transportation on student attendance and achievement. I ask:

1. What is the effect of school transportation on student attendance?
2. What is the effect of school transportation on student achievement?
3. How do these effects differ for economically disadvantaged students?

To answer these questions, I estimate the effects of transportation on students' attendance rates, an indicator for being chronically absent, and standardized math and English Language Arts (ELA) test scores using a rich panel of statewide, student-level enrollment records, achievement, and address data as well as a unique dataset of local transportation provisions I collected from the 50 largest districts in Michigan. To estimate transportation effects, I exploit the walking distance cutoffs that determine student eligibility for the school bus using a regression discontinuity design. Because my treatment is school bus eligibility, my estimates are the intent-to-treat (ITT) effects of riding the school bus, the policy-relevant estimate of school transportation since policymakers can only control who is eligible for transportation and cannot force students to ride the bus.

I find that transportation eligibility increases attendance rates for economically disadvantaged students by two-thirds of a percentage point, the equivalent of approximately one day in a 180 day school year. Similarly, transportation eligibility decreases the probability of being chronically absent for economically disadvantaged students by two to four percentage points. I find little evidence that transportation eligibility affects attendance for students who are not economically disadvantaged. Finally, I detect no significant effects of the school bus on student achievement. These findings imply that school transportation is likely most important for students who would not attend school as frequently without a safe and reliable mode of transportation. Thus, districts should consider implementing a means-tested transportation program or using it as an intervention to reduce chronic absenteeism to more effectively allocate this expensive resource.

This paper proceeds as follows. First, I discuss how school transportation can affect attendance and achievement and the prior research concerning school transportation. Second, I outline Michigan's statewide transportation policies, the context of my study. Third, I describe my data, its sources, and my sample. Next, I explain my research design and how I test its validity. Finally, I present my results and discuss their implications for policy.

Background: The Policy Relevance of Student Attendance

Over the last decade, there has been an increased focus on reducing student absenteeism to improve student outcomes. It is well-established that school attendance is strongly associated with student achievement and educational attainment with some causal evidence suggesting that absences decrease student test scores (Aucejo & Romano, 2016; Gottfried, 2009, 2010, 2011, 2019; Gershenson, et al, 2017; Kirksey, 2019). In particular, chronic absenteeism, commonly defined as missing more than ten percent of days in a school year, is particularly detrimental to school performance. Students who are chronically absent have lower levels of academic achievement, are less eager to learn, and are less likely to graduate on time (Allensworth & Easton, 2007; Chang & Romero, 2008; Gottfried, 2014b). Chronic absenteeism not only affects those who miss school, but their classmates. An increase in the percent of classmates who are chronically absent is associated with lower test scores (Gottfried, 2019).

In addition to student outcomes, chronic absenteeism can negatively impact district budgets and school performance on state accountability systems. In seven states, including California and Texas, the amount of funding a district receives is tied to its average daily attendance (Baker, 2014). In Michigan, the setting of this study, school funding is determined by the number of students in attendance on two count days during the school year. Furthermore, Michigan districts only receive funds for the instructional days they have over 75 percent of students enrolled in attendance (MI Sec 388.1701). Therefore, districts risk losing funding when they have high chronic absenteeism rates. Additionally, schools likely face state intervention if they have high chronic absenteeism rates in most states. Under the Every Student Succeeds Act (ESSA), states are required to report chronic absenteeism rates on state report cards. Furthermore, over 70 percent of states chose to incorporate it into their state accountability system, including Michigan (Bauer, Liu, Schanzenbach, & Shambaugh, 2018).

Although schools are held accountable for chronic absenteeism in addition to student achievement and attainment, family characteristics and environmental factors largely influence these student outcomes, including attendance (Lenhoff & Pogodzinski, 2018). Prior research finds a strong positive relationship between poverty, absences, and chronic absenteeism (Balfanz & Byrnes, 2012; Dougherty, 2018; Gottfried, 2014a; Morrissey, Hutinson, & Winsler, 2014; Ready, 2010). Access to health care, housing instability, neighborhood crime, car ownership, and access to public transit may influence impoverished students' abilities to attend school regularly (Baker, 2014; Lenhoff & Pogodzinski, 2018). For example, low-income students are more likely to miss school because of chronic health conditions (Bauer et al., 2018; Meng, Babey, & Wolstein, 2012). Furthermore, district-level chronic absenteeism rates are higher in cities with high rates of asthma, violent crime, cold weather, and residential vacancy (Singer, Cook, Lenhoff, & Pogodzinski, 2019).

A particularly salient factor that may negatively impact attendance is distance to school. Less than ten percent of students who live more than a mile away from their school walk or bike to school (Federal Highway Administration, 2019). Therefore, students who live farther from school likely rely on a car, bus, or train to transport them to school. Because families who live in high poverty neighborhoods are less likely to own a car, distance likely inhibits low-income students from attending school unless they have access to public or school transportation (Urban Institute Student Transportation Working Group, 2018). In fact, research on commute times and absenteeism in Washington, D.C. and Baltimore, two cities with high percentages of low-income students, finds that students with longer commutes have higher rates of absenteeism (Blagg, Rosenboom, & Chingos, 2018; Stein & Grigg, 2019).

How Can School Transportation Affect Attendance and Achievement?

One school resource that could mitigate the effects of distance to school and other familial and environmental factors that negatively impact school attendance is publicly provided school transportation. School buses can reduce the difficulty of traveling to and from school. First, they remove the logistical and financial burdens of transporting students to school from parents. Without school or public transportation, parents must have access to transportation, have adequate time to take their child to and from school, and be able to afford any additional expenses that the commute incurs. These burdens may be especially prohibitive for low-income families since they are less likely to have reliable access to transportation and adequate time or money to transport their children to school. Second, the school bus provides a daily routine. Research shows that having routines reduces stress in students (Wolin & Bennett, 1984). If the school bus provides families a routine by having a reliable and consistent mode of transportation, it could reduce stress, increasing positive attitudes towards going to school, leading to higher attendance (Gottfried, 2017). Finally, school buses offer a safe way to get to school. If students have to walk through dangerous neighborhoods to get to school or brave extreme weather conditions, they may not go to school. Thus, by providing a reliable and safe way of getting to school, school buses could make it easier for students to get to school on a regular basis, increasing their attendance.

In addition to raising attendance rates, school transportation can affect student achievement. The most direct way that school transportation can change achievement is by increasing attendance. Since I hypothesize that school transportation raises attendance rates and it is well established that regular attendance increases test scores, it follows that school transportation could have a positive effect on achievement as well. However, riding the school bus could have negative effects on achievement even if it increases attendance. Riding the school bus to school likely takes longer than riding in a private car due to the multiple stops and circuitous routes. Thus, long bus rides could harm student achievement by reducing the time students have to do homework, participate in extra-curricular activities, or sleep. To my knowledge, only one descriptive study of the relationship between commute times and achievement exists. Blagg, Rosenboom, & Chingos (2018) find no association between test scores and commute time. Additionally, riding the school bus could decrease test scores if bullying, fighting, and other undesirable social behaviors take place on the bus.

Prior Research on School Transportation and Student Outcomes

Prior research concerning district-provided transportation finds a positive association between transportation and attendance. In Baltimore, Burdick-Will, Stein, & Grigg (2019) show that incidences of violent crime decrease attendance for 9th graders who have to walk through the neighborhoods where the crimes occur. However, there is no change in attendance when students use a district-provided bus pass to ride the public bus through the same neighborhoods. This implies that by providing a safe mode of transportation, districts may mitigate some of the negative effects of traveling to school. Using a nationally representative sample of kindergarteners, Gottfried (2017) finds that riding the school bus is associated with increased attendance. Similarly, school bus riders in New York City have higher attendance rates and are less likely to be chronically absent. However, differences in attendance between students who ride the bus and those who do not are explained by student and school characteristics, implying that riding the bus may allow students to attend better schools rather than directly increase attendance (Cordes et al., 2019). To my knowledge, there is no evidence concerning the relationship between school bus transportation and student achievement.

Although these studies attempt to account for student, school, and district characteristics through covariates and fixed effects, it is likely that there are unobserved characteristics in the error term that are correlated with riding the school bus biasing the results. I add to these studies by providing some of the first causal evidence of the direct effects of the school bus on attendance and achievement using a regression discontinuity design that compares the outcomes of students who live on opposite sides of the walking distance cutoff that determines whether the district provides transportation. Plausibly, the only difference between these two groups is that one is transportation eligible, and one is not, allowing me to estimate the impact of school transportation on student outcomes. Furthermore, my design allows me to compare outcomes of students who attend the same school, allowing me to account for choice of school.

School Transportation in Michigan

According to state law, Michigan school districts are not required to provide transportation to general education students, but districts may choose to do so at their discretion (MI Sec 380.1321). Although most decisions concerning the provision of school transportation are made at the local level, there exist state laws that regulate how transportation is provided and to whom if districts offer it. First, the decision to provide transportation must be made at the elementary, middle, or high school level. For example, if a district offers transportation to one elementary school, they must offer it to all elementary schools. However, they would not have to provide it to high school students. Second, districts that provide transportation must offer it to resident students who attend the public school "which they are eligible to be admitted" and live more than 1.5 miles from that school (MI Sec 380.1321). It is up to interpretation whether this means that districts only have to provide transportation to students who attend their assigned school or all schools in the resident district that the student is eligible to attend. However, many districts state that they only provide transportation to the assigned school. Additionally, some districts offer transportation to students who live closer to their school than the 1.5 mile state mandated cutoff. Finally, Michigan districts cannot charge resident students for transportation

(MI Sec 380.1321). Although there are some state funds for transportation expenses, the majority of school transportation costs are covered by district's operational budgets (MI Sec 388.1674). However, districts can charge students using inter-district choice for transportation if they choose to provide it to them. I also note that the above regulations do not apply to charter schools since they do not have resident students (Michigan Department of Education, 2017).

Data

To estimate the effects of school transportation on student attendance and achievement, I primarily use student-level records from the Michigan Department of Education (MDE) and the Center for Educational Performance and Information (CEPI), and transportation policies collected from the 50 largest school districts in Michigan. The student-level records include enrollment and demographic information (e.g. race and ethnicity, gender, disability status, English Learner status, and economically disadvantaged status), number of days the student attended school, the number of days the student could have attended the school, test scores on state standardized exams (either the Michigan Educational Assessment Program, MEAP, or the Michigan Student Test of Educational Progress, M-STEP), and student addresses geocoded at the census block level for all Michigan public school students from the 2012-13 school year to the 2018-19 school year. I also use school-level records made publicly available by MDE and CEPI that include the school's address, educational settings, and grades offered.

District Transportation Policies

As described above, school transportation in Michigan is at the discretion of local districts. There is no centralized state-administered data resource on individual district policies, so local nuances must be collected directly at the district level. For this paper, I collected district transportation policies for the 50 largest traditional public school districts in Michigan from district websites and bylaws during Fall 2019. The largest districts were determined by enrollment during the 2017-18 school year, the most recent year of student-level data available at the time of collection. These 50 districts account for nine percent of districts in Michigan but contain one-third of the total public school student population in the state. I coded the policies for the date it was last changed, eligibility requirements, the modes of transportation the district offers, and any restrictions on the provision of transportation. In particular, I collected information concerning the walking distance cutoffs that determined eligibility for school-provided transportation. I use these cutoffs as a form of exogeneous variation to estimate the causal effects of school transportation.

In Table 19, I examine variation in transportation policy provisions across districts in my sample. I consider differences by schooling level because Michigan state law requires that decisions regarding the provision of transportation be made at the elementary, middle, and high school levels. All but one of the districts in my sample offer transportation (Grosse Pointe) and all but two districts in my sample only offer yellow bus transportation (Ann Arbor and Detroit to high school students). For these reasons, I focus on the districts that offer school bus transportation in my analysis. Therefore, the results of my analysis can be interpreted as the effects of the school bus on student outcomes. I also examine the prevalence of two types of restrictions on school bus eligibility in Table 19: attendance at assigned school and walking distance cutoffs. 22 districts in my sample explicitly stipulate that students are only offered district-provided transportation if they attend their assigned school. However, the absence of the assigned school provision does not mean that the other districts in the sample provide transportation to all schools in the district. They may rely on the language in the state law concerning “eligible to be admitted” to only offer transportation to the assigned school.

Table 19. District Transportation Policy Provisions

	Elementary	Middle	High
Total Districts	50	50	50
Offers transportation	49	49	49
Must Attend Assigned School	22	22	22
Mode of Transportation			
Yellow Bus	49	49	47
City Bus	0	0	2
Walking Distance Cutoff			
.25 Miles	1	2	0
.5 Miles	5	1	2
.75 Miles	2	1	1
1 Miles	17	8	5
1.5 Miles	10	23	26
No Cutoff	14	14	15

Note. Sample includes the 50 largest traditional public school districts in Michigan in terms of enrollment during the 2017-18 school year.

Thirty-four districts in my sample explicitly state the walking distance cutoff that determine transportation eligibility. In elementary school, the majority of districts have walking distances of one or 1.5 miles. In middle and high school most districts have walking distances of 1.5 miles, the maximum distance set by the state. Districts who choose a cutoff closer than the state mandated cutoff may do so to minimize or maximize the number of transportation eligible students. For example, the percent of students eligible for transportation in districts in my sample that have a 0.75 mile walking distance cutoff would increase by 25 percentage points if they changed the cutoff to 0.5 miles from school, likely increasing transportation costs. Thus, I focus on the effects of school transportation in districts with a 1.5 mile cutoff in my analysis because it is less likely to have been manipulated by districts which could bias my results.

Table 20. District Characteristics of Sample, 2017-18.

	State	Sample	1.5 Mile Cutoff
N Districts	537	50	23
Avg. Total Enrollment	2,520	10,856	12,541
Avg. Sq. Miles	108	65	63
City	6%	32%	35%
Suburb	27%	62%	57%
Rural	67%	6%	9%
Avg. Pct. Female	52%	51%	51%
Avg. Pct. White	79%	67%	70%
Avg. Pct. Black	8%	14%	10%
Avg. Pct. Hispanic	7%	8%	9%
Avg. Pct. Asian	2%	6%	6%
Avg. Pct. Other Race	5%	5%	5%
Avg. Pct. Econ. Dis.	55%	39%	37%
Avg. Pct. SWDs	14%	13%	12%
Avg. Pct. ELs	4%	8%	11%
Avg. Attendance Rate	93.05	93.94	94.42
Avg. Pct. Chronic. Abs.	19%	17%	14%
Avg. Std. Reading Score	-0.02	0.20	0.23
Avg. Std. Math Score	-0.02	0.21	0.26

Note. Unweighted district characteristics created using student level data. Econ. Dis., SWD, and EL are abbreviations for economically disadvantaged, student with disabilities, and English Learner respectively. In Michigan, students are considered economically disadvantaged if they qualify for free or reduced lunch, receive food (SNAP) or cash assistance (TANF), or they are homeless, migrant, or in foster care. Sample includes the 50 largest traditional public school districts in Michigan in terms of enrollment during the 2017-18 school year. 1.5 mile cutoff includes all districts that have a 1.5 mile walking distance cutoff for at least one grade between grades K-8. Attendance rates are from public report made available by the Center for Education Performance and Information. 3 districts with less than 10 students do not have attendance rates available. 24 districts have missing chronic absenteeism rates. One district does not have test scores.

In Table 20, I compare the average characteristics of districts in the collected and analytic samples to all districts in the state during the 2017-18 school year. Sampled districts are more densely populated since they serve more students but are smaller in land area than the average Michigan district. A higher percentage of sampled districts are located in cities and suburbs. Also, they have a higher percentage of non-White students, a lower percentage of economically disadvantaged students, and higher average achievement.

Analytic Sample

To construct my sample, I begin with 428,174 student-year observations of students in grades K-8 who have a walking distance cutoff of 1.5 miles and attend their nearest school offering their grade in their resident district, my proxy for assigned school, between the 2012-13 and 2018-19 school years.[15] It is likely that students are only guaranteed transportation to their assigned school since 22 of the 50 of the district transportation policies I collected explicitly stated that students were only guaranteed transportation to their assigned school. Also, I cannot guarantee that districts that do not have this provision in their transportation policy do not limit transportation eligibility to a student's assigned school since districts may rely on the language in the state law or use their discretion to do so. Even if a district offers transportation to all schools in the district, they must offer it to their assigned school as well. Therefore, by restricting the sample to students who likely attend their assigned school, I am ensuring all students in my sample are transportation eligible if they live more than 1.5 miles from school.

I exclude 2,333 (0.5%) student-year observations of homeless students and 44,760 (10.5%) student-year observations of students with disabilities from my sample because they may receive school transportation regardless of distance between home and school. Under the McKinney-Vento Act, districts are required to transport homeless students to their school of origin (U.S. Department of Education, 2018). Students with disabilities are guaranteed transportation if their Individualized Education Program (IEP) Team deems it as a necessary service (U.S. Department of Education, 2009). Although the number of students with disabilities

[15] To determine a student's nearest school, I first determine which district the student lives in using the population weighted centroid of their resident census block and district boundary shape files from the Michigan Department of Technology, Management, and Budget. Then, I calculate the geodetic ("as the crow flies") distance to from their census block to each school in their resident district that offers general education and the student's grade excluding virtual schools, boarding schools, and other residential schools. I use the school with the shortest distance as their nearest school.

whose IEPs include the provision of transportation may vary by district, existing evidence shows that a large percentage of students with disabilities receive transportation services regardless of whether it is specified in their IEP. Thus, I drop all students with disabilities from my sample.[16] My final analytic sample includes 380,909 student-year observations.[17]

Treatment and Forcing Variables

I use a strict regression discontinuity design that leverages the walking distance cutoffs to estimate the effects of transportation eligibility on student attendance and achievement outcomes. This design assumes that, local to the cutoff, the average student on either side of the cutoff is identical, with one exception: one side is eligible for transportation and the other is not. Thus, any estimated differences in outcomes can be attributed to transportation eligibility as long as families do not choose their residence based on transportation eligibility and there is nothing other than the outcomes that change discontinuously at the cutoff. I consider my estimates to be the intent to treat (ITT) effects of riding the school bus because I use transportation eligibility rather than bus ridership to determine treatment since I do not have data concerning which students actually ride the bus on a daily basis. I likely underestimate the effects of riding the school bus on student outcomes because I consider possible non-compliers—those eligible for transportation but do not ride the bus—as treated. However, these ITT effects can be considered a more policy-relevant parameter than the average treatment effect on the treated because policymakers cannot force students to use a bus. Instead, they can change who is eligible for

[16] My data include special education services provided. However, few students have transportation reported as a necessary service. According to an interview with a Detroit Public Schools Community District administrator, about sixty percent of special education students received door-to-door transportation to any school in the district during the 2017-18 school year (Sattin-Bajaj, 2018). Although DPSCD transported over 3,300 students with disabilities, significantly fewer students had transportation reported as a necessary service in the administrative data during the 2017-18 school year. Therefore, I have no indication in the data concerning which students with disabilities receive transportation and choose to drop them all to ensure they do not bias my results.
[17] Also, I exclude 172 observations of students who do not have reported attendance variables.

transportation to either encourage or restrict school bus use. Therefore, the true impact of changes to transportation policies is likely to include compliers and non-compliers making the effect of transportation eligibility, the ITT effect, the most policy-relevant estimate.

Students are considered transportation eligible if they live more than 1.5 miles walking distance from school. Walking distance, my forcing variable, is calculated from the population weighted centroid of the student's home census block to the exact address of their attended school using Here Application Programming Interface (API), a similar tool to Google Maps, using the quickest route assuming average traffic. Because I do not have any data concerning who districts consider transportation eligible, I assume that walking distance perfectly predicts treatment. This assumption likely biases my results towards zero. If there is an effect of the bus on student outcomes, the inclusion of the outcomes of students considered treated who are not transportation eligible should weaken my estimates. Similarly, the presence of outcomes of students considered not treated who actually are eligible for the school bus in the sample should also reduce the estimated effect of transportation eligibility.

Attendance and Achievement Measures

I estimate the effects of school bus eligibility on student attendance and achievement. I use two measures of attendance: the student's annual attendance rate and an indicator for being chronically absent. I calculate the attendance rate using the rules set out by CEPI. I divide the number of days the student attended the school by the number of days they could have possibly attended.[18] Since I theorize that the school bus increases attendance by lowering the financial and

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[18] Prior to the 2017-18 school year, a student was considered in attendance if they attended any part of the school day. Starting in the 2017-18 school year, a student had to attend at least 50 percent of the school day to be considered in attendance. Although I contend that this change should not affect my results because my estimates are created by comparing attendance outcomes from the same year due to the inclusion of grade-by-school-by year fixed effects, I estimate my models separately for the years before and after the change in the attendance definition as a robustness check. Results are similar in direction and magnitude for each sample and are available by request.

time costs associated with transporting students to and from school, I hypothesize that transportation eligibility may increase the likelihood that a student attends school on a regular basis rather than marginally increasing attendance. Therefore, I also use an indicator for being chronically absent as an outcome. I consider a student to be chronically absent if their attendance rate is less than 90 percent, which is MDE's definition of chronic absence (Center for Educational Performance and Information, 2020). I measure achievement using test scores on the state standardized exam, the MEAP or the M-STEP, for students in grades 3 through 8. Specifically, I use math and ELA test scores standardized within grade, subject, and year.[19]

Table 21 examines differences in characteristics and outcomes between transportation eligible and ineligible students in my full and analytic samples. For my analysis, I restrict my sample to students who live within 0.4 miles of the cutoff, my preferred bandwidth for estimating causal effects. Just under half of students in my sample are transportation eligible. A lower percentage of English Learners, White, and economically disadvantaged students are transportation eligible in the full sample. However, there are few differences between transportation eligible and ineligible students who live closer to the walking distance cutoff. As for attendance rates, students who are transportation eligible have slightly higher attendance rates than students who do not. These differences are similar for students who live within 0.4 miles of the cutoff. Additionally, transportation eligible students have higher test scores, but this difference is much smaller within my preferred bandwidth.

[19] The MEAP was administered during the first two school years of my panel, 2012-13 and 2013-14, while the M-STEP was administered from 2014-15 to 2018-19. Because I standardize the test scores within grade, subject, and year and use school-by-grade-by-year fixed effects in my models, estimates are created by comparing test scores from the same year. Therefore, changes in the test administered should not affect my results.

Table 21. Student Characteristics of Analytic Sample

	1.5 Mile Cutoff					
	Full Sample			0.4 Mile Bandwidth		
	Full Sample	Not Eligible	Eligible	Full Sample	Not Eligible	Eligible
N	380,909	212,737	168,172	93,281	51,347	41,934
Avg. Walk Distance	1.73	0.77	2.95	1.47	1.30	1.69
Pct. Transport Elig.	44%	0%	100%	45%	0%	100%
Pct. Female	51%	50%	51%	50%	50%	51%
Pct. White	78%	80%	75%	75%	75%	74%
Pct. Black	7%	6%	8%	8%	8%	8%
Pct. Hispanic	6%	7%	5%	6%	7%	6%
Pct. Asian	6%	4%	8%	7%	6%	8%
Pct. Other Race	3%	3%	4%	4%	4%	4%
Pct. Econ. Dis.	37%	47%	26%	32%	33%	31%
Pct. English Learner	17%	25%	7%	11%	11%	11%
Pct. Chronic Absent	7%	7%	7%	8%	8%	7%
Avg Attendance Rate	95.79	95.70	95.90	95.68	95.57	95.83
Avg. Std. Math Score	0.36	0.27	0.46	0.36	0.35	0.37
Avg. Std. ELA Score	0.29	0.21	0.38	0.30	0.30	0.31

Note. Sample includes all student by year observations in analytic sample. 0.4 Mile bandwidth includes all students who have a walking distance from home to school that is between 1.1 miles and 1.9 miles. Walking distances are calculated from the population weighted centroid of the student's resident census block to their school assuming average traffic using Here API. Students are transportation eligible (Transport Elig.) if their walking distance to school is greater than 1.5 miles . Econ. Dis. is an abbreviation for economically disadvantaged. In Michigan, students are considered economically disadvantaged if they qualify for free or reduced lunch, receive food (SNAP) or cash assistance (TANF), or they are homeless, migrant, or in foster care. Students are considered chronically absent if they miss more than ten percent of possible days in the school year. Math and English Language Arts (ELA) test scores on the Michigan Educational Assessment Program, MEAP, or the Michigan Student Test of Educational Progress, M-STEP are standardized within grade, subject and year. Because students take these tests in grades 3-8, 285,025 and 283,579 student-year observations in my sample have math or ELA test scores respectively.

Method

I estimate the effects of school bus eligibility on student attendance and achievement using a strict regression discontinuity design. Specifically, I exploit the walking distance cutoffs that determine eligibility for district transportation. I estimate:

$$Y_{igjt} = \beta_1 + \beta_2 Eligible_{ijt} + f\left(distance_{ijt}\right) + \boldsymbol{X_{it}\beta} + \gamma_{gjt} + \varepsilon_{igjt} \tag{6}$$

Where Y_{igjt} is one of the following four outcomes for student *i* in grade *g* who attends nearest school *j* at time *t*: attendance rate, an indicator that equals one if student *i* is chronically absent, standardized math test score, or standardized ELA test score. $Eligible_{ijt}$, my treatment indicator equals one if student *i* is eligible to receive transportation to school *j*. Students in my sample are school bus eligible if they live more than 1.5 miles from school. $f(distance_{ijt})$ is a flexible function of the walking distance from student *i*'s home to their school *j* in year *t*, my forcing variable. I use a linear term of my forcing variable and its interaction with my treatment, $Eligible_{ijt}$ in my preferred models. $\boldsymbol{X_{it}}$ contains student characteristics including race, gender, economically disadvantaged status, and English Learner indicators. In the models where math or ELA test score is the outcome, I include a lagged test score in my vector of student characteristics to account for prior achievement.

Transportation eligibility, school characteristics, and neighborhood characteristics are likely correlated and associated with my outcomes. Therefore, my estimates of the effects of school bus eligibility would be biased if I do not account for students' schools and neighborhoods. In fact, Cordes et al. (2019) find that most differences in attendance between students who ride the bus and those who do not in New York City are due to differences in the schools they attend. This implies that students who ride the bus do so to attend better schools, biasing the direct effect of the school bus on student attendance. To ensure that where students choose to attend school does not bias my results, I include, γ_{gjt}, a grade-by-school-by-year fixed effect in my preferred models. This ensures that my estimates are created by only comparing students who attend the same school and the same grade during the same school year. Because I restrict my sample to students who attend their nearest school, my proxy for assigned school, γ_{gjt} not only holds constant school characteristics but neighborhood characteristics as well, accounting for choice of school and home. Furthermore, the grade-by-school-by year fixed effects account for grade and year specific trends. I cluster by standard errors by school.

One of the conditions of my research design is that I must limit my sample to observations local to the cutoff to produce causal estimates of the effects of transportation eligibility. Thus, I estimate Equation 6 on the sample of students who live within 0.4 miles of the walking distance cutoff, my preferred bandwidth. My choice of bandwidth is informed by the optimal bandwidth procedures proposed by Calonico, Cattaneo, & Titiunik (2014). Additionally, I hypothesize that district-provided transportation has larger effects for impoverished students since low-income students are less likely to have access to direct forms of transportation and they are more likely to live in unsafe neighborhoods (Urban Institute Student Transportation Working Group, 2018; Sampson, Raudenbush, & Earls, 1997). Therefore, they are more likely to rely on schools to provide a reliable and safe way to get to school. To test this hypothesis, I also estimate the model represented by Equation 6 on samples restricted to either economically advantaged or disadvantaged students, my poverty indicator. In Michigan, students are considered economically disadvantaged if they qualify for free or reduced lunch, receive food (SNAP) or cash assistance (TANF), or they are homeless, migrant, or in foster care.

Validity of Design

In order for my research design to estimate the causal effect of school bus eligibility, two assumptions must hold. First, I must assume that nothing other than treatment and outcomes change discontinuously at the cutoff. If other factors change at the cutoff, then my estimate of the effect of transportation eligibility may be biased since my treatment indicator would be correlated with unobserved characteristics in the error term. To provide evidence that this assumption likely holds, I examine whether or not my treatment, $Eligible_{ijt}$ predicts pre-determined observable student characteristics using balance tests. Specifically, I estimate:

$$O_{igjt} = \beta_1 + \beta_2 Eligible_{ijt} + f\left(distance_{ijt}\right) + \gamma_{gjt} + \varepsilon_{igjt} \qquad (7)$$

where O_{igjt} is an indicator for one of the following student characteristics for student *i* in grade *g* attending nearest school *j* at time *t*: female, White, Black, Hispanic, Asian, Other Race, economically disadvantaged, or English Learner. I estimate the model represented in Equation 7 on the sample of students who live within 0.4 miles of the walking distance cutoff using either a linear term of $distance_{ijt}$ and its interaction with my treatment, $Eligible_{ijt}$, or a linear term, a quadratic term, and their interactions with treatment. Table 22 displays the coefficients and standard errors for $Eligible_{ijt}$ for each of the outcomes I predict in my balance tests. I find no significant differences in any of my observable student characteristics at the walking distance cutoff, providing some confidence that no other characteristics change discontinuously at the cutoff other than the treatment and the outcomes.[20]

Second, I must assume that families do not manipulate themselves into treatment, meaning that they do not choose their residences based on school bus eligibility. If families do manipulate themselves into treatment, it is likely that there are unobserved characteristics correlated with treatment biasing my estimates of transportation eligibility. Although school bus eligibility rules are publicly available, they tend to be buried within district bylaws. Furthermore, families may be more focused on which school their children would be assigned to attend rather than whether or not they would be eligible for the school bus when choosing a home. To provide evidence that this assumption holds, I first visually check for discontinuities using histograms of the frequency of observations around the cutoff. In Figure 9, I present the histograms of the frequency of observations in my sample as a function of distance from the cutoff. In Figure 9A, I use a bin size of 0.01 miles and find that there is a large number of observations between 1.5 and

[20] I estimate versions of Equation 2 using various bandwidths. Results are similar and can be found in Table 27. Less than five percent of estimates have p-values less than 0.05 providing confidence that my research design is internally valid.

Table 22. Estimated Coefficients of Transportation Eligibility for Balance Tests

OUTCOMES	(1) Coefficient (SE)	(2) Coefficient (SE)
Female	-0.002	0.012
	(0.011)	(0.016)
White	0.017	0.035
	(0.017)	(0.024)
Black	-0.003	-0.017
	(0.010)	(0.014)
Hispanic	-0.008	-0.016
	(0.008)	(0.010)
Asian	0.001	0.004
	(0.008)	(0.015)
Other Race	-0.008	-0.006
	(0.005)	(0.008)
Econ. Dis.	0.00571	-0.026
	(0.015)	(0.023)
EL	-0.002	-0.003
	(0.011)	(0.014)
Observations	93,281	93,281
WALKING DISTANCE FUNCTIONAL FORM		
Linear Term	X	X
Linear Term interacted with Transportation Eligibility Indicator	X	X
Quadratic Term		X
Quadratic Term interacted with Transportation Eligibility Indicator		X

Note. Standard errors in parentheses. *p<0.1, ** p<0.05, ***p<0.01. Models include school-by-grade-by-year fixed effects. Standard errors are clustered at the school level. The sample includes student-year observations living within 0.4 miles of the transportation eligibility cutoff, my preferred bandwidth. ED and EL are abbreviations for economically disadvantaged and English Learner respectively. In Michigan, students are considered economically disadvantaged if they qualify for free or reduced lunch, receive food (SNAP) or cash assistance (TANF), or they are homeless, migrant, or in foster care.

1.51 miles from the cutoff. Taken by itself, this could imply that families are choosing homes right over the cutoff in order to receive treatment. However, there is little difference in the number of observations on either side of the cutoff when I compare the number of observations that are 0.1 miles from the cutoff in Figure 9B. When combined, the histograms show that there is some evidence of bunching within 53 feet of the cutoff but little evidence of bunching at 530 feet of the cutoff.

Figure 9. Distribution of Observations

Figure 9A: 0.01 Mile Bin Size

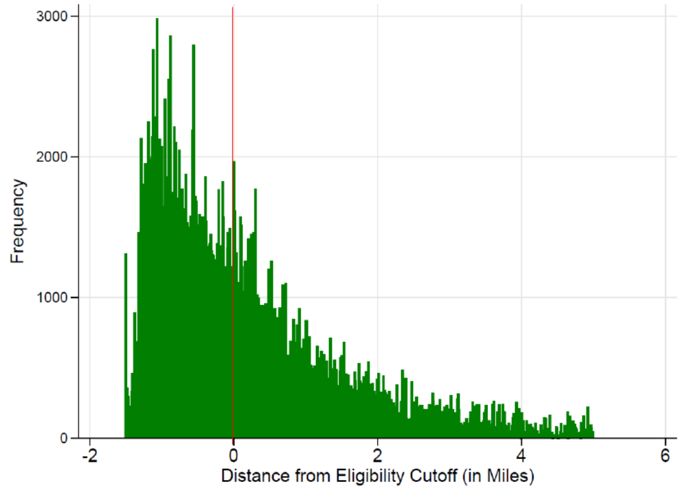
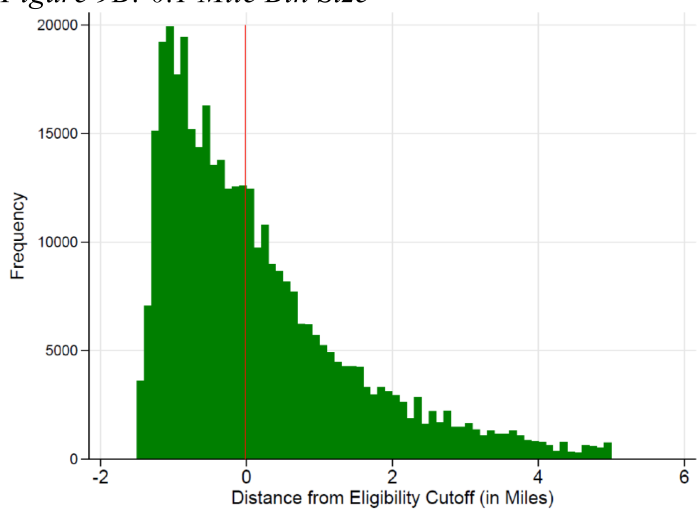


Figure 9B: 0.1 Mile Bin Size



Note. Sample includes observations of students in the analytic sample living between zero and five miles from their attended school.

Next, I formally test for bunching around the cutoff using the statistical test proposed by McCrary (2008). If there is statistically significant evidence of a discontinuity in the density of observations at the cutoff, then it is likely that families manipulate themselves into treatment. I perform the McCrary test using multiple bandwidths and bin sizes. In addition to the choice of bandwidth, the choice of bin size is important in a McCrary test since it regresses the number of observations within a bin as a function of each bin's midpoint to detect discontinuities in density at the cutoff (McCrary, 2008). At my preferred bandwidth, 0.4 miles, and the optimal bin size, 0.004 miles, I find a statistically significant and positive discontinuity in the density of observations. However, if I use a bin size of 0.1 miles, I do not detect a statistically significant discontinuity in the density of observations at the cutoff. Similar to the findings of the visual examinations of the histograms, the results of the McCrary test provide evidence of bunching within a hundred feet of the cutoff but not within five hundred feet of the cutoff.

Given these findings, I argue that it is unlikely that this bunching is evidence of manipulation since it is unlikely that families who choose their residence for school bus eligibility can control whether their home is within a hundredth or a tenth of the mile from the cutoff. Rather, this discontinuity is a likely result of an idiosyncrasy of the distribution of residences in the data. To investigate whether or not the bunching is an artifact of normal residential patterns, I first examine the characteristics of students who live within 0.01 miles of the cutoff and the census blocks they live in. Although five students live in a census block in a given year on average in my sample, I find that there is one census block that is one thousandth of a mile from the walking distance cutoff and is home to over 130 students a year. This census block contains a mobile home park with 430 multi-family homes all with the same address (MHVillage Inc., 2021). Because the McCrary test uses local polynomial regressions that weigh observations closer to the cutoff more heavily, this census block likely causes the discontinuity in the density of observations. To explore this, I estimate the McCrary test without the mobile home park census block and find no statistically significant evidence of bunching. Furthermore, there is little visual evidence of bunching in the histograms of the frequency of observations in the sample with the mobile home park census block is removed as seen in Figure 12 in the Appendix. Therefore, this one census block which exhibits a predictable residential pattern likely drives the bunching.

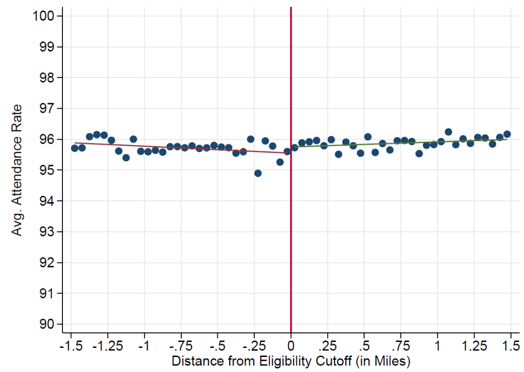
Although the evidence presented above provides confidence that my regression discontinuity design is internally valid, I cannot fully rule out the possibility of manipulation. To address this concern, I estimate the model represented by Equation 6 using a donut regression discontinuity approach as a specification check. Specifically, I exclude observations extremely close to the cutoff, including the mobile home park census block, where there could be possible manipulation. Dropping observations at data heaps produces unbiased estimates of the treatment effect in regression discontinuity designs (Barreca, Lindo, & Waddell, 2015).

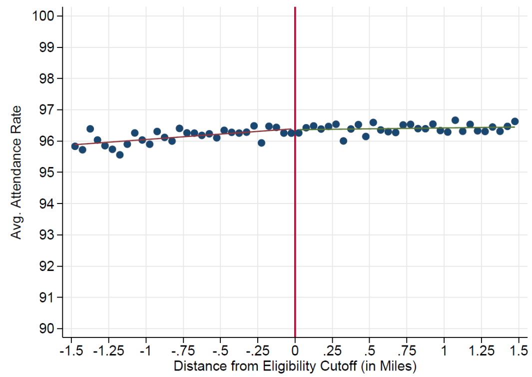
Results

Before I present the results of my main models, I display graphs of the unadjusted average attendance and achievement outcomes by distance from school in Figures 10 and 11 to visually examine discontinuities in the outcomes at the transportation eligibility cutoff. In Figures 10A and 10B, I detect no visual change in attendance rate in the full sample or the sample of economically advantaged students. However, a different pattern emerges in the attendance rates of economically disadvantaged students in Figure 10C. For economically disadvantaged students who are not eligible to ride the school bus, there is a negative relationship between distance and attendance rate. However, this relationship does not exist for transportation eligible students. Furthermore, there is visual evidence of a discontinuity in attendance rates at the cutoff. Taken together, the evidence from Figure 10C implies that the school bus not only mitigates the negative effects of distance on attendance for economically disadvantaged students but improves their attendance as well.

Figure 10. Unadjusted Average Attendance Rate and Proportion Chronically Absent by Distance from Threshold

Figure 10A: Attendance Rate Full Sample *Figure 10B: Attendance Rate Not Econ. Dis.* *Figure 10C: Attendance Rate Econ. Dis.*





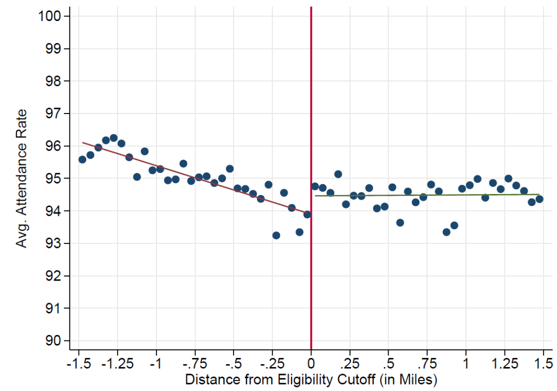
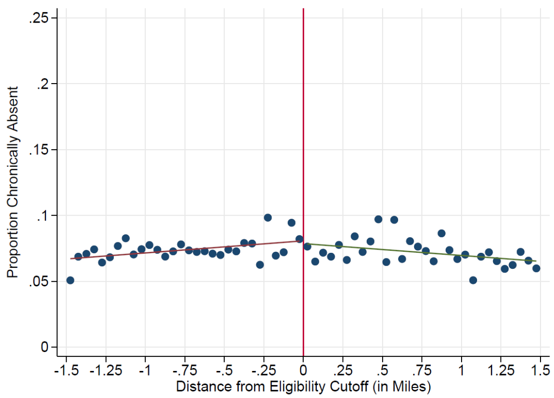
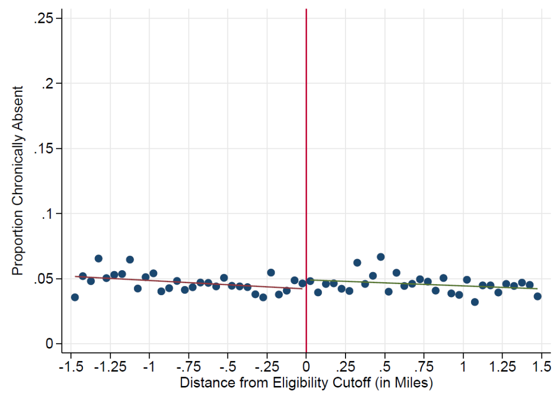
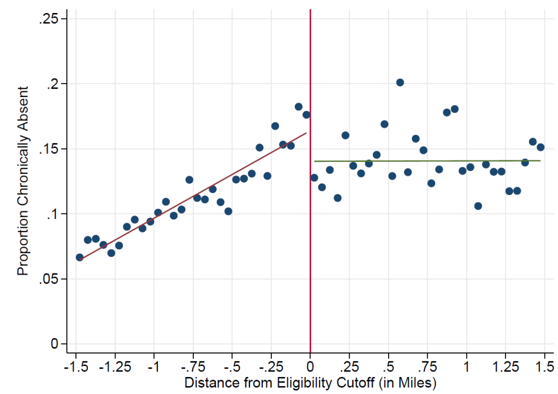


Figure 10D: Chronic. Absent Full Sample *Figure 10E: Chronic. Absent Not Econ. Dis.* *Figure 10F: Chronic. Absent Econ. Dis.*







Note. Each dot represents the average outcome for all observations within a 0.05 mile bin width. Students are considered chronically absent if they miss more than ten percent of possible days in the school year. Walking distances are calculated from the population weighted centroid of the student's resident census block to their school assuming average traffic using Here API. The eligibility cutoff is 1.5 miles. Econ. Dis. is an abbreviation for economically disadvantaged. In Michigan, students are considered economically disadvantaged if they qualify for free or reduced lunch, receive food (SNAP) or cash assistance (TANF), or they are homeless, migrant, or in foster care.

Figure 11. Unadjusted Average Standardized Math and ELA Test Scores by Distance from Threshold

Figure 11A: Math Score Full Sample

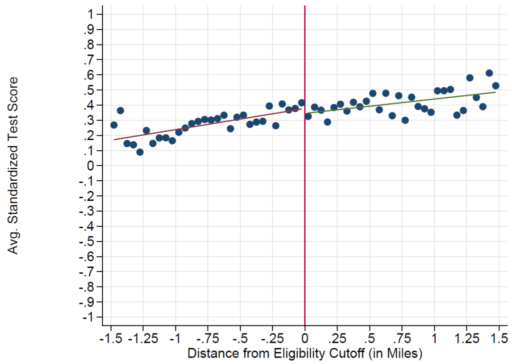


Figure 11B: Math Score Not Econ. Dis.

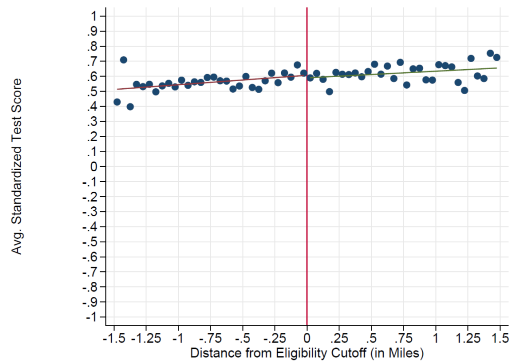


Figure 11C: Math Score Econ. Dis.

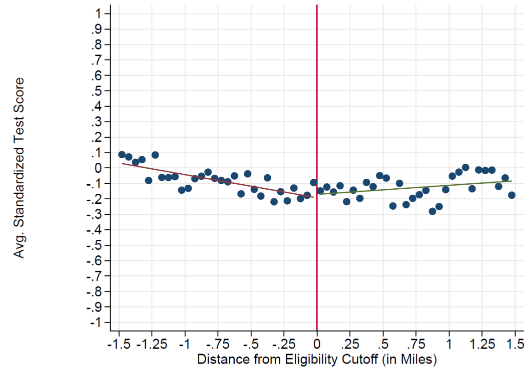


Figure 11D: ELA Score Full Sample

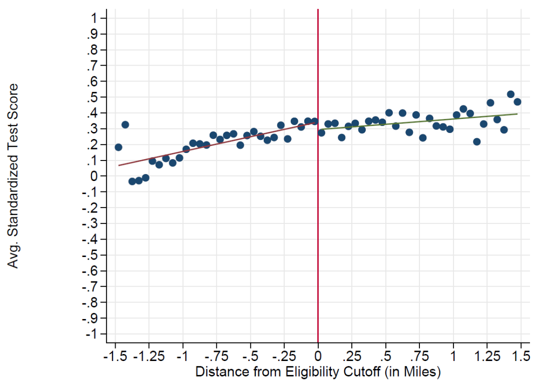


Figure 11E: ELA Score Not Econ. Dis.

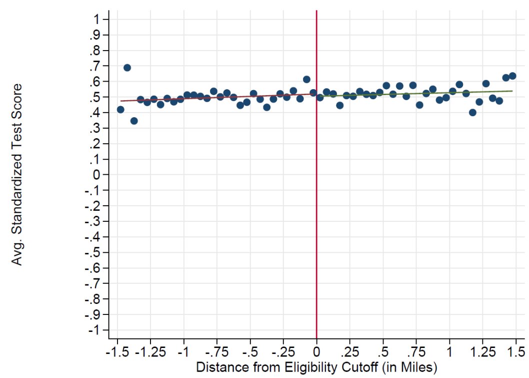
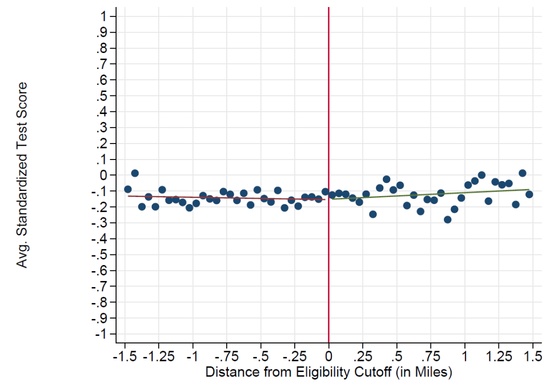


Figure 11F: ELA Score Econ. Dis.



Note. Each dot represents the average outcome for all observations within a 0.05 mile bin width. Math and English Language Arts (ELA) test scores on the Michigan Educational Assessment Program, MEAP, or the Michigan Student Test of Educational Progress, M-STEP are standardized within grade, subject and year. Walking distances are calculated from the population weighted centroid of the student's resident census block to their school assuming average traffic using Here API. The eligibility cutoff is 1.5 mile. Econ. Dis. is an abbreviation for economically disadvantaged. In Michigan, students are considered economically disadvantaged if they qualify for free or reduced lunch, receive food (SNAP) or cash assistance (TANF), or they are homeless, migrant, or in foster care.

An analogous pattern emerges in Figures 10D, 10E, and 10F which displays the unadjusted proportion of chronically absent students by distance from the threshold for the full sample and the samples restricted to economically advantaged or disadvantaged students. There is little difference in the proportion of students who are chronically absent between transportation eligible and ineligible students in the full sample or the sample of economically advantaged students. However, there is evidence that proportion of chronically absent students increases as distance to school increases for economically disadvantaged students who are not school bus eligible. Furthermore, there is evidence that there is a discontinuity in the proportion of students who are chronically absent at the cutoff implying that the school bus reduces the probability of being chronically absent. Figure 11 graphs the relationships between distance to school and standardized math and ELA test scores. There is no evidence of large slope changes or discontinuities for any of my samples, implying that transportation eligibility may have no effect on achievement.

Although the evidence provided in Figure 10 shows that economically disadvantaged students who are transportation eligible have higher attendance rates and are less likely to be chronically absent, it may be biased by unaccounted for student or school characteristics. In Table 23, I present the results of the model represented by Equation 6 using a 0.4 mile bandwidth, providing regression adjusted, causal estimates of the effects of transportation eligibility for the full sample. Columns 1 and 2 display the effects of school bus eligibility on attendance rates and the indicator for being chronically absent respectively. I detect a small positive effect of transportation eligibility on attendance that is statistically significant at a 90 percent confidence level. Specifically, I find that transportation eligibility increases attendance rates by approximately 0.2 percentage points. This is equivalent to almost a half a day increase in attendance in a 180 day school year. Similarly, I find that school bus eligibility decreases the probability of being chronically absent by 1.5 percentage points. In Columns 3 and 4, I present the results for math and ELA test scores. I do not detect any statistically significant effect of transportation eligibility on student achievement.

Table 23. Estimated Effects of Transportation Eligibility

	(1)	(2)	(3)	(4)
	Attendance Rate	**Chronically Absent**	**Math Score**	**ELA Score**
Transportation Eligibility	0.197*	-0.015***	-0.004	0.009
	(0.119)	(0.006)	(0.010)	(0.011)
Distance	-0.581	0.044**	-0.008	-0.026
	(0.367)	(0.018)	(0.025)	(0.035)
Distance*Transport. Eligibility	0.444	-0.0268	0.0340	-0.010
	(0.492)	(0.0228)	(0.0360)	(0.047)
Constant	96.03***	0.0571***	0.129***	0.113***
	(0.088)	(0.004)	(0.007)	(0.008)
Observations	93,281	93,281	52,448	52,228
Adj R Squared	0.020	0.017	0.666	0.578

Note. Standard errors in parentheses. *p<0.1, ** p<0.05, ***p<0.01. Models include student race, gender, economically disadvantaged status, and English Learner covariates and school-by-grade-by-year fixed effects. Standard errors are clustered at the school level. The sample includes student-year observations living within 0.4 miles of the transportation eligibility cutoff, my preferred bandwidth. Students are considered to be transportation eligible if students live farther than 1.5 miles walking distance from school. Walking distances are calculated from the population weighted centroid of the student's resident census block to their school's address assuming average traffic using Here API. Students are considered chronically absent if they miss more than ten percent of possible days in the school year. Math and English Language Arts (ELA) test scores on the Michigan Educational Assessment Program, MEAP, or the Michigan Student Test of Educational Progress, M-STEP are standardized within grade, subject and year.

To examine whether or not the effects of transportation eligibility are larger for economically disadvantaged students, I estimate the model represented by Equation 6 on samples restricted to either economically advantaged or disadvantaged students. The results of these specifications are displayed in Table 24. I find little evidence that transportation eligibility affects the attendance rate or the probability of being chronically absent for economically advantaged students. Instead, I find that the positive effects of school bus eligibility found in the

Table 24. Heterogeneous Effects of Transportation Eligibility by Economically Disadvantaged Status

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Attendance Rate		**Chronically Absent**		**Math Score**		**ELA Score**	
	Not Econ. Dis.	**Econ. Dis.**	**Not Econ. Dis.**	**Econ. Dis.**	**Not Econ. Dis.**	**Econ. Dis.**	**Not Econ. Dis.**	**Econ. Dis.**
Transportation Eligibility	-0.011	0.661**	-0.003	-0.040***	-0.010	0.006	0.004	0.013
	(0.105)	(0.285)	(0.005)	(0.014)	(0.012)	(0.017)	(0.013)	(0.022)
Distance	-0.146	-1.582**	0.026*	0.096**	-0.011	0.010	-0.044	0.036
	(0.328)	(0.752)	(0.014)	(0.044)	(0.030)	(0.048)	(0.039)	(0.066)
Distance*Transport. Eligibility	0.268	0.895	-0.026	-0.060	0.062	-0.045	0.051	-0.170**
	(0.466)	(1.123)	(0.020)	(0.058)	(0.043)	(0.069)	(0.056)	(0.084)
Constant	96.36***	93.75***	0.043***	0.172***	0.146***	0.004	0.126***	-0.012
	(0.069)	(0.209)	(0.003)	(0.010)	(0.008)	(0.013)	(0.009)	(0.014)
Observations	63,299	29,982	63,299	29,982	35,756	16,692	35,690	16,538
Adj R Squared	0.003	0.011	0.003	0.007	0.656	0.615	0.543	0.570

Note. Standard errors in parentheses. *p<0.1, ** p<0.05, ***p<0.01. Models include student race, gender, and English Learner covariates and school-by-grade-by-year fixed effects. Standard errors are clustered at the school level. The sample includes student-year observations living within 0.4 miles of the transportation eligibility cutoff, my preferred bandwidth. Samples are restricted to either economically disadvantaged or advantaged students. Students are considered to be transportation eligible if students live farther than 1.5 miles walking distance from school. Walking distances are calculated from the population weighted centroid of the student's resident census block to their school's address assuming average traffic using Here API. Students are considered chronically absent if they miss more than ten percent of possible days in the school year. Math and English Language Arts (ELA) test scores on the Michigan Educational Assessment Program, MEAP, or the Michigan Student Test of Educational Progress, M-STEP are standardized within grade, subject and year. Econ. Dis. is an abbreviation for economically disadvantaged. In Michigan, students are considered economically disadvantaged if they qualify for free or reduced lunch, receive food (SNAP) or cash assistance (TANF), or they are homeless, migrant, or in foster care.

full sample are driven by the effects for economically disadvantaged students. Specifically, I find that transportation eligibility increases attendance rates for economically disadvantaged students by two-thirds of a percentage point. This is equivalent to about one day in a 180 day school year. Moreover, school bus eligibility decreases the probability of being chronically absent for economically disadvantaged students by four percentage points. This large effect on chronic absenteeism for economically disadvantaged students confirms my hypothesis that school transportation has the greatest impact on students who do not have a reliable, consistent, and safe way to get to school without it. Finally, Table 24 shows little evidence that school bus eligibility has a significant effect on achievement for economically advantaged or disadvantaged students.

Specification Checks

In order to ensure that my results are not sensitive to my choices in functional form, bandwidth, estimator, and sample, I perform the following specification checks. First, I estimate Equation 1 using various bandwidths and a quadratic polynomial term of distance to school, my forcing variable. Results of these specifications are similar and can be found in Tables 28 and 29 in the Appendix. Second, I use a nonparametric estimator, the optimal bandwidth calculated using the method proposed by Calonico, Cattaneo, & Titiunik (2014), and the robust bias-corrected inference procedures detailed by Calonico, Cattaneo, & Farrell (2020) with district, grade, and year fixed effects to estimate the effects of school bus eligibility on my attendance outcomes.[21] Specifically, I estimate local linear polynomial regressions with a first order

[21] At the time of this writing, the rdrobust command that implements the procedures discussed by Calonico, Cattaneo, & Titiunik (2014) and Calonico, Cattaneo, & Farrell (2020) does not allow for the use of fixed effects. Therefore, I must create binary indicators for each school-by-grade-by-year fixed effect. However, I have over 20,000 school-by-grade-by-year combinations in my data and Stata does not allow for that many variables. Therefore, I use the district, grade, and year fixed effects for the non-parametric models due to computational limitations at this time. Furthermore, the rdrobust command was unable to calculate standard errors in the models where standardized test score was an outcome. Therefore, I only display the results of the attendance outcomes in Table 30 in the Appendix.

polynomial function to construct the estimates and a second order polynomial function to construct the bias correction with triangular kernel functions. Results of the models using the nonparametric estimator are displayed in Table 30 in the Appendix. The estimates of transportation eligibility from the nonparametric model are similar in direction and slightly larger in magnitude than the models using a parametric estimator and school-by-grade-by-year fixed effects.

Finally, I estimate the model represented by Equation 1 on samples that exclude observations within 0.01, 0.05, and 0.1 miles of the cutoff. Although I argue that the discontinuity in the density of observations that I detect at the cutoff is driven by an idiosyncrasy of residential patterns, I use this donut regression discontinuity approach to account for possible manipulation extremely close the cutoff as a robustness check. I present the results of the donut regressions in Table 25. First, I find that the positive effect of school bus eligibility on attendance rates in the full sample is not robust to the exclusion of observations close to the cutoff. Second, I show that the estimated transportation eligibility effects on attendance rates for economically disadvantaged students are similar in direction and magnitude but lose statistical significance when the sample is reduced. Finally, I find that the estimated effects of transportation eligibility on chronic absenteeism for the full sample and the sample of economically disadvantaged students are similar and statistically significant when observations within 0.01 or 0.05 miles from the cutoff are excluded. However, they are no longer statistically significant when all observations within 0.1 miles from the cutoff are excluded. Because this sample exclusion reduces the sample by almost one third, my inability to detect significant effects may be due to a loss of power. Taken together, the results of these specification checks show that, at the very least, my finding that transportation eligibility reduces the probability of being chronically absent

Table 25. Estimated Effects of Transportation Eligibility, Donut Regressions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Attendance Rate			**Chronically Absent**			**Math Score**			**ELA Score**		
	Full Sample	**Not Econ. Dis.**	**Econ. Dis.**	**Full Sample**	**Not Econ. Dis.**	**Econ. Dis.**	**Full Sample**	**Not Econ. Dis.**	**Econ. Dis.**	**Full Sample**	**Not Econ. Dis.**	**Econ. Dis.**
0.01 Mile Exclusion												
Transport. Eligibility	0.135	-0.052	0.562*	-0.011*	-0.002	-0.033**	-0.007	-0.013	0.002	0.009	0.005	0.011
	(0.126)	(0.107)	(0.292)	(0.006)	(0.005)	(0.013)	(0.010)	(0.012)	(0.017)	(0.012)	(0.013)	(0.022)
Observations	90,042	61,292	28,750	90,042	61,292	28,750	50,841	34,741	16,100	50,629	34,680	15,949
0.05 Mile Exclusion												
Transport. Eligibility	0.146	-0.070	0.451	-0.014*	-0.003	-0.034*	-0.002	-0.019	0.026	0.002	-0.007	0.018
	(0.165)	(0.137)	(0.362)	(0.008)	(0.006)	(0.018)	(0.012)	(0.013)	(0.023)	(0.015)	(0.017)	(0.026)
Observations	80,665	54,702	25,963	80,665	54,702	25,963	45,423	31,028	14,395	45,232	30,973	14,259
0.1 Mile Exclusion												
Transport. Eligibility	0.016	-0.178	0.258	-0.008	0.002	-0.028	0.004	-0.012	0.034	-0.014	-0.005	-0.052
	(0.200)	(0.182)	(0.446)	(0.011)	(0.010)	(0.025)	(0.017)	(0.020)	(0.033)	(0.022)	(0.025)	(0.036)
Observations	68,223	46,371	21,852	68,223	46,371	21,852	38,256	26,221	12,035	38,096	26,169	11,927

Note. Standard errors in parentheses. *p<0.1, ** p<0.05, ***p<0.01. Models include walking distance to school, its interaction with transportation eligibility, student race, gender, economically disadvantaged status, and English Learner covariates and school-by-grade-by-year fixed effects. Standard errors are clustered at the school level. The sample includes student-year observations living within 0.4 miles of the transportation eligibility cutoff, my preferred bandwidth. Observations that are within either 0.01, 0.05, or 0.1 miles are excluded. Students are considered to be transportation eligible if students live farther than 1.5 miles walking distance from school. Walking distances are calculated from the population weighted centroid of the student's resident census block to their school's address assuming average traffic using Here API. Students are considered chronically absent if they miss more than ten percent of possible days in the school year. Math and English Language Arts (ELA) test scores on the Michigan Educational Assessment Program, MEAP, or the Michigan Student Test of Educational Progress, M-STEP are standardized within grade, subject and year. Econ. Dis. is an abbreviation for economically disadvantaged. In Michigan, students are considered economically disadvantaged if they qualify for free or reduced lunch, receive food (SNAP) or cash assistance (TANF), or they are homeless, migrant, or in foster care for economically disadvantaged students is likely not a result of my choices in functional form, bandwidth, estimator, and sample.

Falsification Test

Although my results are robust to many of my specification choices, there still may exist unobserved characteristics that are correlated with living 1.5 miles away from the schools in my sample, biasing my estimates. For example, if multi-family housing is located closer to schools while single family homes are more likely to be located past the walking distance cutoff, then my estimates could be biased by the effects of living in single family homes on my outcomes. To provide evidence that it is unlikely that living in the neighborhoods that are 1.5 miles away from the schools in my sample is correlated with unobserved factors that determine either attendance or achievement, I estimate the model represented by Equation 1 on the sample of elementary school students who attend their nearest school and live in a district in my sample that has a walking distance cutoff of 1.5 miles for middle schools but not for elementary schools. This sample provides an ideal test to falsify my results for two reasons. First, students in the placebo sample are not affected by the 1.5 mile cutoff that determines transportation eligibility in my main sample. Therefore, my results are likely biased if I detect a significant effect of transportation eligibility when I estimate my model on this sample. Second, the students in my placebo sample are very similar to those in my main sample because they live in the same neighborhoods and could even be in the same families as students in my main sample. Therefore, if there are family or neighborhood characteristics that are biasing my estimates of transportation eligibility, they should affect my placebo sample as well because they live in the same neighborhoods as my main sample.

To ensure that students in my placebo sample live in the same neighborhoods as those in my main sample, I use the walking distance from home to the nearest middle school in their resident district as my forcing variable in my falsification test. Therefore, I consider students in my placebo sample as treated if they live 1.5 miles or more from the middle school that they would attend, the same schools that students attend in my main sample.[22] I present the results of my falsification tests for each of my four outcomes for the full sample and the samples restricted to either economically advantaged or disadvantaged students in Table 26. For all outcomes and samples, I do not detect a statistically significant effect of transportation eligibility. Furthermore, most of the estimates are in the opposite direction of the main results. Thus, the results of this falsification test provide evidence it is likely that no unobserved characteristics associated with living in the neighborhoods in my sample are correlated with my treatment and predict my outcomes, giving more confidence that my models are estimating the causal effect of transportation eligibility.

Discussion

In this paper, I provide some of the first causal evidence of school transportation effects on student attendance and achievement. I find that being eligible for school bus transportation—the intent-to-treat (ITT) estimate of school bus use—decreases the probability of being chronically absent especially for economically disadvantaged students by two to four percentage points. Combined with prior research, my results show that the school bus can mitigate the

[22] I also estimate my falsification test using distance from home to the attended elementary school as the forcing variable. The results of this falsification test are similar to the results of the falsification test presented in Table 8 and are available by request. Because the elementary schools may be located in different neighborhoods than middle schools, students in the placebo sample considered treated using the distance to the attended school may be less likely to live in the same neighborhoods as the students in the main sample than the students in the placebo sample that are considered treated using the distance to the nearest middle school. Therefore, I prefer distance to middle school as the forcing variable determining treatment in my falsification test.

Table 26. Placebo Effects of Transportation Eligibility

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Attendance Rate			**Chronically Absent**			**Math Score**			**ELA Score**		
	Full Sample	**Not Econ. Dis.**	**Econ. Dis.**	**Full Sample**	**Not Econ. Dis.**	**Econ. Dis.**	**Full Sample**	**Not Econ. Dis.**	**Econ. Dis.**	**Full Sample**	**Not Econ. Dis.**	**Econ. Dis.**
Transportation Eligibility	-0.118	-0.075	-0.168	0.001	-0.006	0.013	-0.001	-0.007	0.002	-0.018	-0.012	-0.024
	(0.116)	(0.132)	(0.221)	(0.007)	(0.006)	(0.012)	(0.019)	(0.023)	(0.034)	(0.018)	(0.025)	(0.033)
Distance	0.248	-0.340	1.111	-0.000	0.020	-0.020	0.028	0.016	0.089	0.023	0.004	0.093
	(0.422)	(0.408)	(0.751)	(0.022)	(0.016)	(0.046)	(0.057)	(0.077)	(0.087)	(0.072)	(0.090)	(0.111)
Distance*Transport. Elig.	-0.094	0.990	-1.769	0.012	0.005	-0.002	-0.071	-0.015	-0.195*	-0.035	-0.042	-0.084
	(0.724)	(0.754)	(1.208)	(0.035)	(0.032)	(0.073)	(0.067)	(0.104)	(0.099)	(0.087)	(0.117)	(0.146)
Constant	96.24***	96.42***	94.49***	0.048***	0.035***	0.138***	0.197***	0.238***	0.021	0.131***	0.167***	-0.029
	(0.090)	(0.096)	(0.175)	(0.005)	(0.004)	(0.009)	(0.0144)	(0.018)	(0.023)	(0.018)	(0.023)	(0.026)
Observations	56,186	34,521	21,665	56,186	34,521	21,665	15,066	9,589	5,477	15,033	9,573	5,460
Adj R Squared	0.015	0.007	0.008	0.012	0.011	0.006	0.611	0.594	0.583	0.553	0.528	0.547

Note. Standard errors in parentheses. *p<0.1, ** p<0.05, ***p<0.01. Models include student race, gender, economically disadvantaged status, and English Learner covariates and school-by-grade-by-year fixed effects. Standard errors are clustered at the school level. The placebo sample includes student-year observations of elementary school students who attend their nearest school in their resident district, live in districts with a walking distance cutoff of 1.5 miles for middle school but not elementary school, and live within 0.4 miles of the transportation eligibility cutoff, my preferred bandwidth. Students are considered to be transportation eligible if students live farther than 1.5 miles walking distance from their nearest middle school. Walking distances are calculated from the population weighted centroid of the student's resident census block to their nearest middle school's address assuming average traffic using Here API. Students are considered chronically absent if they miss more than ten percent of possible days in the school year. Math and English Language Arts (ELA) test scores on the Michigan Educational Assessment Program, MEAP, or the Michigan Student Test of Educational Progress, M-STEP are standardized within grade, subject and year. Econ. Dis. is an abbreviation for economically disadvantaged. In Michigan, students are considered economically disadvantaged if they qualify for free or reduced lunch, receive food (SNAP) or cash assistance (TANF), or they are homeless, migrant, or in foster care.

negative effects of distance on attendance for low-income students. In particular, the large effects of transportation eligibility on chronic absenteeism for vulnerable students provide some compelling evidence that school-provided transportation most likely increases attendance for students who would regularly miss school without the school bus, in accordance with my hypothesis. However, my results show little evidence that district-provided transportation has an effect on student achievement. Although it is well-established that attendance is positively associated with achievement, the possible positive benefits of increased attendance on achievement due to the use of the school bus could be outweighed by the negative effects of long commutes or increased bullying, fighting, or participation in other undesirable social behaviors on the school bus.

For districts focused on increasing attendance rates, my findings may imply that at least maintaining existing bus routes, if not increasing the amount of transportation provided, could help curb chronic absenteeism. However, widespread provision of school transportation may not be the most cost-effective or efficient way to allocate this expensive resource since it has little effect on attendance for economically advantaged students or on achievement. Instead, districts concerned with reducing chronic absenteeism could implement means-tested school bus programs that provide transportation for free to all low-income students, similar to the National School Lunch Program. Additionally, districts could use school transportation as an intervention for chronically absent students. If it is identified that getting to school is a barrier to regular attendance for a particular student, schools could choose to provide that student transportation regardless of where they live.

Although I provide evidence that transportation eligibility reduces chronic absenteeism for low-income students, more evidence is needed in order to make any strong policy recommendations concerning transportation. First, my study generalizes largely only to districts located in cities and suburbs, not rural communities, since the districts in my sample have fewer economically disadvantaged students and mostly are suburban. In particular, I only estimate the effects of transportation eligibility for students living in a district with a 1.5 mile walking distance cutoff, local to the cutoff. The school bus likely has a larger effect in rural districts where half of students live at least ten minutes away from the nearest school by car (Edwards, in press). Furthermore, increasing access to school bus transportation may not raise attendance for students living within a half mile of their school since the burden of walking to school is much smaller for them than students living over a mile away from school.

Second, research concerning the effects of the school bus on other outcomes, the mechanisms that could explain variation in school bus effects, and the effectiveness of other modes of transit would help provide policymakers with a more complete picture of the effectiveness of district transportation when making decisions concerning its provision. For example, riding the bus could increase disciplinary incidents and lower other socioemotional outcomes which could outweigh its positive effects on attendance. Furthermore, the effects of the school bus on achievement as well as other outcomes may vary by time spent on the bus. Riding the school bus may make a child attend school more often, but the longer he or she spends on the bus, the more difficulty he or she may have concentrating at school, negatively affecting achievement and negating any of the attendance benefits of riding the bus on achievement. Additionally, other modes of transit, like public transportation or ridesharing services, could be more effective in getting students to school regularly. Finally, cost-effectiveness studies of school transportation are needed to determine whether the benefits of increasing or changing the provision of transportation would offset the high costs associated with the school bus. In conclusion, this paper provides a starting point for future work on the effects of school transportation, which I have shown to have meaningful effects on student attendance and chronic absence—an increasingly salient metric for education policy and decision-making.

APPENDIX

Table 27. Estimated Coefficients of Transportation Eligibility for Balance Tests, All Bandwidths and Splines

OUTCOMES	(1) Female	(2) White	(3) Black	(4) Hispanic	(5) Asian	(6) Other Race	(7) Econ. Dis.	(8) EL
Linear Spline								
0.5 Mile Bandwidth	0.004	0.023	-0.011	-0.007	0.002	-0.007	-0.003	0.000
	(0.0091)	(0.014)	(0.008)	(0.007)	(0.007)	(0.004)	(0.013)	(0.009)
0.4 Mile Bandwidth	-0.002	0.017	-0.003	-0.008	0.001	-0.008	0.006	-0.002
	(0.011)	(0.017)	(0.010)	(0.008)	(0.008)	(0.005)	(0.015)	(0.011)
0.3 Mile Bandwidth	0.010	0.023	-0.008	-0.019**	0.007	-0.003	-0.020	-0.003
	(0.011)	(0.020)	(0.011)	(0.010)	(0.012)	(0.006)	(0.017)	(0.012)
0.25 Mile Bandwidth	0.005	0.031	-0.012	-0.017*	0.005	-0.007	-0.022	-0.001
	(0.013)	(0.021)	(0.012)	(0.009)	(0.013)	(0.007)	(0.019)	(0.013)
0.2 Mile Bandwidth	-0.004	0.039	-0.014	-0.013	0.001	-0.013	-0.033	-0.003
	(0.016)	(0.024)	(0.013)	(0.011)	(0.014)	(0.008)	(0.020)	(0.013)
0.15 Mile Bandwidth	-0.010	0.030	-0.021	0.002	0.002	-0.013	-0.007	0.009
	(0.021)	(0.029)	(0.015)	(0.015)	(0.015)	(0.009)	(0.025)	(0.015)
Quadratic Spline								
0.5 Mile Bandwidth	0.007	0.019	-0.005	-0.010	0.001	-0.006	0.003	-0.004
	(0.014)	(0.022)	(0.012)	(0.009)	(0.013)	(0.007)	(0.021)	(0.014)
0.4 Mile Bandwidth	0.012	0.035	-0.017	-0.016	0.004	-0.006	-0.026	-0.003
	(0.016)	(0.024)	(0.014)	(0.010)	(0.015)	(0.008)	(0.023)	(0.014)
0.3 Mile Bandwidth	-0.012	0.037	-0.014	-0.001	-0.008	-0.014	-0.013	0.001
	(0.020)	(0.026)	(0.015)	(0.012)	(0.015)	(0.009)	(0.023)	(0.015)
0.25 Mile Bandwidth	-0.009	0.057**	-0.020	-0.000	-0.019	-0.017	-0.022	-0.005
	(0.022)	(0.029)	(0.016)	(0.014)	(0.017)	(0.011)	(0.025)	(0.016)
0.2 Mile Bandwidth	-0.011	0.038	-0.018	0.009	-0.011	-0.019	0.0113	0.005
	(0.0255)	(0.0325)	(0.0188)	(0.0159)	(0.0167)	(0.0123)	(0.0301)	(0.020)
0.15 Mile Bandwidth	-0.003	0.056	-0.014	0.000	-0.006	-0.037**	0.023	0.018
	(0.034)	(0.038)	(0.023)	(0.016)	(0.019)	(0.015)	(0.038)	(0.023)

Note. Standard errors in parentheses. *p<0.1, ** p<0.05, ***p<0.01. Models include walking distance to school, its interaction with transportation eligibility, and school-by-grade-by-year fixed effects. Standard errors are clustered at the school level. In the models with a quadratic spline, I also include a quadratic term of walking distance and its interaction with transportation eligibility. Students are considered to be transportation eligible if students live farther than 1.5 miles walking distance from school. Walking distances are calculated from the population weighted centroid of the student's resident census block to their school's address assuming average traffic using Here API. Econ. Dis. and EL are abbreviations for economically disadvantaged and English Learner respectively. In Michigan, students are considered economically disadvantaged if they qualify for free or reduced lunch, receive food (SNAP) or cash assistance (TANF), or they are homeless, migrant, or in foster care.

Table 28. Estimated Coefficients of Transportation Eligibility, All Bandwidths and Splines

	(1)	(2)	(3)	(4)
	Attendance Rate	**Chronically Absent**	**Math Score**	**ELA Score**
Linear Spline				
0.5 Mile Bandwidth	0.175	-0.014**	-0.005	0.005
	(0.108)	(0.005)	(0.009)	(0.009)
0.4 Mile Bandwidth	0.197*	-0.015***	-0.004	0.009
	(0.119)	(0.006)	(0.010)	(0.011)
0.3 Mile Bandwidth	0.306**	-0.015**	0.002	0.017
	(0.142)	(0.007)	(0.011)	(0.013)
0.25 Mile Bandwidth	0.289*	-0.012	-0.001	0.021
	(0.159)	(0.008)	(0.012)	(0.014)
0.2 Mile Bandwidth	0.363*	-0.014	-0.004	0.024
	(0.202)	(0.010)	(0.014)	(0.015)
0.15 Mile Bandwidth	0.354	-0.016	-0.008	0.031
	(0.233)	(0.012)	(0.018)	(0.020)
Quadratic Spline				
0.5 Mile Bandwidth	0.299*	-0.016**	-0.002	0.016
	(0.160)	(0.008)	(0.012)	(0.015)
0.4 Mile Bandwidth	0.362**	-0.017*	-0.005	0.018
	(0.184)	(0.010)	(0.014)	(0.016)
0.3 Mile Bandwidth	0.358	-0.015	-0.013	0.015
	(0.221)	(0.012)	(0.016)	(0.017)
0.25 Mile Bandwidth	0.461*	-0.021	-0.009	0.020
	(0.252)	(0.013)	(0.019)	(0.021)
0.2 Mile Bandwidth	0.312	-0.017	-0.019	0.012
	(0.269)	(0.014)	(0.023)	(0.023)
0.15 Mile Bandwidth	0.528*	-0.025	-0.026	-0.013
	(0.308)	(0.017)	(0.028)	(0.027)

Note. Standard errors in parentheses. *p<0.1, ** p<0.05, ***p<0.01. Models include walking distance to school, its interaction with transportation eligibility, student race, gender, economically disadvantaged status, and English Learner covariates and school-by-grade-by-year fixed effects. Standard errors are clustered at the school level. In the models with a quadratic spline, I also include a quadratic term of walking distance and its interaction with transportation eligibility. Students are considered to be transportation eligible if students live farther than 1.5 miles walking distance from school. Walking distances are calculated from the population weighted centroid of the student's resident census block to their school's address assuming average traffic using Here API. Students are considered chronically absent if they miss more than ten percent of possible days in the school year. Math and English Language Arts (ELA) test scores on the Michigan Educational Assessment Program, MEAP, or the Michigan Student Test of Educational Progress, M-STEP are standardized within grade, subject and year.

Table 29. Heterogeneous Effects by Economically Disadvantaged Status, All Bandwidths and Splines

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Attendance Rate		**Chronically Absent**		**Math Score**		**ELA Score**	
	Not Econ. Dis.	**Econ. Dis.**	**Not Econ. Dis.**	**Econ. Dis.**	**Not Econ. Dis.**	**Econ. Dis.**	**Not Econ. Dis.**	**Econ. Dis.**
Linear Spline								
0.5 Mile Bandwidth	-0.018	0.576**	-0.003	-0.036***	-0.007	-0.004	0.005	0.003
	(0.091)	(0.259)	(0.004)	(0.012)	(0.011)	(0.016)	(0.011)	(0.018)
0.4 Mile Bandwidth	-0.011	0.661**	-0.003	-0.040***	-0.010	0.006	0.004	0.013
	(0.105)	(0.285)	(0.005)	(0.014)	(0.012)	(0.017)	(0.013)	(0.022)
0.3 Mile Bandwidth	0.075	0.805**	-0.004	-0.037**	-0.006	0.020	0.010	0.039
	(0.121)	(0.378)	(0.006)	(0.018)	(0.014)	(0.020)	(0.015)	(0.027)
0.25 Mile Bandwidth	0.077	0.764*	-0.001	-0.034	-0.012	0.020	0.016	0.031
	(0.133)	(0.408)	(0.007)	(0.021)	(0.014)	(0.023)	(0.015)	(0.031)
0.2 Mile Bandwidth	0.217	0.891	-0.007	-0.035	-0.006	0.006	0.016	0.037
	(0.152)	(0.563)	(0.008)	(0.028)	(0.016)	(0.026)	(0.018)	(0.035)
0.15 Mile Bandwidth	0.274	0.797	-0.009	-0.039	0.004	-0.021	0.026	0.037
	(0.173)	(0.686)	(0.009)	(0.034)	(0.022)	(0.034)	(0.025)	(0.040)
Quadratic Spline								
0.5 Mile Bandwidth	0.074	0.880**	-0.004	-0.043**	-0.010	0.011	0.010	0.029
	(0.141)	(0.364)	(0.007)	(0.018)	(0.015)	(0.021)	(0.016)	(0.031)
0.4 Mile Bandwidth	0.162	0.852*	-0.006	-0.040	-0.007	-0.003	0.008	0.042
	(0.153)	(0.449)	(0.008)	(0.024)	(0.015)	(0.024)	(0.017)	(0.036)
0.3 Mile Bandwidth	0.142	0.963*	-0.003	-0.043	-0.011	-0.018	0.009	0.036
	(0.172)	(0.581)	(0.009)	(0.032)	(0.018)	(0.031)	(0.020)	(0.036)
0.25 Mile Bandwidth	0.258	1.133	-0.010	-0.050	0.006	-0.028	0.012	0.045
	(0.187)	(0.695)	(0.009)	(0.036)	(0.022)	(0.034)	(0.025)	(0.040)
0.2 Mile Bandwidth	0.165	0.939	-0.007	-0.049	0.003	-0.047	0.001	0.029
	(0.218)	(0.722)	(0.010)	(0.041)	(0.026)	(0.047)	(0.027)	(0.046)
0.15 Mile Bandwidth	0.421*	1.048	-0.016	-0.053	-0.011	-0.030	-0.033	-0.003
	(0.251)	(0.900)	(0.012)	(0.054)	(0.029)	(0.068)	(0.032)	(0.060)

Note. Standard errors in parentheses. *p<0.1, ** p<0.05, ***p<0.01. Models include student race, gender, and English Learner covariates and school-by-grade-by-year fixed effects. Standard errors are clustered at the school level. In the models with a quadratic spline, I also include a quadratic term of walking distance and its interaction with transportation eligibility. Students are considered to be transportation eligible if students live farther than 1.5 miles walking distance from school. Walking distances are calculated from the population weighted centroid of the student's resident census block to their school's address assuming average traffic using Here API. Students are considered chronically absent if they miss more than ten percent of possible days in the school year. Math and English Language Arts (ELA) test scores on the Michigan Educational Assessment Program, MEAP, or the Michigan Student Test of Educational Progress, M-STEP are standardized within grade, subject and year. Econ. Dis. is an abbreviation for economically disadvantaged. In Michigan, students are considered economically disadvantaged if they qualify for free or reduced lunch, receive food (SNAP) or cash assistance (TANF), or they are homeless, migrant, or in foster care.

Table 30. Estimated Effects of Transportation Eligibility, Non-Parametric Approach

	(1)	(2)	(3)	(4)	(5)	(6)
	Attendance Rate			**Chronically Absent**		
	Full Sample	**Not Econ. Dis.**	**Econ. Dis.**	**Full Sample**	**Not Econ. Dis.**	**Econ. Dis.**
Conventional Estimate	0.413***	0.068	0.992***	-0.019***	-0.003	-0.048***
	(0.157)	(0.109)	(0.360)	(0.006)	(0.005)	(0.013)
Robust and Bias-Corrected Estimate	0.408**	0.076	1.002***	-0.021***	-0.004	-0.052***
	(0.164)	(0.127)	(0.361)	(0.007)	(0.006)	(0.015)
N	380,909	238,248	142,661	380,909	238,248	142,661
Effective N	95,782	89,341	36,155	112,374	65,789	39,871
Bandwidth for Estimate	0.411	0.572	0.483	0.486	0.415	0.530
Bandwidth for Bias Correction	0.655	0.913	0.719	0.764	0.683	0.864

Note. Standard errors in parentheses. *p<0.1, ** p<0.05, ***p<0.01. Models include student race, gender, economically disadvantaged status, and English Learner covariates and district, grade, and year fixed effects. Standard errors are clustered at the school level. Bandwidths are in miles. Optimal bandwidths and bias-corrected and robust estimates are calculated using the procedures proposed by Calonico, Cattaneo, and Titiunik (2014) and Calonico, Cattaneo, and Farrell (2020). Students are considered to be transportation eligible if students live farther than 1.5 miles walking distance from school. Walking distances are calculated from the population weighted centroid of the student's resident census block to their school's address assuming average traffic using Here API. Students are considered chronically absent if they miss more than ten percent of possible days in the school year. Econ. Dis. is an abbreviation for economically disadvantaged. In Michigan, students are considered economically disadvantaged if they qualify for free or reduced lunch, receive food (SNAP) or cash assistance (TANF), or they are homeless, migrant, or in foster care.

Figure 12. Distribution of Observations without Mobile Home Park Census Block

Figure 12A: 0.01 Mile Bin Size

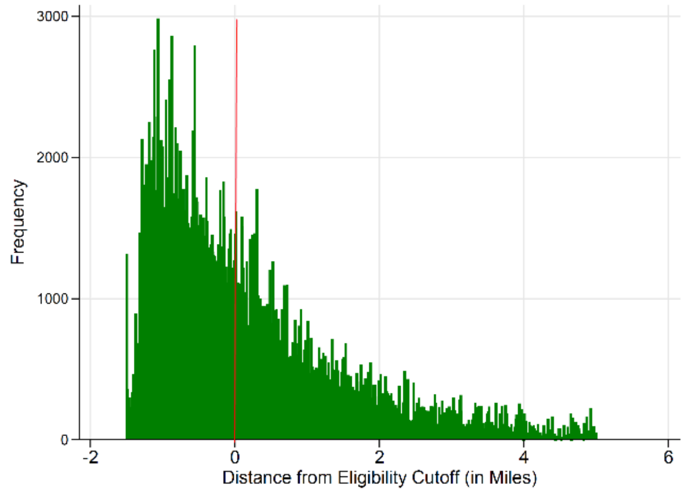
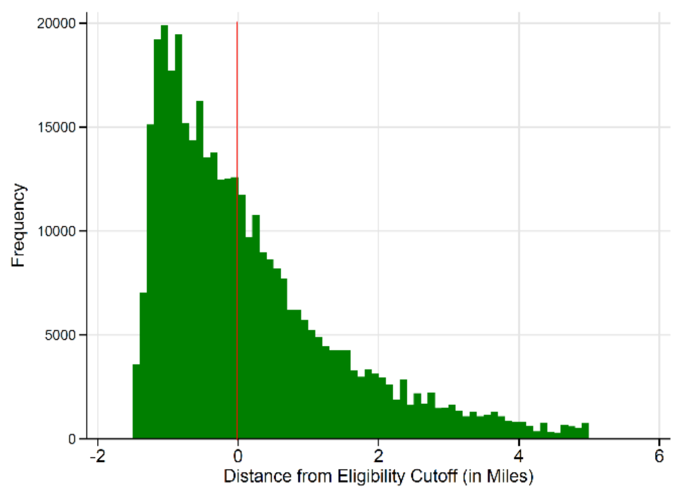


Figure 12B: 0.1 Mile Bin Size



Note. Sample includes observations of students in the analytic sample living between zero and five miles from their attended school excluding the census block containing Independence Woods Mobile Home Park.

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