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An Examination Of Student Mobility In U.s. Public Schools

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Abstract
Student mobility—the event of students moving into and out of schools—is prevalent and has established negative relationships with both academic and non-cognitive outcomes for mobile students and the classrooms and schools that serve them. Despite this, there is a dearth of research examining student mobility, and, in particular, only a sparse literature that allows for causal interpretations of the causes and consequences of student mobility. The research presented in this dissertation aims to address some of the gaps in the literature on student mobility. Chapter one of the dissertation presents a framework that defines student mobility and outlines the relationships between causes and consequences of mobility within different contexts. Chapter two uses the Early Childhood Longitudinal Study-Kindergarten cohort to explore student- and school-level correlates of mobility, as well as relationships between mobility and academic achievement. In chapters three and four, I empirically examine student mobility in the context of charter schools. In chapter three I use data from the Evaluation of Charter School Impacts to estimate the effect of charter school admissions and attendance on student mobility. Chapter four uses statewide data from Colorado to explore student mobility within the traditional and charter school sectors. Together I find that: 1) rates of mobility vary based on student background characteristics and indicators of school quality, 2) students who won admissions to charter middle schools were less likely to experience mobility than their peers who lost admissions lotteries, 3) mobility rates in Colorado's charter schools are higher than in TPSs in the state, both descriptively and after controlling for school characteristics, and 4) the motivation for student mobility and the relative quality of students' sending and receiving schools are important moderators of mobility's relationship with student achievement.

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ABSTRACT

AN EXAMINATION OF STUDENT MOBILITY IN U.S. PUBLIC SCHOOLS

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Student mobility—the event of students moving into and out of schools—is prevalent and has established negative relationships with both academic and non-cognitive outcomes for mobile students and the classrooms and schools that serve them. Despite this, there is a dearth of research examining student mobility, and, in particular, only a sparse literature that allows for causal interpretations of the causes and consequences of student mobility. The research presented in this dissertation aims to address some of the gaps in the literature on student mobility. Chapter one of the dissertation presents a framework that defines student mobility and outlines the relationships between causes and consequences of mobility within different contexts. Chapter two uses the Early Childhood Longitudinal Study-Kindergarten cohort to explore student- and school-level correlates of mobility, as well as relationships between mobility and academic achievement. In chapters three and four, I empirically examine student mobility in the context of charter schools. In chapter three I use data from the Evaluation of Charter School Impacts to estimate the effect of charter school admissions and attendance on student mobility. Chapter four uses statewide data from Colorado to explore student mobility within the traditional and charter school sectors. Together I find that: 1) rates of mobility vary based on student background characteristics and indicators of school quality, 2) students who won admissions to charter middle schools were less likely to experience mobility than their peers who lost admissions lotteries, 3) mobility rates in Colorado's charter schools are higher than in TPSs in the state, both descriptively and after controlling for school characteristics,

and 4) the motivation for student mobility and the relative quality of students' sending and receiving schools are important moderators of mobility's relationship with student achievement.

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Student mobility is a phenomenon that refers to the event of students moving into and out of schools. Thirty-four percent of fourth graders participating in the mathematics portion of the National Assessment of Educational Progress (NAEP) 1998 changed schools at least one time in the two years prior (Rumberger, 2003), and during the 1990–91 school year 17 percent of third graders had attended three or more schools since the first grade (United States General Accounting Office, 1994). And these figures do not capture the most prevalent type of mobility, that which is built into our schooling system when students move from elementary to middle school and again when they enter high school—this structural mobility impacts the majority of students (Meyer, 2011).

Student mobility is prevalent and has established negative relationships with both academic and non-cognitive outcomes for mobile students, as well as the classrooms and schools that serve them (Mehana & Reynolds, 2004; Raudenbush, Jean, & Art, 2011; Thomas B. Fordham Institute, 2012). However, additional evidence shows that under the right circumstances, such as a move from a low-performing school to a high-performing school, mobility may in fact improve students' academic performance (de la Torre & Gwynne, 2009). Because of its prevalence and demonstrated association with other important educational outcomes, it is important to explore student mobility as both a result of decisions made within families, schools, and at the policy level and a mediator of other key phenomena. Despite this, there is a dearth of research examining student mobility, and, in particular, only a sparse literature that does so in a way to allow for causal interpretations of the consequences of student mobility (Thomas B. Fordham Institute, 2012).

This dissertation aims to help fill the need for more research in the field by improving our understanding of how behaviors and conditions of students and their families, schools, and policies result in varying mobility circumstances, and how these different circumstances are differentially related to harmful outcomes. Chapter One of this dissertation lays out a framework detailing the causes and consequences of student mobility of varying types and circumstances. The chapter also reviews prior literature to establish different definitions of student mobility and identify student-, school-, and policy-level causes of student mobility. The literature review will also explore the proximal and distal consequences of mobility for students, classrooms, and schools. This framework will then be used to guide the empirical analysis presented in Chapters Two through Four.

In Chapter Two, I use nationally representative data from the Early Childhood Longitudinal Study set to examine rates of different types of mobility and to explore, both descriptively and through predictive modeling, student- and school-level predictors of different types of mobility. I then go on to explore the consequences of student mobility by examining the relationship between mobility of differing types and later student achievement.

In Chapters Three and Four, I empirically examine student mobility in the context of charter schools. Charter schools—public schools that are subject to less oversight and regulation than traditional public schools (TPSs)—have become prominent in the education landscape (Ravitch, 2010). Student mobility may operate differently in these schools than in TPSs given the potential differences in the policy context and school characteristics of charter schools. Furthermore, there is the inherent student mobility built into the conceptualization of school choice; with increased schooling options in school choice systems, students can change schools to find one that better meets their personal needs if their current one is not suitable (Dauter & Fuller, 2011; Lubienski, Gulosino, & Weitzel, 2009). It is essential to understand how charter schools—as one of the primary educational reforms that are shaping the public school system in the United

States—impact important educational outcomes, student mobility among them. In Chapter Three, I use data from the Evaluation of Charter School Impacts, which utilizes the results of charter admissions lotteries as a natural experiment to explore causal links between charter schools and student mobility among middle school students. In Chapter Four, I use administrative records from the state of Colorado to examine rates of student mobility in charters and TPSs across different student and school characteristics.

Together I find that: 1) rates of mobility vary based on student background characteristics and indicators of school quality, 2) students who won admissions to charter middle schools were less likely to experience mobility than their peers who lost admissions lotteries, 3) mobility rates in Colorado's charter schools are higher than in TPSs in the state, both descriptively and after controlling for school characteristics, and 4) the motivation for student mobility and the relative quality of students' sending and receiving schools are important moderators of mobility's relationship with student achievement.

II. CHAPTER ONE – UNPACKING STUDENT MOBILITY: DEFINITIONS, PREDICTORS, AND CONSEQUENCES

Introduction

A dearth of studies focus on student mobility. This despite student mobility's associations—both negative and positive—with important educational outcomes, as well as the large numbers of students who experience mobility over the course of their K–12 educations. Thirty-four percent of third graders taking the NAEP math assessment in 1998 had changed schools at least once in the prior two years (Rumberger, 2003).

In particular, we lack a well-conceptualized framing of associations between different types of student mobility, what motivates them to occur, and the different consequences that may be the result. When one accounts for variants in the motivators, types, and consequences of student mobility, the complexity of this phenomenon becomes apparent and the utility of a well-conceived framing of these considerations is clear.

To illustrate this complexity, consider three examples: First, students and their families may opt to engage in student mobility if an increase in income results in access to a private school that was previously unattainable due to the cost of tuition. Second, schools can generate student mobility through the expulsion of students. Third, a policy may prescribe the closure of low-performing schools and the relocation of students in these schools to other facilities. Each of these potential motivators of student mobility would result in a different type of student mobility—voluntary, structural, and involuntary, respectively. In turn these different mobility circumstances, arising in different types of mobility, may ultimately result in different consequences. The student transferring to the private school, as well those involuntarily moved from low-performing schools into ostensibly higher-performing ones, may experience a boost in the quality of their schools, their peers, and their access to services and programs that may ultimately improve their academic performance. The expelled students, however, may find themselves with limited or nonexistent schooling options that may in turn impede their academic progress. As these examples demonstrate, student mobility type, motivation, and consequences are all interrelated, and taking into account variation across these domains is important for establishing a nuanced understanding of student mobility.

In this chapter, I will address the gap in the literature on student mobility by first presenting a framework that outlines the relationships between different types of student mobility and their motivators and consequences, and then provide additional descriptions and background information about each element of this framework based on prior literature. The formal framing of relationships between the motivators and consequences of student mobility may help to guide others' pursuit of research on student mobility and will be used as the foundation of empirical work in the remainder of this dissertation.

Relational Framework of Student Mobility

The types, motivators, and consequences of student mobility vary, as will be described in detail below. These variables are crucial to take into account when interpreting the results of student mobility studies, and are important to account for, when possible, when designing a study on this topic. The type, motivators, and consequences of student mobility are interrelated, with different motivators resulting in different types of mobility, and different types of mobility resulting in different consequences. Based on the prior literature, the details of which are presented in the following sections of this chapter, I present, in Figure II.1, a framework that depicts the relationships and considerations that are important to consider in a study of student mobility. The framework depicts how different types of mobility—structural vs. nonstructural, voluntary vs.

involuntary, reactive and strategic—are caused by differing mobility motivators and result in varying consequences. Figure II.1 also depicts other factors that must be considered in mobility studies: 1) the direct relationship between some of student mobility's motivators—such as a change in family income—and the distal outcomes of student mobility, 2) the presence of variables—in particular student demographic and school compositional characteristics—that may be correlated with the motivators, type, and consequences of student mobility, and 3) the potential impacts of operational considerations—e.g., entrances vs. exits, within- vs. between-year mobility—on each aspect of the mobility pathway.

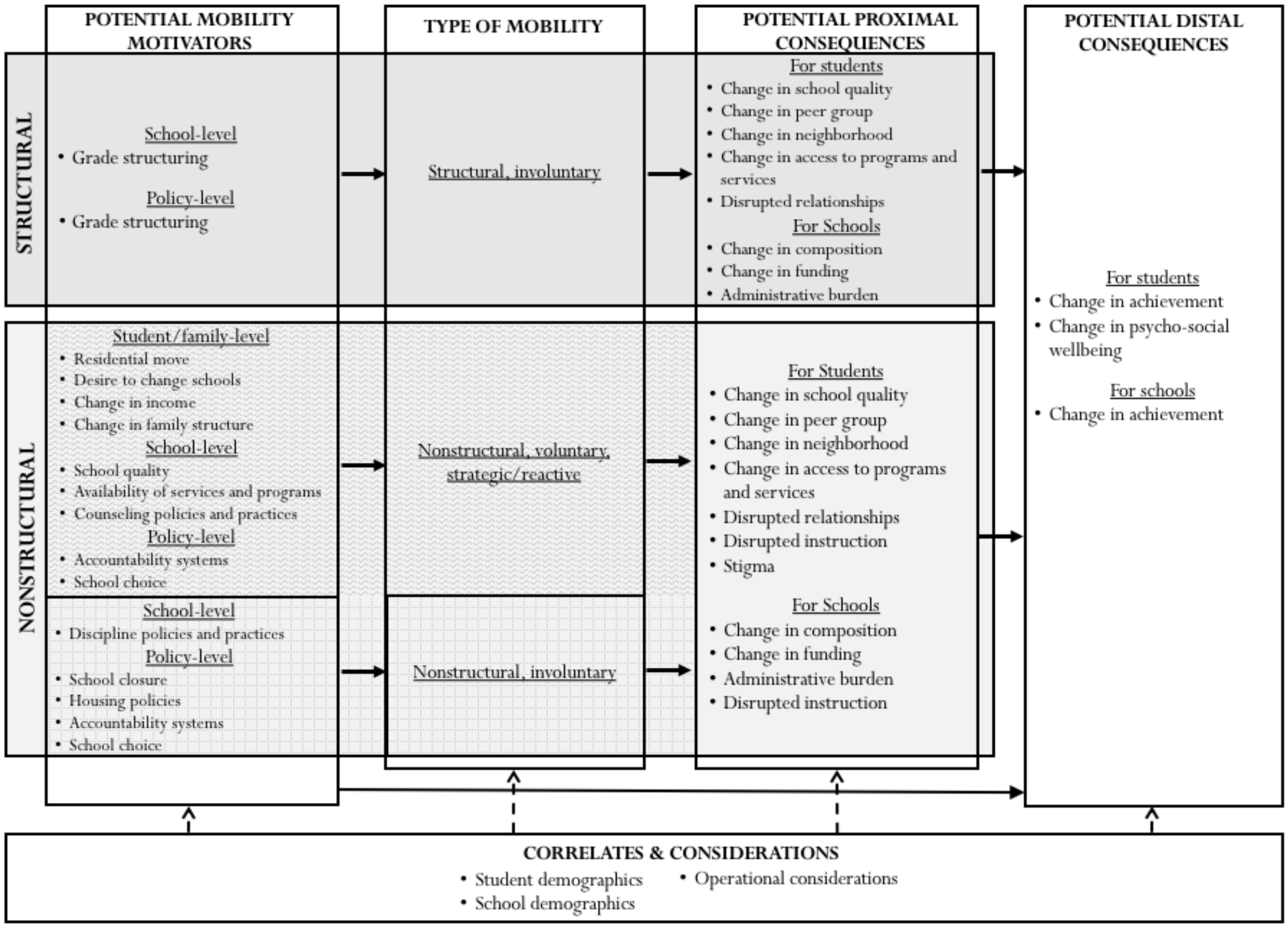

Figure II.1. Relational framework for student mobility.

Defining Types and Variants of Student Mobility

In its broadest definition, student mobility is the movement of students into and out of schools. The literature addressing student mobility uses different terminology to discuss such movements. *Student turnover*, *attrition*, *retention*, *dropout*, *school switches*, *exits*, and *entrances* are all terms used to denote student mobility. Some studies use one or more of these terms in addition to, or instead of, the term "mobility" to describe the phenomenon. These differences in nomenclature are often linked to variation in how mobility is defined and operationalized. In most studies, the broad definition of student mobility provided above is tailored to the particularities of a given study. Table II.1 describes the primary distinctions in types of student mobility, as well as other mobility characteristics that are important in considering student mobility studies. Variation in working definitions of student mobility is driven largely by researchers' questions and theories and by the data available to them. This variation is important in the development and interpretation of studies of student mobility, and the key distinctions in defining student mobility listed in Table II.1 are described in greater detail below.

Table II.1

Student Mobility Definitions and Distinctions

Student Mobility Variants	Description
Reasons for Mobility	
Structural vs. nonstructural	**Structural**: mobility that results from the completion of the highest grade offered in a school (e.g., between elementary and middle school and between middle and high school). **Nonstructural**: mobility that is not structural, i.e., mobility that occurs at some time other than the completion of a school's terminal grade.
Voluntary vs. involuntary	**Voluntary:** student mobility that is initiated by a student or the student's family. **Involuntary:** student mobility that is mandated by a school or policy, e.g., expulsions or school closures.
Strategic vs. reactive	**Strategic:** mobility initiated by a student or the student's family for the purpose of gaining access to improved schooling opportunities, e.g., a residential move made to gain access to a higher-performing school district. **Reactive:** mobility necessitated by circumstances not directly related to the pursuit of improved schooling opportunities, e.g., a job loss that makes tuition unaffordable and thus necessitates a transfer.
Operational Definitions of Mobility	
Exits vs. entrances	**Exit**: mobility *out* of a school, i.e., a student unenrolling at a school. **Entrance**: mobility *into* a school, i.e., a student enrolling in a new school.
Switches vs. dropouts	**Switch:** when a student exits one school and enrolls in another, i.e., the mobility incidence involves both an exit and an entrance. **Dropout:** when a student exits his or her school but does not enroll in a new school, i.e., the mobility incident includes an exit, but not an entrance.
Between-year vs. within-year	**Between-year:** mobility that occurs after the completion of one school year and before the start of the next. **Within-year:** mobility that occurs in the midst of a school year.

Structural and *nonstructural* mobility are the most common distinction researchers make when studying student mobility. Structural mobility occurs when a student completes the terminal grade at his or her school and must therefore move on to a different school that serves a higher grade levels. A good general definition of nonstructural, or nonpromotional, mobility is presented in a 2012 report by the Thomas B. Fordham Institute: "[Non-structural s]tudent mobility is the phenomenon of students in grades K–12 changing schools for reasons other than customary promotion from elementary school to middle school or from middle school to high school" (p. 13). Much student mobility is structural, a feature of the way schooling is organized, but frequently this movement is not of interest in studies of mobility. Researchers are often interested in studying nonstructural mobility specifically, rather than examining the mobility that is built into the institutional structure of the education system, because this type of mobility is more directly influenced by the behaviors and qualities of students and schools and may be more closely related to other outcomes of interest.

Another key distinction is between *voluntary* and *involuntary* mobility. Voluntary student mobility is instigated by a student and his or her family. Involuntary student mobility is mandated by a school or a larger agent of policy. Examples of voluntary mobility include mobility that results from a student's residential move or from the decision to take advantage of alternate schooling choices. Mobility that is precipitated by an expulsion or the closure of a school would be examples of involuntary mobility. In the case of involuntary mobility, a student and his or her family are not given the option to remain in their school. Structural mobility is necessarily involuntary, while nonstructural mobility may be either voluntary or involuntary.

Strategic and *reactive* mobility form a further distinction between types of mobility. When families initiate student mobility—that is, make a voluntary move—these school changes can be either strategic or reactive (Dauter & Fuller, 2011). Strategic moves are those school changes motivated by a desire to seek out better learning opportunities—e.g., mobile students who made a residential move or enrolled in a charter school in order to seek a school with higher academic achievement or a special program or club. Strategic moves should ostensibly result in enrollment in a school that is an improvement over the sending school in some way—e.g., academic achievement, safety—deemed important to the student and his or her family. Reactive moves, on the other hand, are school changes that follow from circumstances unrelated to the pursuit of higher-quality educational options—e.g., students who made a residential move that was necessitated by a job loss in the family or parental divorce. Because this type of student mobility is not made in order to attain improved schooling options, it is more likely to result in a change in school quality that is negative or neutral and less likely to result in a positive quality change than a strategic move. For these reasons, when concerned with identifying which students are most at risk of being mobile, or in examining the impact of mobility on educational outcomes, it is meaningful to distinguish between strategic and reactive moves; these two types of mobility will arise from different circumstances and may likely result in different outcomes. Unfortunately, the data available for studying student mobility often do not allow for this important distinction to be made.

It is important to consider other aspects of student mobility in addition to distinctions between structural and nonstructural mobility, voluntary and involuntary mobility, and strategic and reactive mobility. One such aspect is whether or not the measure of student mobility includes student exits, student entrances, or both. Broadly defined, student mobility occurs both when students *leave their school* and when they *enter a new one*, but many studies only examine one direction of mobility. Data availability and study objectives are two primary reasons that determine whether student entrances and/or exits are included in mobility measures. Commonly, studies on student mobility examine only student exits from their schools (e.g., Zimmer & Guarino, 2013). For example, a study may examine only student exits because the data set being used does not include sufficient data on student entrances or because researchers have framed their study such that only student exits, not entrances, are relevant—e.g., a study of student dropouts. In other studies, researchers explore both student exits from and entrances into schools (Dauter & Fuller, 2011). For example, a study may be interested in describing how shifting enrollments caused by student exits and entrances change the makeup of a school over the course of a school year.

Yet another characteristic of mobility studies is the distinction between school switches and dropouts. When a student exits his or her school for either structural or nonstructural reasons, he or she may either *switch* to a different school or *drop out* of school altogether. Switches occur at all grade levels and can result from decisions made by students and their families, schools, or changes in policy that impact enrollment. The choice to drop out, on the other hand, tends to occur in the later grades of schooling and is nearly always the result of decision-making on the part of the student or his or her family. In each state and in Washington, DC, laws mandate the age to which schooling is compulsory for all children; this age ranges from 16 to 18 (U.S. Department of Education, Institute of Education Sciences, 2013), so dropouts are typically studied among high school students. Even though choosing to forgo enrollment in a new school is a decision made by a student and his or her family, the initial exit from school may result from school- or policy-based circumstances. Students who drop out may permanently refrain from enrollment in school, or they may choose to reenter school at some point in the future.

School mobility that occurs between school years and that which occurs during the school year create another distinction frequently discussed in the literature on student mobility. When students engage in mobility between school years, they complete an entire school year at their sending school before enrolling at a new school—for either structural or nonstructural reasons—or dropping out altogether. Students who engage in within-school-year mobility, on the other hand, switch schools or drop out during the course of a school year. Relative to between-school-year mobility, within-school-year mobility may cause greater instructional disruption for the mobile student as well as his or her sending and receiving schools, resulting in an increased risk of negative impacts on achievement for mobile students and their peers (Kerbow, Azcoitia, & Buell, 2003). Between-school-year mobility may also be less likely to be reactive (see below) in nature than within-school-year mobility. Because of these distinctions, it can be insightful to consider the timing of student mobility when examining its motivators and consequences.

Researchers must keep these definitions and distinctions in mind when studying the motivators and consequences of student mobility. Most studies on student mobility explore only certain cases of student mobility, and the focus of a given study should influence the interpretation of their findings because it limits the extent to which findings may be generalizable to other student mobility circumstances. Different types of mobility are likely to arise from different circumstances and in turn are likely to result in different consequences for mobile students and their schools. These relationships will be described in the framework presented in this chapter.

Motivators of Student Mobility

Just as there are many definitions of student mobility, the motivators of student mobility are also varied. Table II.2 outlines motivators of student mobility. The motivators arise from three levels of influence: students and their families, schools, and the larger policy context.

Table II.2

Motivators of Student Mobility

Source	Description
Student/family	The majority of nonstructural student mobility events are a consequence of decisions or circumstances of students and their families. Student mobility initiated by students and their families may result from: • Residential moves • Desire to change schools • Change in financial resources • Change in family structure
School	School policies, practices, and conditions influence student mobility rates. Schools may impact mobility indirectly by influencing the enrollment choices of students and their families through: • School quality • Available services and programs • Counseling policies and practices Further, schools may directly cause student mobility by impacting involuntary mobility through: • Discipline policies and practices • Grade structuring

Origin of Mobility	Description
Policy	Student mobility may be directly impacted by administrative and policy decisions made at the district, state, or national level through: • Grade structuring • School closure • Housing polices Policies may also indirectly impact voluntary and involuntary mobility if they result in changes to school practices and quality or lead students and their families to consider switching schools. Such policies include: • Accountability systems • School choice These policies may influence student mobility both through school conditions and practices and through student/family schooling choices.

Residential moves are the primary source of nonstructural student mobility, according to the research. The exact percentage of nonstructural mobility attributable to residential mobility varies across studies—58 percent according to both a study of mobility among high school students in California (Rumberger, 2003) and a study of mobility among elementary students in Chicago (Kerbow, 1996), and 70 percent according to a national study of mobility among high school students (Rumberger & Larson, 1998). Despite this variation, residential moves remain the predominant motivator. This finding is not surprising in light of census data that demonstrated that

35 percent of the US population moved residences over the five years between 2005 and 2010 (Ihrke & Faber, 2012).

Sometimes, it is a desire to change schools that motivates a residential move. In a study of mobility among high school students, Rumberger (2003) found that the second most cited reason for a school switch was that students asked to be moved to a new school, either to take advantage of a particular academic program; to attend a different public, private, or magnet school; or for some other reason. Students and their families may choose to engage in voluntary mobility in order to seek out a schooling option they feel will be a better fit. Mobility motivated by the desire to seek out a new school may or may not occur jointly with a residential move. Unfortunately, a limitation in the current literature is a lack of information on the extent to which schooling decisions are a motivating factor in residential moves. For example, descriptive evidence from the National Longitudinal Study of Youth and the Current Population Survey suggests that residential changes are most frequently motivated by housing-related decisions, changes in family structure, and job-related changes (Hanushek, Kain, & Rivkin, 2004; Schachter, 2001). While these studies describe several potential motivations for a residential move, they do not examine the role of schooling in these decisions.

Changes in family financial resources or structure may also cause student mobility. A job loss or divorce, for example, may force a family to make a reactive school change if the family is no longer able to afford tuition or must sell their family home and move to a new location. On the other hand, if a parent is promoted or a new wage earner enters the household, a student and his or her family may be able to make a strategic school switch. This move could include a residential move into a better school district or a move into a private school that was previously unaffordable.

With each of the student/family motivators of student mobility, it is important to consider these factors in the context of other student and family characteristics that are associated with differences in mobility rates. These characteristics are related to the student and family motivators of student mobility but are not likely to be direct causes of mobility themselves. For example, student and family characteristics may be associated with the likelihood of residential mobility. Compared to the national average of a 35 percent residential mobility rate between 2005 and 2010, Blacks and Hispanics moved at a rate of 43 percent over the same period, and those who lived in rental housing moved at a rate of 66 percent (compared to less than 25 percent of those in owner-occupied housing), based on census data (Ihrke & Faber, 2012). Being a minority student or living in rental housing does not itself cause student mobility. However, because these characteristics are associated with higher rates of residential mobility, which often does motivate student mobility, it is important to account for these and other characteristics of students and their families that are associated with the likelihood that a student will experience mobility.

In addition, studies have found that Black and Hispanic students, English language learners (ELLs), low-income students, students with disabilities, students with low academic achievement and engagement, students who have been retained in a grade, younger students, students who live in urban areas, students from single-parent households, and students with low parental education levels are all more prone to mobility than their peers (Dauter & Fuller, 2011; de la Torre & Gwynne, 2009; Fong, Bae, & Huang, 2010; Jimerson, Anderson, & Whipple, 2002; Rumberger & Larson, 1998; Temple & Reynolds, 2000). Again, these characteristics are not direct causes of student mobility, but they are related to a higher incidence of student mobility through their association with social, economic, and other circumstances that lead some families to be more prone to mobility than others. In all, these findings from descriptive and predictive research demonstrate that students from disadvantaged backgrounds, of racial and ethnic minorities, with less stability in their homes, and with less engagement with the social and academic aspects of school are more likely to be mobile. These studies highlight associations between student characteristics and student turnover that are important to consider when examining mobility, in addition to direct motivators of student mobility that arise from students and their families.

While evidence suggests that the majority of student mobility incidents are initiated by students and their families, schools can influence this decision to change schools in many ways. For one, the decision to change schools may be motivated by the quality of the sending and/or receiving schools. Higher-quality schools may experience lower rates of student attrition—students unenrolling from their school—if students and their families are more satisfied with their schooling, compared to poorer-quality schools. For example, using the National Education Longitudinal Study (NELS) data, Rumberger and Thomas (2000) find that high schools with higher-quality teachers had lower rates of dropouts and school switches, after controlling for student characteristics. Further, schools with higher mean salaries for teachers also had lower rates of student mobility. Rumberger and Thomas (2000) also tested whether mobility rates were different for public and private schools. They found that Catholic and other private schools had lower rates of dropout than public schools, after controlling for student characteristics. These findings illustrate how school quality, in this case measured by teacher quality and financial resources, are related to mobility rates—with higher-quality schools experiencing less mobility and lower-quality schools experiencing more.

In addition to school quality, schools may offer a particular program or service—e.g., sports teams, music programs, services for students with disabilities—that attracts students to their institution (Rumberger, 2003). Such services or programs may both generate mobility if a student changes schools to take advantage of them and inhibit mobility if they encourage enrolled students to remain. In a study of school choice and parental preferences in New Orleans (Harris & Larsen, 2015), the Education Research Alliance for New Orleans found that in elementary, middle, and high school, families had an increased likelihood of choosing a school if it offered extracurricular programming, in particular, football and band. Elementary and middle school families were also more likely to choose a school if it offered either free or paid after-school care. These findings highlight the importance of programs and services offered by schools in influencing parents' schooling choices and demonstrate the potential influence of these factors on student mobility.

Schools may also influence student mobility through their counseling practices (Heilig & Darling-Hammond, 2008), in addition to influencing voluntary mobility through school quality and program offerings. Counselors may motivate mobility incidents by encouraging students with disciplinary issues to find a new school before involuntary measures must be taken. In California, 30 percent of parents of mobile high school students indicated that their student's school asked them to transfer (Rumberger, 2003). Counselors may encourage students with a particular skill or proficiency or a given disability requiring special services to enroll in a school with programs or services that may better suit their needs. On the other hand, they may intervene when a student is considering dropping out or switching schools and counsel them to remain enrolled.

Schools influence mobility rates not only indirectly, but may also directly influence mobility through mechanisms that motivate both structural and nonstructural involuntary student mobility. Schools can directly contribute to involuntary student mobility through disciplinary practices and grade structuring. Schools have the authority to expel students, thus forcing them to involuntarily transfer to a new school or dropout all together. This is, however, only a small source of student mobility. For example, during the 2012–13 school year in Chicago, 489 students were expelled—less than 1 percent of the of 403,000 children enrolled in TPSs and charter schools during that year (Ahmed-Ullah & Richards, 2014). Schools that have the authority to determine which grades they serve have the ability to influence structural student mobility. While most TPSs do not have control over their grade spans, charter and private schools may determine the grades they serve. Grade structuring as a motivator of structural student mobility will be discussed further below in the context of policy-related precipitants of student mobility.

Other school characteristics are associated with, but are not likely to directly cause, student mobility. For example, in their NELS study, Rumberger and Thomas (2000) identify several characteristics of the student body composition related to student mobility. Given the association between mobility and students' race/ethnicity, economic background, and prior achievement described above, it is unsurprising that schools with higher numbers of students who have been held back a grade, low-income students, and Black and Hispanic students experience higher rates of student mobility. A second study, using a sample of Chicago Public Schools elementary students, also finds that the concentration of low-income students is positively associated with student mobility (Temple & Reynolds, 2000). Rumberger and Thomas (2000) also found differences in mobility rates based on school sector, with private schools, both parochial and non-parochial, having lower mobility rates than public schools. These compositional and sector characteristics may impact actual or perceived school quality, the availability of programs and services, counseling policies and procedures, discipline practices, and grade structuring, which may in turn impact student mobility rates. For this reason, it is important for mobility studies to account for student composition and school sector, in addition to school-level covariates that are direct motivators of student mobility.

Beyond student/family- and school-level motivators of student mobility are several policy-level motivators of both voluntary and involuntary mobility. One important policy-level source of involuntary mobility is through the structuring of school grades, which determines the nature of structural student mobility. One of the main grade structuring differences across and within states and districts is between those with primary school structures—serving students in grades K–8 in a single school—and those where students are divided into elementary schools—typically serving students in kindergarten through fifth or sixth grade—and middle schools—generally serving students beginning in fifth or sixth grade through eighth grade (Rockoff & Lockwood, 2010). Depending on which system is mandated by district and/or state policy, students might encounter differing numbers of structural moves over the course of their K–12 education. Students educated in a primary school system, for example, need only make a structural move prior to the start of high school in ninth grade. In recent years, school districts, including Philadelphia, Milwaukee, and Baltimore, have been moving away from the middle school model in favor the primary school model (Meyer, 2011). In 2005 there were just under 9,000 middle schools—the most at any point in time. Since then, the numbers have begun to dwindle, with less than 7,950 in 2010 (Meyer, 2011). This trend reduces the number of structural moves students need to make.

School closures and housing policies are other examples of policy-level motivators of involuntary student mobility that are nonstructural in nature. In recent years, school districts have closed schools as a way to address shrinking enrollments and poor performance (Engberg, Gill, Zamarro, & Zimmer, 2012). When a school is closed, all the students who were formerly enrolled there are forced to change schools. Policies that impact housing are also likely to have an impact on student mobility. One example of such policies is federally funded relocation programs for low-income families living in neighborhoods with concentrated poverty levels, including public housing projects (O. Johnson, 2012). Such programs are designed to improve the neighborhoods and schools that low-income children are exposed to by relocating families into better-resourced neighborhoods. The effectiveness of such programs is predicated, in part, on participating students changing schools—presumably to higher-performing schools—when they move to their new neighborhoods.

Additional policies may indirectly influence voluntary student mobility by affecting the conditions inside of schools and altering the schooling choices for students and their families. One such example is accountability policies. Accountability systems, such as No Child Left Behind (NCLB), may increase rates of strategic upward mobility. They may increase transparency and information about school quality, which may in turn lead to larger numbers of families opting to move their child to a higher-performing school (Hastings & Weinstein, 2008). Further, provisions of the law may encourage student mobility, as is the case with NCLB. Under NCLB, students attending Title I schools that fail to demonstrate adequate yearly progress (AYP)—an indicator of whether a school has met pre-determined performance targets on standardized assessments—for two years in a row are given the option to transfer to another public school within the same district, either TPS or charter, that has higher performance (Spring, 2010). This option has not been widely exploited, however, with only 1 percent of the 6.2 million students who were eligible in the 2004–05 school year taking advantage of the school choice provision (Gill et al., 2008). To the extent that NCLB and other accountability systems improve families' knowledge of and access to relatively higher-performing schools, student mobility may increase as students and their families seek better schooling alternatives.

Accountability systems like NCLB may, on the other hand, impact mobility that is instigated by schools and may disproportionately impact certain groups of students. Evidence suggests that NCLB, as well as other state accountability programs, has provided an incentive for schools to manipulate their enrollments to improve their performance on assessments (Glennie, Bonneau, Vandellen, & Dodge, 2012; McNeil, Coppola, Radigan, & Vasquez Heilig, 2008). Glennie, Bonneau, Vandellen, and Dodge (2012) use data on 258 high schools in North Carolina between the years of 1997–98—the first year of the accountability system there—and 2004–05 and find that schools that had increasing dropout rates saw improvements in school-wide performance in subsequent years, suggesting that schools improved their performance by encouraging outward mobility among problematic students.

School choice polices may also indirectly influence rates of student mobility. The establishment of school choice systems is designed to be a mechanism for increasing access to high-quality education for all students. Proponents of choice systems believe that providing schooling options to children who have historically been underserved by TPSs will improve academic performance and opportunities for these students (Lubienski et al., 2009). Because of the competition generated by the option granted to students to move elsewhere if their families are dissatisfied, it has been theorized that the education market will adapt to accommodate the need of students and become increasingly high performing in order to attract and retain enrollees (Lubienski et al., 2009). In this way, student mobility is an important feature of school choice polices, as dissatisfied students can change schools to find a better fit. While the influx of schooling choices may contribute to higher rates of student mobility, it is also possible that school choice mechanisms may reduce the incidence of mobility. As Dauter and Fuller (2011) explain, "the quality, identity and reputation of particular types of schools may act to enrich student engagement and reduce mobility" (p. 4). To the extent that schools of choice are able to offer a more diverse range of educational options to meet families' educational needs, these schools may reduce rather than inflate rates of student mobility.

While school choice as an education reform strategy encompasses multiple approaches to the provision of schooling, such as magnet schools and voucher programs, charter schools have been the most popular form of education choice (Ravitch, 2010). The charter school sector accounts for a substantial share of the educational market—over 2 million students, or almost 5 percent of nationwide public school enrollments in 2012 (National Alliance for Public Charter Schools, 2012)—and continues to grow. Charter laws are passed on a state-by-state basis, with states outlining different stipulations for their charter sector. To date, 42 states and the District of Columbia have laws allowing charter schools (National Alliance for Public Charter Schools, n.d.-a).

Though limited in number and scope, studies exploring rates of student mobility among charter schools have provided important insights. Several studies generally find that student mobility is less prevalent in charter schools than in TPSs—though not in every instance—but suggest that the presence of charter schools contributes to higher rates of nonstructural student mobility within a district. A recent study conducted by Zimmer and Guarino (2013) used student-level data spanning seven years, 2000–01 through 2006–07, from an unidentified, large, urban school district to explore whether mobility rates for low-achieving students were different in charters and TPSs. The authors focus on nonstructural school switches between public schools at the elementary, middle, and high school level. Descriptive statistics for their data indicate that, overall, students transfer out of charter schools at a lower rate than they do out of TPSs, with mobility rates of 12 percent and 15 percent over the seven years, respectively (Zimmer & Guarino, 2013). However, descriptions of student enrollments across the two sectors show that charter schools and TPSs differ in their student demographics. Charter schools, for example, enroll more

Black (67 percent vs. 65 percent) and White students (19 percent vs. 14 percent) and fewer limited English proficiency (LEP) (2 percent vs. 7 percent) and IEP students (12 percent vs. 15 percent) than TPSs (Zimmer & Guarino, 2013). Based on results from regression analyses, which control for these observed differences in student enrollments, the authors find that low-performing students in TPSs are between 1 percent and 5 percent (depending on the tested subject and how low achievement is operationalized) more likely to switch schools than higher-performing students enrolled in either TPSs or charters. Low-performing students in charter schools, on the other hand, are no more or less likely to leave their school than higher-performing students enrolled in TPSs or charters. Further, they find that low-performing students in charters are significantly less likely to be mobile than low-performing students in TPSs. These findings suggest that charter schools may do a better job of promoting stability in enrollment among low-performing students than TPSs.

The New York City Independent Budget Office published a study (Roy, 2014) that analyzed the mobility rates among a cohort of 3,043 kindergarten students from 53 charter schools and 7,208 students enrolled in neighboring TPSs to explore cross-sector differences. After controlling for student characteristics using regression analysis methods, the report found that charter students are 23 percent less likely to leave their school than their peers in TPSs (Roy, 2014). The report did, however, find variation in this relationship based on student characteristics. Low-income students left charters at about the same rate as their higher income peers; in TPSs, low-income students leave at greater rates than their higher-income peers. Further, students with disabilities are more likely to leave a charter school than a TPS. Other studies have mirrored the findings of these two studies, finding lower overall rates of student turnover and expulsions in charters than in TPSs (Ahmed-Ullah & Richards, 2014; Dauter & Fuller, 2011). As above, these results suggest that students in charter schools experience lower rates of mobility than their peers in TPSs and that the extent of these cross-sector differences varies based on characteristics of students.

In a study using seven years of district-wide administrative data from Los Angeles, Dauter and Fuller (2011) found evidence that charter schools experienced lower rates of student mobility than TPSs. However, they also found that the presence of charter schools in the education market contributed to higher rates of system-wide student mobility across Los Angeles. The authors found that as the number of charter schools in Los Angeles grew, so did the rate of student mobility. This finding suggests that as families are given more schooling options, more students will engage in nonstructural mobility and change schools.

Contrary to what descriptive and predictive studies found, studies utilizing data from charter admissions lotteries suggest that mobility rates may be the same between charter lottery winners and losers. A primary flaw of most studies comparing mobility among charters and TPSs is their inability to account for selection bias that may arise if students who elect to attend charter schools are systematically different than those who do not. In exploring the impact of charter schools on student achievement, some studies have utilized the results of charter school lotteries as a natural experiment to overcome this limitation. These studies compare the outcomes of students who entered and won charter lotteries to those who entered and lost, typically going on to attend a TPS. This method has not been utilized to study mobility directly, but some studies using charter lotteries have examined mobility rates among lottery winners and losers to provide context. In two such studies, both using lottery results from charter schools in Massachusetts, researchers found no difference in mobility rates among charter lottery winners compared to lottery losers, subsequent to any mobility into charters or other schools that took place between the charter lotteries and the start of the following school year (Abdulkadiroglu, Angrist, Dynarski, Kane, & Pathak, 2011;

Angrist, Dynarski, Kane, Pathak, & Walters, 2012). In a lottery study using a single Knowledge is Power Program (KIPP) middle school, Angrist et al. (2012) found no difference in the rates of school switches in grades six through eight between lottery winners and lottery losers. In their study using charter lottery results from five middle and three high schools, Abdulkadiroglu et al. (2011) also found no significant difference in school-switching rates between charter middle school lottery losers and winners. For charter high schools, they found charter lottery winners to be 5 to 6 percent more likely to switch schools than lottery losers, though a single school in their sample drives much of this differential.

A limitation of studies utilizing admissions lottery results is that their analysis is limited to oversubscribed charter schools that volunteer to participate, which may be a sample of schools that does not represent the charter sector as a whole. In sum, despite a lack of significant findings in lottery studies, observational studies examining the relationship between charter schools and student mobility demonstrate a relationship between school choice policies and student mobility.

Across each level of influence, multiple circumstances may motivate student mobility. These motivators result in different types of student mobility and are differentially associated with the potential consequences of student mobility. The relationship between student mobility's motivators and both the type and consequences of student mobility will be outlined in the framework presented in this chapter.

Consequences of Student Mobility

Studies of student mobility demonstrate that important consequences of mobility may exist for students, classrooms, and schools; typically, these consequences are found to be negative, at least in the short term. Tables II.3 and II.4 outline the proximal, or direct, consequences of student mobility for students and classrooms/schools, respectively. These proximal consequences are mediators between student mobility and its distal, or indirect, consequences, also presented in these tables.

Table II.3

Proximal and Distal Consequences of Student Mobility for Mobile Students

Consequences of Mobility	Description
Proximal	
Change in school quality	Mobile students may experience a schooling environment in their new school that is of a different quality than their sending school—may be a positive or negative change.
Change in peer group	Mobile students are likely to experience exposure to a different peer group in their new school than they did in their sending school—may be a positive or negative change.
Change in neighborhood	Mobile students may experience a different neighborhood context surrounding their school, home, or both—may be a positive or negative change.
Change in access to programs and services	Mobile students may experience a change in their access to programs and services offered through their school—may be a positive or negative change.
Disrupted relationships	Mobile students and their families may experience a disruption in their relationships with teachers and staff and with school networks of peers and parents from their sending school; this may negatively impact mobile students.
Disrupted instruction	Mobile students may experience a discontinuity in their instruction when they move from classes in their sending school into new courses in their receiving school; this may negatively impact mobile students.
Stigma	Mobile students may experience stigma as a result of their mobility—resulting from the circumstances of their mobility or their status as a new student; this may negatively impact mobile students.

Consequences of Mobility	Description
Distal	
Change in achievement	As a result of the proximal consequences of mobility for students, a mobility incident may result in a positive or negative change in academic achievement for mobile students.
Change in psychosocial wellbeing	As a result of the proximal consequences of mobility, a mobility incident may result in a positive or negative change in the psychosocial wellbeing of mobile students.

Student mobility has been shown to have a negative relationship with students' academic performance, as well as their psychological and social well-being (de la Torre & Gwynne, 2009; Engberg et al., 2012; Langenkamp, 2014; Mehana & Reynolds, 2004; Pettit & McLanahan, 2003; Rumberger, 2003; Scherrer, 2013). While linkages have been made between student mobility and academic and psychosocial well-being for mobile students, there is little reason to believe that student mobility would directly impact these outcomes. Instead, the effect of student mobility on these measures occurs through other more proximal consequences of mobility (Mehana & Reynolds, 2004). In particular, after experiencing student mobility, mobile students can experience a change in school quality, a change in their peer group, a change in the neighborhood surrounding their school and/or home, a change in their access to programs and services, disrupted relationships with school staff and student and parent networks, disrupted instruction in academic courses, and stigma associated with being the new student or the circumstances of the school change. The first four areas of potential change—school quality, peer groups, neighborhood, and access to programs and services—can be either positive or negative, depending on the circumstances surrounding the mobility incident. For example, if a student moves from a poorly performing school with few resources into a school with abundant resources and higher levels of achievement, this change in school quality is a potential benefit to the student. When student mobility results in a positive shift in schooling opportunities, this is called "upward mobility" (de la Torre & Gwynne, 2009; Thomas B. Fordham Institute, 2012).

On the other hand, if the quality of the sending school is higher than that of the receiving school, the change in school quality may harm the student. To the extent that they occur, disrupted relationships with staff and school networks, disrupted instruction, and stigma are all likely to be negative for mobile students. Each of these proximal consequences of mobility that a mobile student may potentially experience has an established relationship with student achievement and/or student psychosocial well-being (Barr, 1973; Benson & Borman, 2010; Hanushek, Kain, & Rivkin, 2002; Hanushek & Rivkin, 2006; C. M. Johnson & Memmott, 2006; Laar & Sidanius, 2001; Pettit & McLanahan, 2003; Scherrer, 2013; Zimmer & Toma, 2000). These distal consequences of mobility are typically those of interest in studies examining the impact of student mobility, and in very few cases are these proximal consequences of mobility explored as an outcome.

Studies have demonstrated a negative relationship between student mobility and academic achievement and completion. Mehana and Reynolds (2004) conducted a meta-analysis exploring the relationship between mobility and student achievement. They synthesized findings from 26 studies of the relationship between student mobility—they include studies of both structural and nonstructural mobility—and reading achievement and 19 studies of the relationship between student mobility and mathematics achievement. The authors conclude that mobility had a significant and negative relationship with both reading and math achievement. The authors converted effect sizes into growth scores on the Iowa Tests of Basic Skills (ITBS) in order to provide an applied interpretation of their findings. Based on this method, they conclude that, on average, mobile students are four months behind non-mobile students in both reading and math.

In their paper examining the impact of grade structuring on student achievement, Rockoff and Lockwood (2010) explored whether the transition from elementary to middle school was harmful for New York City students by comparing the performance of middle school students to that of students enrolled in K–8 schools. They found that relative to peers enrolled in K–8 elementary schools, students who moved into middle schools in either sixth or seventh grades experienced a drop in math and English language arts achievement during the year of their transfer and continued to experience a decrease in performance relative to K–8 students through eighth grade. Specifically, the authors found that during sixth grade, students who transitioned to middle school in that grade experienced a 0.18 and 0.16 standard deviation drop in their performance relative to their K–8 peers in math and English, respectively. Similarly, during seventh grade, students who transitioned to middle school in that grade experienced a 0.17 and 0.14 standard deviation drop in their math and English scores, respectively, relative to the performance of their peers enrolled in K–8 schools. The authors are not able to conclude the causal mechanisms of their findings, but their work provides evidence to suggest that the grade structuring of schools is related to student achievement. While the authors do not discuss student mobility in their article, their findings suggest a negative relationship between structural mobility and students' academic performance.

Even in the case of upward student mobility, students may experience disruption in their instruction and relationships with teachers and peers that negatively impacts their achievement, at least in the short term. School closure studies provide an opportunity to observe the impact of what is presumably upward mobility (if the schools closed are indeed the worst schools in a given district) induced by a policy decision. Engberg et al. (2012) conducted a study of school closures in an anonymous urban district that used an instrumental variables approach to explore the impact of school closure on academic achievement at the elementary level. They found that displaced students moving into schools with equal performance to their closed school had math and reading achievement that was significantly lower in the first year after closure. In the second and third years, they were still lower but not significantly so. Students who moved to a higher-performing school experienced smaller negative impacts, resulting in performance that was not significantly worse. Similar results were found in a study of elementary school closures in Chicago (de la Torre & Gwynne, 2009), though this study only found negative impacts on students' math and reading performance in the year the closures were announced—by the first year after closure, the authors noted math and reading achievement levels among displaced students that were indistinguishable from what would have been expected if their school had not closed; this pattern holds for the first three years after closure. They also found that the rate of growth was faster for students who were displaced to high-performing schools compared to those sent to low-achieving schools. These studies suggest that the impact of student mobility on achievement for students whose school is closed is minimal and is likely to be short term. These studies, which focus on students who leave the lowest-performing schools in a district—as those schools slated for closure typically are—demonstrate that student mobility that results in access to higher-quality schools may ultimately improve academic achievement in the long run.

Several studies have established a relationship between student mobility and psychological and social consequences (Langenkamp, 2014; Simpson & Fowler, 1994; Wood, Halfon, Scarlata, Paul, & Nessim, 1993). In the most methodologically rigorous example, Langenkamp (2014) uses two waves of data from the National Longitudinal Study of Adolescent Health (Add Health) and utilizes propensity score analysis in order to create a less-biased comparison group of students who did not experience mobility. Based on this analysis, Langenkamp (2014) found that students who switched schools reported having closer relationships with their teachers but were less likely to have a friend in their school than students who remained in the same school. These findings suggest that, while transfer students may have relatively strong relationships with their teachers, they may be socially marginalized among their peers.

Table II.4

Proximal and Distal Consequences of Student Mobility for Classrooms and Schools

Consequences of Mobility	Description
Proximal	
Change in student composition	Student mobility may lead to change in the composition of classrooms' and schools' student bodies—this change may be positive or negative depending on the characteristics of mobile students entering and exiting the classrooms/schools.
Change in funding	Student mobility may lead to changes in available funding for classrooms and schools if tuition and/or tax dollars increase with the addition of new students or decrease with the loss of current students.
Disrupted instruction	Classrooms and schools may experience disruptions in instructions if teachers and other school staff must accommodate entering or exiting students during the school year. Instructional disruptions are likely to have a negative impact on classrooms and schools.
Administrative burden	Schools experiencing student mobility may be required to expend administrative resources to address new enrollees and student exits. For example, student mobility may necessitate meeting with new parents and adjusting course rosters to accommodate changing enrollments.
Distal	
Change in achievement	As a result of the proximal consequences of mobility for classrooms and schools, student mobility may result in a positive or negative change in academic achievement for classrooms and schools.

As in the case of consequences of mobility for students, there are both proximal and distal consequences of student mobility for schools and classrooms. As a direct result of student mobility, schools may experience a change in school composition, a change in funding if tuition or tax dollars leave or enter with students, disruption of classroom instruction as teachers accommodate changes in their rosters midyear, and administrative burden associated with addressing student turnover. The first two of these consequences for schools and classrooms could be positively impacted by mobility, if, for example, lower-achieving students exit a school or funding increases when a new student enrolls. On the other hand, if student mobility results in an influx of low-achieving students or a reduction in funding, these consequences are likely to be negative for classrooms and schools. The need to interrupt instruction to accommodate students as they enter or exit the classroom and an increase in administrative burden that may deflect resources away from instructional supports may be harmful for the performance of schools and classrooms. Each of these proximal consequences of student mobility has an established relationship with achievement at the school and/or classroom level (Condron & Roscigno, 2003; Greenwald, Hedges, & Laine, 1996; Kerbow, 1996; Lash & Kirkpatrick, 1990; Rumberger & Palardy, 2005).

The above outcomes are most proximally associated with student mobility, but of more interest, typically, is how these proximal consequences result in changes in achievement at the school or classroom level. An established relationship exists between student mobility and achievement at the classroom and school level. In a study of student mobility among elementary schools in a Southeastern state, Thompson, Meyers, and Oshima (2011) found a significant and negative relationship between school-level student mobility rate and reading, language arts, and mathematics achievement on the state's standardized test. This relationship remained significant after adding controls for school poverty and school size.

These findings were mirrored in a study that utilized administrative data from eight urban districts in the state of Ohio in the 2003–04 school year to examine the relationship between school-level mobility rates and their categorical rating on the state's school rating system (Rhodes, 2005). The author used predictive discriminate analyses, which compared the accuracy in predicting a school's performance based on school-level mobility to the rate of correct predictions achieved using a random draw, and found that student mobility had a predictive rate that was twice as high as random assignment (Rhodes, 2005). Rhodes (2005) found that schools with high mobility rates were twice as likely as schools with low rates of mobility to be placed in the bottom two categories of the Ohio school rating system—academic emergency and academic watch.

Another study, conducted by Raudenbush, Jean, and Art (2011), also found a negative impact of student mobility on the achievement of schools. This study used student-level data on third graders in Chicago in 1998 and followed them through fifth grade to examine the impact of school- and grade-level mobility rates on school- and grade-level mathematics achievement. Using data from prior to third grade, the authors use propensity score methods to predict the amount of student mobility to which a student is likely to be exposed in his or her schools and classrooms during third grade. These predictions were then divided into different strata, and variation in the actual amount of student mobility students within a single stratum were exposed to was leveraged to estimate the impact of student mobility. The authors used this method to attempt to account for the potential of systematic differences between students who attend high- and low-mobility schools by comparing only students with similar propensities for exposure to student mobility at the school and grade levels. The authors found small but statistically significant effects of both school- and grade-level mobility on cumulative math achievement in schools and grade levels. For example, they found that in 1998, math achievement growth in a high-mobility school—one with a mobility rate one standard deviation above average among the study schools—was nearly 9 percent lower than that in a low-mobility school—one with a mobility rate one standard deviation lower than average among study schools. For grade-level mobility, the effects were smaller but still significant, with high-mobility grades experiencing math achievement growth 1.7 percent lower than low-mobility grades. Notably, the authors did not find significant variation in the effect of school-level mobility on math achievement between mobile and non-mobile students. This finding in particular highlights the potential importance of student mobility not only for the achievement of mobile students, but for that of entire schools as well. These studies demonstrate that student mobility not only impacts the performance of mobile students themselves, but it may also have a more wide-reaching impact on achievement. Operating through the proximal consequences that student mobility may have on schools, student mobility can affect achievement at the classroom and school level.

The prior research on student mobility reviewed in the preceding sections was used as the basis for the relational framework presented at the beginning of this chapter. In turn, this framework was used to guide the design and discussion of the empirical analyses presented in the remainder of this dissertation.

Conclusion

Student mobility is not a simple phenomenon to define, nor are the motivators and consequences uniform across different types of mobility. The aim of this chapter was first to clarify differences in definitions of student mobility and outline motivators and consequences associated with mobility of various types and then to present a framework that describes the relationships between these three aspects of student mobility. Given the complexity of student mobility, one study could not, on its own, examine every facet of this issue. Taken together, however, studies exploring the various aspects of student mobility can help to reveal relationships between student mobility and characteristics of students, families, schools, and broader policy contexts. This framework can help guide future research on student mobility by providing a systematic depiction of the relationships between the various characteristics of student mobility, which can be used in the development and interpretation of studies of student mobility.

In the remainder of the dissertation, I will present three empirical chapters that address various aspects of the framework as described above. Guided by the framework presented in this chapter, and by prior research on student mobility, these empirical chapters will contribute to the literature on student mobility by exploring relationships between different types, motivators, and consequences of student mobility.

III. CHAPTER TWO – EXAMINING THE CORRELATES AND CONSEQUENCES OF STUDENT MOBILITY NATIONALLY USING THE EARLY CHILDHOOD LONGITUDINAL STUDY

Introduction

This chapter explores rates of structural and nonstructural student mobility and residential mobility in a nationally representative sample. It will also examine student- and school-level predictors of student mobility and the relationship between mobility and later achievement. To accomplish these tasks, I will use data from the Early Childhood Longitudinal Study-Kindergarten Class of 1998–1999 (ECLS-K). This nationally representative data set follows a cohort of students from kindergarten through eighth grade and provides a rich source of information on students, families, teachers, schools, and wider contexts.

The causes of student mobility are varied and occur at the level of students and their families, schools, and policy, as I discussed in greater detail in the first chapter. The majority of student mobility incidents are initiated by students and their families and are most frequently due to a residential move (Kerbow, 1996; Rumberger, 2003; Rumberger & Larson, 1998). Other causes at the student and family level include a desire to change schools, a change in family income or employment, and a change in the family structure. The ECLS-K data set contains information on both residential mobility and student mobility. These data allow for differentiation between student and residential mobility that occur independently, as well as school changes that are likely to have resulted from a residential move. Additional student- and family-level covariates, including demographic characteristics that do not cause, but are associated with variance in, student mobility will also be examined in this chapter.

Though students and their families initiate the majority of student mobility incidents, schools can influence both voluntary and involuntary student mobility. Conditions related to the quality of either the sending or receiving schools can influence voluntary student mobility rates (Rumberger & Thomas, 2000). For some students and their families, mobility occurs in order to escape poor schooling conditions or to seek higher-quality conditions at a new school. Schools may also influence voluntary mobility decisions for students and their families through their counseling practices and policies (Heilig & Darling-Hammond, 2008; Rumberger, 2003) or through the availability of specific services or programs that may be necessary or attractive for certain families (Rumberger, 2003). Further, schools can cause involuntary student mobility through disciplinary practices, such as expulsion, and grade structuring, which may influence the number of structural moves a student makes over the course of his or her schooling. In exploring school-level predictors of student mobility, this chapter will include measures of school quality, such as academic performance and school safety, to determine which measures are predictive of student mobility in the ECLS-K data.

Many studies have established a link between student mobility and student achievement (de la Torre & Gwynne, 2009; Engberg et al., 2012; Mehana & Reynolds, 2004; Rumberger, 2003; Scherrer, 2013). As discussed in Chapter One, it is unlikely that student mobility is directly impacting academic performance, but rather that it causes other conditions, such as a change in the quality of the school a student attends, discontinuity in academic instruction, and disrupted relationships with school teachers and staff. Evidence suggests that even if a student moves from a lower-quality school to a higher-quality school, mobility may negatively impact the academic achievement of mobile students, at least in the short term (Engberg et al., 2012). This chapter will examine the relationship between students' prior exposure to mobility and their later academic achievement, taking into consideration the number of school switches and the quality of the sending and receiving schools.

By examining these student- and school-level predictors of student mobility and exploring the relationship between mobility and future achievement, this chapter will contribute to the literature on student mobility. The use of a nationally representative data set, with rich information about student and school characteristics, is one of the main strengths of this analysis. In particular, the distinction between student mobility that is concurrent with residential mobility and that which is not has been underexplored in the research exploring the correlates and consequences of student mobility. Furthermore, the detailed measures on school characteristics available in the data allow for a nuanced exploration of relationship between the quality of sending and receiving schools and student mobility.

Research Questions

1. What are the rates of different types of mobility—residential mobility and structural and nonstructural student mobility—across waves of the ECLS-K data, overall and for subgroups of students enrolled in public schools?
2. Among students who made structural or nonstructural school moves, what percentage of moves qualify as upward mobility—movement to a school with higher rates of mathematics achievement—overall and for subgroups of students in public schools?
3. Which student- and school-level characteristics are associated with residential mobility and/or nonstructural student mobility? For students experiencing a school change, what student-level characteristics are associated with upward mobility?
4. How are students' mobility histories, including number, type, and quality of moves, associated with later achievement?

Data

This chapter will utilize data from two sources, the Early Childhood Longitudinal Study, Kindergarten cohort (ECLS-K) and the Common Core of Data (CCD). The ECLS-K, which is the primary data source for this chapter, is a U.S. Department of Education, National Center for Education Statistics (NCES) data set. It is a longitudinal data set that comprises a nationally representative probability sample of 21,260 kindergarteners enrolled in public and private schools during the 1998–99 school year. These students were followed across a total of seven waves with data collections during kindergarten, the fall of first grade, the spring of first grade, the spring of third grade, the spring of fifth grade, and the spring of eighth grade[1] (Tourangeau, Nord, Le, Sorongon, & Najarian, 2009). During fall of first grade, data was collected for a subsample of the entire ECLS-K population—because of the reduced sample, these data will not be used in the present study. The ECLS-K data include standardized student assessments and surveys of students' parents, teachers, and principals. In order to limit the scope of this analysis, I will restrict my analyses to explore mobility among public school students in the ECLS-K sample, excluding those enrolled in private schools.

A second NCES data set, the CCD, will be used in addition to the ECLS-K data to supplement the school-level variables available in the ECLS-K. The CCD is an annual survey of "fiscal and non-fiscal data about all public schools, public school districts and state education agencies in the United States" (Common Core of Data [CCD], n.d.). The CCD contains basic school characteristics such as the name and address of a school; characteristics of students and staff,

[1] These grades represent the grade level of a student on the traditional trajectory during a given wave (i.e., first grade in 1999–00, third grade in 2001–02, etc.). The data also includes those students who were held back or promoted early, so while the vast majority of students in a given wave will be in the same grade, not all will be.

including demographics; and information on a school's revenues and expenditures. Of particular relevance to the present study is the data in the CCD on the highest grade served by a given school in each year. This data will aid in determining whether a given mobility incident was structural or nonstructural in nature. The ECLS-K restricted-use data contains school identifiers that allow the CCD to be linked to the ECLS-K data set. However, this identifier is not present in the kindergarten wave, preventing these two data sets from being combined. For this reason, the analyses in this chapter will be restricted to the spring of first grade through spring of eighth grade waves. Table III.1 presents the sample sizes for students enrolled in public schools, across waves of the ECLS-K used in the analysis for this chapter.

Table III.1

Public School Student and School Sample Sizes in the Early Childhood Longitudinal Study, Kindergarten Cohort

Wave	Student sample size	School sample size
Spring 1st grade	13,540	1,650
Spring 3rd grade	11,960	2,530
Spring 5th grade	9,330	2,010
Spring 8th grade	7,810	2,270

Source: Early Childhood Longitudinal Study, Kindergarten Cohort of 1999-99

As with all data sources, there are limitations associated with using the ECLS-K to explore student mobility. The first is the age of the data. Likely shifts in demographics, education policy, and other factors in the time since the ECLS-K sample was selected would impact the occurrence and impacts of student mobility. School choice policies, and charter school laws in particular, have changed the education landscape and, by design, are likely to directly impact the quantity and nature of student mobility incidence. The influx of charter schools in the years since the collection of the ECLS-K data may have contributed to higher rates of student mobility if students are taking advantage of their additional choices by switching schools more often than in the past, or it may have reduced the incidence of mobility if increased schooling options have improved families' satisfaction with their school and led to more stability.

A second limitation of the ECLS-K is that the data on school switches is relatively crude. For the count measure of the number of school switches a student experienced, no additional information accounts for what motivated this switch (e.g., expulsion, structural advancement to a higher school, residential move, etc.). Further, because two to three school years pass in between waves of data collection and the mobility measures do not provide details about the exact timing of mobility incidents—only that they happened between two waves of data collection—it is not possible to discern whether mobility incidents were quite recent or happened two or three years in the past. The data on residential moves is a bit more detailed and includes a follow-up question for students who moved that asks why the residential move was made, which includes among the options having sought out a better school. However, as with school switches, it is not possible to determine the exact timing of residential mobility in the intervening period between waves of data collection.

Despite these limitations, the ECLS-K is well suited to exploring questions about student mobility for several reasons. A primary strength of this data is that it is nationally representative of the kindergarten class from the 1998–99 school year. Given this design, the findings have more generalizability than most studies of student mobility. Further, given the longitudinal nature of the data, the ECLS-K makes it possible to explore the mobility patterns of this nationally representative cohort of students throughout the elementary and middle school grades. An additional strength of this data is the ability to distinguish between student and residential mobility. This feature makes it possible to examine separately the predictors and associated outcomes of student mobility that occur separate of residential moves, residential moves that occur without student mobility, and residential moves and student mobility that are concurrent. These strengths of the ECLS-K make it a worthwhile and valuable source of data for exploring issues of student mobility.

Measures and Methods

The ECLS-K data set contains two primary measures of mobility. The first variable is a measure of the number of school switches since the prior survey wave. This is a count variable and provides no details about why the school switches occurred. The second variable of interest in the ECLS-K is a measure of whether a student has moved residences since the last survey. Descriptive information, across waves, for these two measures is presented below in Table III.2.

Table III.2

Incidence of Student and Residential Mobility across Waves

Time frame	Student Mobility		Residential Mobility	
Wave A–Wave B	Affected students *n* %	Avg. number of incidents for affected students	Affected students *n* %	Avg. number of incidents for affected students
1st grade–3rd grade	1,720 16.67%	1.24 (0.534)	2,970 25.19%	1.18 (0.574)
3rd grade–5th grade	1,570 18.38%	1.14 (0.428)	1,690 18.20%	1.12 (0.385)
5th grade–8th grade	3,850 58.01%	1.17 (0.458)	1,790 24.19%	1.18 (0.528)

Source: Early Childhood Longitudinal Study, Kindergarten Cohort of 1999-99
Note. Standard deviations in parenthesis.
Time frame represents the time between a given wave, A, and the following wave, B, during which student and residential mobility is measured. When calculating the percentage of mobile students, the denominator for each cell is equal to the number of students enrolled in public schools at time A who have non-missing data on the mobility variables at time B.

These two measures of mobility, in conjunction with data on schools' highest offered grade and the academic performance of their students, are used to calculate three binary mobility indicators used in this chapter. The first is a measure of whether a mobile student's move was structural or nonstructural. Among students who experienced at least one school switch since the prior wave, they were assumed to have experienced structural mobility if the highest grade offered by their school in the prior wave is lower than the grade the student is in during the following wave. Moves that were not determined to be structural are assumed to be nonstructural.

The second measure used in the analyses for this chapter is an indicator of whether a school switch was upward, that is, improved the quality of school attended by a mobile student. Among students who experienced at least one school switch since the prior wave, a move is considered upward if a student's sending school was in a lower achievement quintile—as measured by principal reports of the proportion of children on grade level in math and reading—than their receiving school. Lastly, the count variable describing the number of residential moves a student experienced was transformed into a dichotomous indicator identifying students who did and did not experience residential mobility since the prior wave. In addition to looking at these measures separately, the analyses in this chapter also explore the intersection of these three measures (e.g., upward, nonstructural mobility and residential mobility with and without a concurrent school switch) in descriptive and predictive analyses. Further, for students who have experienced residential mobility, a follow-up question asks why they moved—e.g., nicer house, safer area, less expensive, evicted, better schools—which is used to explore rates of residential mobility motivated by access to higher-quality schools. Table III.3 presents each of the mobility measures used in this chapter.

Table III.3

Definition of Mobility Measures Used in Analyses

Mobility Variable	Description
Type	
Residential	A dichotomous indicator equal to one if a student experienced a residential move since the prior wave of data collection.
Nonstructural	A dichotomous indicator equal to one if 1) a student experienced a school change since the prior wave of data collection and 2) the student is enrolled in a grade in the current wave that was offered at the school the student attended during the prior wave of data collection.
Structural	A dichotomous indicator equal to one if 1) a student experienced a school change since the prior wave of data collection and 2) the student is enrolled in a grade in the current wave that is higher than was offered at the school the student attended during the prior wave of data collection.
Quality	
Upward	A dichotomous indicator equal to one if 1) a student experienced a school change since the prior wave of data collection and 2) the school the student attends in the current wave is in a higher achievement quintile—based on the percent of students in the school performing on grade level in math—than the school the student attended during the prior wave of data collection.

For the first and second research questions, additional student-level variables from ECLS-K and CCD will be used to examine mobility among subgroups of students, including those based on race/ethnicity and socioeconomic status (SES) and to explore the predictors of mobility, such as student demographics and prior achievement and measures of school quality. For the third and fourth research questions, additional student- and school-level variables will be included as covariates in models predicting the likelihood of mobility and the relationship between mobility and future achievement. The student- and school-level variables used for the descriptive and predictive analyses are presented with summary statistics in Tables A.1 and A.2.

Sample weights. To account for differing probabilities of selection as well as participant nonresponse in the data collection for the ECLS-K, sampling weights are applied to the analyses in this chapter to allow descriptive figures to be nationally representative (Winship & Radbill, 1994). The ECLS-K data contain multiple sample weights that can be used for either cross-sectional analyses involving only one wave of data or longitudinal analyses that link multiple waves of data together (Tourangeau et al., 2009). For research questions one and two, cross-sectional sample weights from each respective wave of data are applied.[3] Prior research has demonstrated that when sample weights are a function of only independent variables in a model, unweighted coefficients are both appropriate and more efficient than weighted estimates (Winship & Radbill, 1994). For this reason, sample weights are not used in the regression analyses for research questions three and four.

Multiple imputation. To address missing data, multiple imputation methods were employed. Multiple imputation is a more effective method of reducing bias and increasing efficiency than listwise deletion and other imputation approaches, such as mean or median substitution, especially when rates of missing data are relatively high (Allison, 2001; Enders, 2010). For multiple imputation to yield unbiased estimates of missing values, the data must either be missing at random (MAR) or missing completely at random (MCAR); however, it is difficult to

[3] These cross-sectional weights are C4CW0, C5CW0, C6CW0, and C7CW0 for the first-, third-, fifth-, and eighth-grade spring waves, respectively.

make either assumption with typical observational data (Enders, 2010). Given the wealth of time-constant and time-varying covariates present in the ECLS-K data, many of the mechanisms that are plausibly responsible for missingness can be accounted for in the imputation models.

In this chapter, two separate imputation procedures were performed: the first is used for research question three, where mobility measures are the outcome of interest, and the second is used for research question four, where student achievement is the focal outcome measure. Multiple imputation was not used for the descriptive findings in research questions one and two. The highest proportion of missing information is present on school-level variables. Among these, the highest rates of missingness were dichotomous indicators for whether a school offered a gifted and talented program and whether it was a school of choice, a magnet school, or a regular public school; 37 to 39 percent of values for these variables were missing. Rates of missing data for student achievement and background data were much lower and largely fell between 1 and 10 percent.

Data missing on independent variables were recovered using five multiply imputed data sets. Estimates and standard errors from these imputed data sets were averaged using standard rules (Rubin, 2009). More specifically, regression coefficients and standard errors were pooled across the five data sets to produce a single estimate. For the regression coefficients, the arithmetic average was taken across the five data sets. The pooled variance involves two sources of error, the typical sampling error and sampling error resulting from missing data. As such, the pooled variance is composed of within- and between-imputation variance.

Methods. To answer the first research question, I employ descriptive methods to explore rates of residential mobility and both structural and nonstructural student mobility among public school students in each wave of the ECLS-K data. These analyses were conducted among the aggregate sample, as well as for subgroups of students based on race/ethnicity, SES, special education status, English language learner status, and academic achievement. These analyses incorporate appropriate sampling weights included in the ECLS-K data to compute nationally representative figures.

To explore rates of upward mobility for the second research question, I again employ descriptive techniques. A school switch is considered "upward" if a student moves to a school where performance on standardized mathematics assessments—as measured by the principals' report of the percent of students performing at or above grade level—falls within a higher quartile among the school sample than their sending school. Prior research has demonstrated that math achievement is impacted by teachers and schools to a greater extent than is reading achievement (Fryer, 2014; Nye, Konstantopoulos, & Hedges, 2004); for this reason, the principals' report of students' mathematics performance is used. Based on this definition, rates of upward mobility among different subgroups of students, and for each type of mobility, were calculated. As above, these descriptive analyses will incorporate sampling weights to allow these figures to be nationally representative.

To answer the second and third research questions, I will employ multilevel modeling techniques to explore student- and school-level predictors of mobility and the extent to which student mobility predicts achievement. For both research questions, the modeling strategy I employ will account for the panel structure of the data, with multiple years of data for each student, as well as the nested nature of the data, with students nested in schools (Heck & Thomas, 2000).

In answering the third research question, three-level linear probability models (LPMs) were employed to identify student- and school-level predictors of differing types of mobility. By applying the ordinary least squares (OLS) framework in the case of a dichotomous dependent variable, LPMs compute the change in the probability of "success" associated with individual covariates in the model, controlling for any additional covariates (Wooldridge, 2002). In this chapter, "success" occurs when a student experiences mobility, either residential, nonstructural, or upward, depending on the specific model being estimated.

Because of the application of a linear modeling strategy to a dichotomous dependent variable, there are limitations associated with LPMs. One shortcoming is that LPMs may produce predicted probabilities that fall outside of the range of zero and one, which can result in out-of-range estimates when calculating predicted probabilities for cases in the sample. This is not the primary aim of this chapter, however, and does not interfere with the identification of significant predictors of the outcome of interest. As Wooldridge explains, "[p]redicted probabilities outside the unit interval are a little troubling when we want to make predictions, but this is rarely central to an analysis. Usually, we want to know the ceteris paribus effect of certain variables on the probability" (2002, p. 236). A second limitation of LPMs is that these models violate the homoskedasticity assumption for OLS models—that the variance of the unobservable error is constant across values of the explanatory variables. This can result in inaccurate test statistics (Wooldridge, 2002) because in LPMs, due to the binary dependent variable, there is necessarily heteroskedasticity if the probability depends on any of the independent variables. This limitation can be easily addressed by producing heteroskedasticity-robust test statistics that "are valid—at least in large samples—whether or not the errors have constant variance, and we do not need to know which is the case" (Wooldridge, 2002, p. 251).

Despite the limitations of these models, LPMs are frequently used because they are easy to interpret and provide accurate hypothesis tests in larger samples when robust standard errors are used to account for potential heteroskedasticity (Wooldridge, 2002). In exploring the student- and school-level predictors associated with student and residential mobility, Equation III.1 represents the first level of the multilevel LPM that was employed.

$$\Pr(Y_{tij} = 1) = \pi_{0ij} + \pi_{1ij}(WAVE_{tij}) + u_{tij} \quad \text{(III.1)}$$

In this equation, $\Pr(Y_{tij} = 1)$ represents the probability that student *i* in school *j* at time *t* will have experienced mobility between two waves of data collection. The left side of the equation is equal to the odds of experiencing mobility for a given student, in a given school, during a given wave of the data. The odds of having experienced mobility for student *i* in school *j* during the interval between data collections leading up to time zero—i.e., the period between the spring of first grade and the spring of third grade—is represented by the π_{0ij} parameter. The change in the odds for each additional wave that passes in the data is captured by the π_{1ij} parameter. The error in the first level of the model is represented by u_{tij}.

In the second-level model for the analysis in the second research question, the parameters on the right-hand side of the first level become the left-hand side of the model. Equation III.2 represents this model.

$$\pi_{pij} = \beta_{p0j} + \beta_{p1j}X_{ij} + \varepsilon_{pij} \quad \text{(III.2)}$$

Each of the P = 2 estimated parameters in level one, represented by π_{pij} in Equation III.2, are decomposed into three level-two parameters. The intercept, β_{p0j}, is equal to the average odds of mobility for student *i* in school *j* across waves. β_{p1j} is equal to the change in the odds of student mobility associated with X_{ij}, a vector of lagged (*t*-1) student-level covariates, including achievement and demographic characteristics, for the *p*th parameter. The error in the second level of the model is represented by ε_{pij}.

The third-level model for this analysis is shown in Equation III.3.

$$\beta_{pqj} = \gamma_{pq0} + \gamma_{pq1} Z_j + \varsigma_{pqj} \quad \text{(III.3)}$$

Each of the Q = 2 estimated parameters in level two, represented by β_{pqj} in Equation III.3, are decomposed into the level-three equation. The intercept, γ_{pq0}, is equal to the average odds of mobility for students across waves in school j. γ_{pq1} is equal to the change in the odds of student mobility associated with Z_j, a vector of lagged (t-1) school-level covariates, such as math performance on standardized assessments and teacher quality measures, for the *q*th parameter. The error in the second level of the model is represented by ε_{pij} . The error in the second level of the model is represented by ς_{pqj} . This three-level modeling approach outlined in Equations III.1, III.2, and III.3 will be estimated in Stata using the **xtmixed** command, with the **vce(cluster)** option to produce robust standard errors.

In order to answer the second part of research question three, which looks at student-level predictors of upward mobility, the same general multi-level LPM modeling procedures described above will be used. The sample for this question will be limited to those students who have experienced mobility, and the left-hand side of the first-level equation depicted in Equation III.1 will be altered. For this question, $\Pr(Y_{tij} = 1)$ represents the probability that a mobile student *i* in school *j* at time *t* will experience upward mobility. The left side of the equation is equal to the odds of experiencing upward mobility for a given mobile student, in a given school during a given wave of the data. The second- and third-level equations retain the same form and contain the same measures as above (Equations III.2 and III.3) but will model student- and school-characteristics associated with the odds of upward mobility among mobile students, rather than the odds of mobility among the full sample.

In answering the fourth research question, examining the relationship between students' mobility histories and future achievement, a similar modeling technique to that used for the second research question will be employed, with adjustments for the use of a continuous, rather than dichotomous, outcome variable. Equation III.4 presents the first level of the three-level model to be executed for this analysis.

$$Y_{tij} = \pi_{0ij} + \pi_{1ij}(wave_{tij}) + u_{tij} \quad \text{(III.4)}$$

In this equation, Y_{tij} represents the mathematics score of student *i* in school *j* at time *t*. The math score of student *i* in school *j* at time zero—the spring of kindergarten—is represented by the π_{0ij} parameter. The change in math scores for each additional wave that passes in the data is captured by the π_{1ij} parameter. The error in the first level of the model is represented by u_{tij}.

As above, the parameters in the first level of the model can be decomposed into the second level of the model, which accounts for student-level covariates. The level-two model can be further decomposed into a level-three model, which includes school-level covariates. The level-two and level-three models are presented in Equations III.5 and III.6.

$$\pi_{pij} = \beta_{p0j} + \beta_{p1j}X_{ij} + \varepsilon_{pij} \quad \text{(III.5)}$$

$$\beta_{pqj} = \gamma_{pq0} + \gamma_{pq1}Z_j + \varsigma_{pqj} \quad \text{(III.6)}$$

The level-two and -three models in Equations III.5 and III.6 are of the same form as those used in research question three, and the interpretation of the parameters is comparable, though in relation to performance on the math assessment instead of mobility. In order to explore the relationship between mobility histories and achievement, additional measures will be added to the vector of student-level characteristics, X_{ij}, in the level-two equation. These will be measures of the number of times a student has experienced each type of mobility, separately, prior to the assessments, as well as an interaction between the number and quality of school switches. The three-level modeling approach outlined in Equation III.4 will be estimated in Stata using the **xtmixed** command.

Results

What are the rates of different types of mobility? Results from the first set of descriptive analyses demonstrate that students in the full sample experience residential mobility at around the same rate across waves, ranging from around 16 to 18 percent, with rates increasing slightly over time (see Table III.4). Rates of residential mobility vary across student subgroups, with high-SES students experiencing the lowest rates of residential mobility—between 11 and 13 percent. Low-SES students have the highest rates of residential mobility prior to the third- and fifth-grade waves, 21 and 23 percent, with rates remaining high at 22 percent leading into the eighth-grade wave. By eighth grade, however, other subgroups of students have surpassed the rate of mobility among low-SES students. Prior to this wave, 24 percent of students with disabilities experienced residential mobility, and 23 percent of students with the lowest academic achievement did so.

Across waves and subgroups, the majority of students experiencing residential mobility also experienced a school change—directly caused by the mobility, or not—during the same period (see Table III.4). Only for English language learners in the third-grade wave did the majority of residential moves—64 percent—not coincide with a school switch. Largely, the proportion of residential moves that include a school switch increase over time in a pattern, with rates of over 70 percent for each subgroup by eighth grade. Given that many students move from elementary to middle school between fifth and eighth grades, this jump in concurrent school switches is not surprising.

Despite residential mobility frequently occurring concurrently with school switches, few parents of students who made a residential move report accessing a better school as the reason for their move (see Table III.4). In the full sample, 8, 11, and 7 percent of residential mobility was motivated by accessing a better school in the third-, fifth- and eighth-grade waves, respectively. Across waves, the highest reported rate of residential mobility motivated by school quality is 14 percent among English language learners who moved prior to the third-grade wave. In the fifth-grade wave, moves motivated by school quality drop for this group of students to just under 4 percent, the lowest rate reported across any group and wave. A similar pattern is observed among high academic achievers, among whom 11 percent of residential mobility is motivated by school quality in the third-grade wave and only 4 percent of moves are motivated by access to better school in the fifth grade. By eighth grade, rates of this motivation for residential mobility rise back up to 10 percent.

Table III.4

Residential Mobility Rates across Waves and Student Subgroups

	3rd Grade			5th Grade			8th Grade		
Student group	Residential mobility	Pct. res. mobility w/school switch	Pct. res. mobility for school quality	Residential mobility	Pct. res. mobility w/school switch	Pct. res. mobility for school quality	Residential mobility	Pct. res. mobility and school switch	Pct. res. mobility for school quality
Full sample	15.69%	52.98%	8.38%	16.12%	57.02%	10.53%	17.91%	74.76%	7.35%
Low SES	20.87%	53.82%	10.32%	22.65%	62.10%	9.29%	21.63%	74.71%	8.10%
High SES	10.96%	49.43%	5.99%	11.75%	49.81%	8.69%	13.05%	76.51%	11.56%
White/Asian	14.88%	55.53%	7.55%	14.41%	57.63%	8.66%	17.12%	72.85%	7.27%
Black/ Hispanic	16.93%	49.61%	9.77%	19.04%	57.13%	11.10%	19.72%	76.47%	7.44%
English language learners	13.01%	36.40%	13.53%	15.34%	42.92%	3.89%	--	--	--
Students with disabilities	14.78%	55.00%	4.06%	14.89%	52.04%	6.14%	24.29%	80.77%	11.99%
Low academic achievers	17.51%	52.04%	9.18%	17.64%	64.85%	11.06%	22.96%	81.92%	8.90%
High academic achievers	14.85%	57.45%	10.88%	13.74%	56.83%	4.41%	14.32%	72.89%	9.69%

Sources: Early Childhood Longitudinal Study, Kindergarten Cohort of 1999-99 and the Common Core of Data
Note. Mobility rates are adjusted with sample weights to provide nationally representative figures.

Across student groups, the rates of student mobility prior to the third- and fifth-grade waves include around one-quarter to one-third of students, with rates then jumping to include closer to two-thirds of students prior to the eighth-grade wave (see Table III.5). This jump in mobility rates leading into the eighth grade is consistent with many students making structural moves into middle schools, as evidenced by the coinciding drop in the percent of student mobility that is nonstructural in nature. Across groups, the proportion of mobility that is nonstructural is between 50 and 60 percent for all groups, but nonstructural mobility that occurs prior to the eighth grade accounts for only between 9 and 10 percent of all student mobility.

While the proportion of student mobility that is nonstructural does not vary dramatically across groups, differences remain across subgroups (see Table III.5). In the third-grade wave, for Black and Hispanic students, as well as for students with disabilities, nonstructural mobility accounts for over 60 percent of all student mobility. For high-SES students, on the other hand, only 49 percent of third-grade student mobility is nonstructural. Across waves, Black and Hispanic students consistently have the highest rates of nonstructural mobility for mobile students. High academic achievers, on the other hand, have relatively low rates of nonstructural mobility among mobile students relative to other subgroups across waves.

Table III.5

Student Mobility Rates across Waves and Student Subgroups

	3rd Grade		5th Grade		8th Grade	
Student group	Student mobility rate	Pct. of student mobility nonstructural	Student mobility rate	Pct. of student mobility nonstructural	Student mobility rate	Pct. of student mobility nonstructural
Full sample	21.76%	54.92%	27.75%	48.51%	61.71%	9.76%
Low SES	25.46%	59.45%	33.38%	47.61%	64.36%	9.70%
High SES	18.59%	48.51%	24.80%	50.11%	62.09%	8.65%
White/Asian	20.61%	51.45%	27.17%	43.42%	60.47%	9.79%
Black/Hispanic	23.35%	62.62%	28.90%	58.16%	62.93%	10.02%
English language learners	15.92%	57.43%	25.76%	58.06%	--	--
Students with disabilities	23.86%	60.61%	27.64%	55.77%	66.99%	8.70%
Low academic achievers	24.09%	59.33%	34.40%	49.82%	68.09%	9.03%
High academic achievers	20.67%	54.05%	24.78%	46.59%	59.44%	8.48%

Sources: Early Childhood Longitudinal Study, Kindergarten Cohort of 1999-99 and the Common Core of Data
Note. Mobility rates are adjusted with sample weights to provide nationally representative figures.

What are rates of upward mobility? cross nearly all waves and subgroups of students, the majority of student mobility incidents resulted in a move to a school of higher quality (see Table III.6). In the full sample, 74, 56, and 49 percent of school switches were upward in direction in the third-, fifth-, and eighth-grade waves, respectively. Rates of upward mobility are, in nearly every instance, higher for students who have made a nonstructural move than for students who made a structural move. Among the full sample in the fifth-grade wave, for example, 63 percent of nonstructural moves resulted in enrollment in a higher-quality school, while only 50 percent of structural moves did so.

In the third-grade wave, mobile students who were White and Asian, high achieving or high SES experienced the high rates of upward mobility—77, 75 and 73 percent, respectively. During this same period, the group with the lowest proportion of mobility resulting in improved school quality was English language learners, with a rate of 52 percent. In the fifth-grade wave, high-SES students again saw high rates of upward mobility, and Black and Hispanic and English language learners also had high rates, with 58, 58, and 57 percent of mobile students, respectively. By fifth grade, low-SES students and students with disabilities saw the highest rates of upward mobility with 52 and 55 percent, respectively.

In the third-grade wave, only among high-SES and high-achieving students were rates of upward mobility higher for structural switchers—83 and 78 percent, respectively—than for nonstructural switchers—62 and 72 percent, respectively. In the fifth-grade wave, upward mobility was higher among nonstructural mobility than structural mobility, in all cases. In the eighth-grade wave, low-achieving students had slightly higher upward mobility rates among structural switchers—52 percent—than among nonstructural switchers—51 percent.

Table III.6

Upward Mobility Rates across Waves and Student Subgroups

	3rd Grade			5th Grade			8th Grade		
	Rate among all student mobility	Rate among nonstructural mobility	Rate among structural mobility	Rate among all student mobility	Rate among nonstructural mobility	Rate among structural mobility	Rate among all student mobility	Rate among nonstructural mobility	Rate among structural mobility
Full sample	73.78%	74.36%	72.90%	55.58%	62.61%	49.91%	49.07%	59.68%	47.83%
Low SES	70.91%	74.17%	65.37%	55.93%	60.43%	52.14%	52.05%	57.72%	51.52%
High SES	72.89%	61.86%	83.09%	57.98%	81.26%	38.64%	45.85%	68.69%	42.42%
White/Asian	76.64%	77.26%	75.86%	54.53%	64.09%	48.18%	50.15%	62.76%	47.64%
Black/ Hispanic	66.04%	67.23%	63.97%	57.86%	61.86%	52.70%	47.12%	54.31%	47.97%
English language learners	51.88%	49.01%	56.22%	58.24%	65.91%	47.25%	--	--	--
Students with disabilities	64.87%	65.88%	63.30%	47.36%	54.12%	39.75%	55.40%	56.23%	54.71%
Low academic achievers	60.98%	62.77%	58.37%	46.92%	49.78%	44.48%	51.24%	50.64%	51.95%
High academic achievers	75.13%	72.22%	78.96%	56.71%	75.47%	44.85%	45.48%	47.13%	45.94%

Sources: Early Childhood Longitudinal Study, Kindergarten Cohort of 1999-99 and the Common Core of Data
Note. Mobility rates are adjusted with sample weights to provide nationally representative figures.

Which student- and school-level characteristics are associated with residential, nonstructural, and upward mobility? Results from the multilevel linear probability models predicting residential mobility identify few significant covariates (see Table III.7). Of the student-level covariates, only three significantly predict the likelihood of residential mobility (see Table III.7). The higher a student's SES, the lower the likelihood of residential mobility. Each additional point on the continuous SES scale is associated with a 3 percent decrease in the likelihood of student mobility ($p = .000$). On the other hand, the number of days a student was absent or tardy are both associated with higher rates of residential mobility. For each additional day a student was absent, the probability of experiencing residential mobility increases by 0.2 percent ($p = .000$), and the same pattern and magnitude is true for each additional day a student was tardy ($p = .001$).

Among school-level covariates, only one was found to significantly predict the likelihood of residential mobility (see Table III.7). As the proportion of a student's classmates that are identified as Hispanic increases, the likelihood of that student experiencing residential mobility increases. For each additional percent of the student body made up of Hispanic students in a student's school, the likelihood of residential mobility increases by 0.1 percent ($p = 0.017$). The dearth of significant school-level predictors of residential mobility suggests that school characteristics may not play a large roll in families' decisions to make a residential move.

Table III.7

Multilevel, Linear Probability Model Predicting Residential Mobility with Student- and School-Level Covariates

	Full Model		
	Coef.	Std. Error	p-value
Intercept	0.174	0.051	**0.001**
Time variables (ref. 3rd-grade wave)			
5th-grade wave	-0.011	0.015	0.475
8th-grade wave	0.036	0.029	0.215
Time-invariant student characteristics			
Male	0.002	0.005	0.600
Black (ref. White)	-0.001	0.010	0.917
Hispanic (ref. White)	-0.017	0.009	0.061
Asian (ref. White)	-0.002	0.011	0.863
Other race/ethnicity (ref. White)	-0.007	0.012	0.566
Lagged student characteristics			
SES	-0.029	0.004	**0.000**
Age	-0.001	0.000	0.263
Special ed. participation	0.003	0.008	0.736
English language learner	-0.003	0.014	0.808
Absences	0.002	0.000	**0.000**
Days tardy	0.002	0.000	**0.001**
Math IRT score	0.000	0.000	0.497
Reading IRT score	0.000	0.000	0.996
Lagged school enrollment characteristics			
Total enrollment	0.000	0.004	0.952
Overcrowded	-0.005	0.006	0.425
Pct. FRL	0.000	0.000	0.174
Pct. White	0.000	0.000	0.891
Pct. Black	0.000	0.000	0.806
Pct. Hispanic	0.001	0.000	**0.017**
Pct. Asian	0.000	0.000	0.339
Pct. On grade level math	0.000	0.000	0.753
Lagged school safety conditions			
Weapons at school	0.000	0.010	0.978
Children involved in fights	-0.001	0.006	0.838
Lagged school operational characteristics			
Special ed. school	0.009	0.014	0.522
Gifted program offered	0.001	0.007	0.867
Magnet school	0.002	0.012	0.898
School of choice	-0.004	0.009	0.655
School n	3,990		
Student n	10,510		

Sources: Early Childhood Longitudinal Study, Kindergarten Cohort of 1999-99 and the Common Core of Data

As with residential mobility, results from the multilevel linear probability models predicting nonstructural student mobility identify few significant covariates (see Table III.8). None of the school-level measures included in the model significantly predicted the probability of nonstructural mobility. Among the student-level predictors, four are significantly associated with the likelihood of nonstructural student mobility (see Table III.8). Black students are significantly more likely to experience nonstructural student mobility than their White peers. Black students experience nonstructural student mobility at a rate that is 2 percent higher than their White peers, controlling for student- and school-level covariates ($p = 0.002$). Asian students, on the other hand, experience significantly lower rates of nonstructural mobility than their white peers. Asian students had nonstructural mobility rates that were 1 percent lower than their white peers ($p = 0.036$).

Students' SES and special education status also proved to be significant predictors of nonstructural mobility. In regard to students' family SES, students from better-off families are significantly less likely to experience nonstructural mobility than their lower-SES peers ($p = 0.030$). Special education students, on the other hand, experience a greater likelihood of mobility. Students who were identified as having special education needs are just under 2 percent more likely to experience nonstructural mobility than their non-special education peers ($p = 0.021$).

Table III.8

Multilevel, Linear Probability Model Predicting Nonstructural Student Mobility with Student- and School-Level Covariates

	Full Model		
	Coef.	Std. Error	p-value
Intercept	0.122	0.043	**0.004**
Time variables (ref. 3rd-grade wave)			
5th-grade wave	-0.031	0.013	**0.017**
8th-grade wave	-0.035	0.032	0.267
Time-invariant student characteristics			
Male	0.005	0.003	0.106
Black (ref. White)	0.023	0.008	**0.002**
Hispanic (ref. White)	0.000	0.006	0.954
Asian (ref. White)	-0.014	0.007	**0.036**
Other race/ethnicity (ref. White)	-0.005	0.007	0.490
Lagged student characteristics			
SES	-0.005	0.002	**0.030**
Age	0.000	0.000	0.354
Special ed. participation	0.016	0.007	**0.021**
English language learner	0.003	0.009	0.700
Absences	0.000	0.000	0.099
Days tardy	0.001	0.000	0.093
Math IRT score	0.000	0.000	0.665
Reading IRT score	0.000	0.000	0.294
Lagged school enrollment characteristics			
Total enrollment	-0.006	0.005	0.230
Overcrowded	0.003	0.006	0.582
Pct. FRL	0.000	0.000	0.758
Pct. White	0.000	0.000	0.515
Pct. Black	0.000	0.000	0.109
Pct. Hispanic	0.001	0.000	0.101
Pct. Asian	0.000	0.000	0.428
Pct. On grade level math	0.000	0.000	0.243
Lagged school safety conditions			
Weapons at school	-0.011	0.008	0.175
Children involved in fights	0.009	0.006	0.189
Lagged school operational characteristics			
Special ed. school	0.001	0.012	0.923
Gifted program offered	-0.005	0.005	0.370
Magnet school	-0.007	0.010	0.497
School of choice	-0.001	0.007	0.877
School n	3,940		
Student n	10,400		

Sources: Early Childhood Longitudinal Study, Kindergarten Cohort of 1999-99 and the Common Core of Data

As with residential and nonstructural mobility, results from the multilevel linear probability models predicting upward mobility among students who made a school switch identified few significant covariates (see Table III.9). None of the student-level predictors of upward mobility were significant in the model predicting upward mobility among mobile students (see Table III.9). This is consistent with descriptive findings demonstrating very little variation in rates of upward mobility across subgroups of students (see Table III.6).

Only three of the school-level predictors were significantly associated with the likelihood of upward mobility among mobile students (see Table III.9). As the percent of students' peers that are eligible for free or reduced-price lunch (FRL) increases by one, the likelihood of experiencing upward mobility increases by 0.2 percent ($p = 0.001$). School safety concerns also increase the likelihood of upward mobility. Students who attend a school where the principal has reported that students and/or teachers have been attacked or involved in fights are nearly 6 percent more likely to be upwardly mobile than their peers in schools where fights have not occurred ($p = 0.020$). These findings suggest that students in low-income schools and schools where safety is a concern are more highly motivated to gain access to better quality schools. On the other hand, students who attend schools that offer a gifted program are 5 percent less likely to be mobile than their peers in schools where such a program is not offered ($p = 0.024$).

Table III.9

Multilevel, Linear Probability Model Predicting Upward Student Mobility with Student- and School-Level Covariates

	Full Model		
	Coef.	Std. Error	p-value
Intercept	0.244	0.138	0.086
Time variables (ref. 3rd-grade wave)			
5th-grade wave	-0.082	0.051	0.122
8th-grade wave	-0.119	0.083	0.168
Time-invariant student characteristics			
Male	0.008	0.011	0.435
Black (ref. White)	-0.026	0.024	0.269
Hispanic (ref. White)	-0.035	0.020	0.076
Asian (ref. White)	-0.022	0.031	0.485
Other race/ethnicity (ref. White)	-0.030	0.044	0.503
Lagged student characteristics			
Nonstructural mobility	0.025	0.030	0.417
SES	0.009	0.011	0.425
Age	0.002	0.001	0.201
Special ed. Participation	0.005	0.019	0.807
English language learner	-0.010	0.029	0.743
Absences	0.000	0.001	0.893
Days tardy	0.000	0.001	0.813
Math IRT score	0.000	0.001	0.376
Reading IRT score	0.001	0.000	0.322
Laged school enrollment characteristics			
Total enrollment	-0.013	0.010	0.198
Overcrowded	0.004	0.022	0.869
Pct. FRL	0.002	0.000	**0.001**
Pct. White	0.000	0.000	0.512
Pct. Black	0.000	0.001	0.897
Pct. Hispanic	0.001	0.001	0.415
Pct. Asian	0.001	0.001	0.505
Lagged school safety conditions			
Weapons at school	-0.012	0.023	0.607
Children involved in fights	0.057	0.023	**0.020**
Lagged school operational characteristics			
Special ed. School	0.046	0.062	0.465
Gifted program offered	-0.052	0.022	**0.024**
Magnet school	-0.048	0.040	0.253
School of choice	0.001	0.041	0.985
School n	2,680		
Student n	5,390		

Sources: Early Childhood Longitudinal Study, Kindergarten Cohort of 1999-99 and the Common Core of Data

How are students' mobility histories associated with later achievement? When using multilevel linear models to predict the impact of students' mobility histories on their later achievement, some significant relationships were identified for mathematics achievement (see Table III.10). Measures of both student mobility type and quality were found to be significant predictors. Among the different types of student mobility specified in the second model in Table III.10, only structural mobility was found to result in later math achievement that was significantly different than among non-mobile students. Students who experienced a structural school switch without a residential move have significantly lower math achievement than their peers who did not experience a school switch ($p = 0.018$), after controlling for student- and school-level covariates. No other types of mobility—residential alone, nonstructural alone, residential with a nonstructural school switch, and residential with a structural school switch—were found to be significantly associated with math achievement relative to their peers who remained in the same school.

Table III.10

Multilevel, Linear Model of Student Mobility History as a Predictor of Mathematics Achievement

	Mobility Type			Mobility Quality		
	Coef.	Std. Error	p-value	Coef.	Std. Error	p-value
Intercept	62.26	3.85	**0.000**	62.10	3.80	**.000**
Time variables (ref. 3rd-grade wave)						
5th-grade wave	25.04	0.80	**0.000**	25.08	0.79	**.000**
8th-grade wave	45.37	2.03	**0.000**	45.34	2.00	**.000**
Mobility type (ref. non-mobile)						
Residential	-0.15	0.39	0.699	--	--	--
Nonstructural	-0.68	0.55	0.216	--	--	--
Structural	-0.84	0.35	**0.018**	--	--	--
Residential * nonstructural	0.67	0.88	0.448	--	--	--
Residential * structural	-0.59	0.81	0.466	--	--	--
Mobility quality (ref. non-mobile)						
Mobility	--	--	--	-0.71	0.36	**0.050**
Mobility * upward	--	--	--	-0.38	0.59	0.524
Additional student- and school-level covariates from Table A.1 included, but not displayed for brevity						
School n	4,220			4,280		
Student n	10,940			11,060		

Sources: Early Childhood Longitudinal Study, Kindergarten Cohort of 1999-99 and the Common Core of Data

When modeling the relationship between the quality of a school move and later math achievement (Table III.11), notable differences are present. Students who experienced mobility that was lateral or downward had lower later math achievement than their stable peers ($p = 0.050$), after controlling for student- and school-level covariates. Students who experienced upward mobility, on the other hand, had math achievement that was indistinguishable from that of their stable peers.[3] This finding suggests that the quality of a school switch is important for predicting the impact student mobility may have on future achievement. When students move to a school that is no better, and potentially worse, than their sending school, they may experience lower math achievement because of the disruption caused by their school switch or because the lower quality of their new school has a negative effect on their achievement. Upward moves may mitigate the negative, disrupting effects that seem to be experienced by students who move to a school that is no better or worse than their prior school.

When replicating the analyses presented in Table III.10 to look at reading scores, no significant relationships were found between mobility type or quality and achievement (see Table III.11). Prior research has demonstrated that math achievement is influenced by the quality of instruction students receive to a greater extent than reading achievement (Fryer, 2014; Nye et al., 2004). Similarly, the findings in this chapter suggest that math achievement may be impacted by the disruption associated with school switch in a way that reading achievement is not. Students' prior reading knowledge may be more directly applicable to their new schools and classrooms, whereas expectations of math knowledge and skills may vary more across schools and classrooms.

[3] Additional analyses were conducted to explore whether the relationship between making an upward move and later math achievement varied based on the degree of the school quality increase resulting from a school change. This analysis, which looked separately at moves to a school where student rates of student achievement were one, two, three, or four quartiles above that of their sending school, found that regardless of the degree of quality change, having made an upward move was not significantly associated with later math achievement.

Table III.11

Multilevel, Linear Model of Student Mobility History as a Predictor of Reading Achievement

	Mobility Type			Mobility Quality		
	Coef.	Std. Error	p-value	Coef.	Std. Error	p-value
Intercept	86.15	4.35	**0.000**	86.07	4.33	**0.000**
Time variables (ref. 3rd-grade wave)						
5th-grade wave	27.43	0.89	**0.000**	27.56	0.88	**0.000**
8th-grade wave	50.18	2.25	**0.000**	50.35	2.22	**0.000**
Mobility type (ref. non-mobile)						
Residential	-0.18	0.41	0.668	--	--	--
Nonstructural	-0.14	0.58	0.817	--	--	--
Structural	-0.56	0.43	0.190	--	--	--
Residential * nonstructural	0.92	1.14	0.423	--	--	--
Residential * structural	-1.56	1.03	0.137	--	--	--
Mobility quality (ref. non-mobile)						
Mobility	--	--	--	-0.24	0.48	0.615
Mobility * upward	--	--	--	-1.05	0.83	0.226
Additional student- and school-level covariates included from Table A.1, but not displayed for brevity						
School n	4,210			4,270		
Student n	10,910			11,040		

Sources: Early Childhood Longitudinal Study, Kindergarten Cohort of 1999-99 and the Common Core of Data

To further explore relationships between mobility type and mobility quality and later mathematics achievement, additional descriptive analyses were conducted. Three regression analyses explore the relationship between structural mobility and math achievement over time and whether differences in the relationships between nonstructural or upward mobility and math achievement among students with differing characteristics exists. Descriptive analysis is used to determine whether different types of school changes result in varied rates of upward mobility, broken out by the degree of school quality improvement upwardly mobile students experience in their receiving school. Table III.12 demonstrates that the negative impact of structural mobility without a concurrent residential move identified in Table III.10 is isolated to students who experience structural mobility prior to the fifth-grade wave. In other words, students who experience a structural move between third and fifth grades experience a significant reduction in fifth-grade math achievement ($p = 0.008$), while students who experience a structural move between the first and third grades or between the fifth and eighth grades do not have math achievement that differs significantly from their peers who did not experience mobility. This analysis where mobility was disaggregated by type and timing also demonstrates a significant, negative relationship between nonstructural moves without concurrent residential moves that occur between the fifth and eighth grades ($p = 0.020$).

Table III.12

Multilevel, Linear Model of Study Wave as a Moderator of the Relationship between Math Achievement and Student and Residential Mobility

	Coef.	Std. Error	p-value
Intercept	62.153	3.857	**0.000**
Time variables (ref. 3rd-grade wave)			
5th-grade wave	25.201	0.802	**0.000**
8th-grade wave	45.727	2.078	**0.000**
Interactions (ref. non-mobile)			
Structural * 3rd grade	0.228	0.582	0.695
Structural * 5th grade	-2.410	0.908	**0.008**
Structural * 8th grade	-1.090	0.844	0.197
Nonstructural * 3rd grade	0.684	0.628	0.277
Nonstructural * 5th grade	-1.708	1.151	0.138
Nonstructural * 8th grade	-3.406	1.460	**0.020**
Residential * 3rd grade	-0.011	0.011	0.983
Residential * 5th grade	-0.088	0.742	0.906
Residential * 8th grade	-0.781	1.334	0.558
Structural * residential * 3rd grade	-0.288	1.164	0.805
Structural * residential * 5th grade	3.051	2.046	0.137
Structural * residential * 8th grade	-1.233	1.880	0.512
Nonstructural * residential * 3rd grade	-0.757	1.177	0.521
Nonstructural * residential * 5th grade	1.186	2.104	0.574
Nonstructural * residential * 8th grade	4.825	2.703	0.075
Additional student- and school-level covariates included from Table A.1, but not displayed for brevity			
School *n*	4,220		
Student *n*	10,940		

Sources: Early Childhood Longitudinal Study, Kindergarten Cohort of 1999-99 and the Common Core of Data

The research finds few significant relationships when examining moderating relationships based on student characteristics between nonstructural or upward mobility and math achievement (see Table III.13). In particular, Model 1 in Table III.13 shows that, for the relationships between nonstructural mobility and math achievement, no significant moderating relationships were found among any of the student characteristics explored—race, SES, IEP status, and ELL status.

Table III.13

Multilevel, Linear Models: Student Characteristics as Moderators of Nonstructural or Upward Mobility and Math Achievement

	Nonstructural Mobility			Upward Mobility		
	Coef.	Std. Error	p-value	Coef.	Std. Error	p-value
Intercept	62.029	3.858	**0.000**	61.705	3.794	**0.000**
Time variables (ref. 3rd-grade wave)						
5th-grade wave	25.041	0.798	**0.000**	24.996	0.784	**0.000**
8th-grade wave	45.166	2.030	**0.000**	45.140	1.994	**0.000**
Mobility variable (ref. non-mobile)						
Nonstructural	-0.263	0.729	0.718	--	--	--
Lateral/downward	--	--	--	0.077	0.432	0.859
Upward	--	--	--	-0.344	0.562	0.542
Interactions						
Black * nonstructural	1.420	1.287	0.270	--	--	--
Black * lateral/downward	--	--	--	0.510	0.981	0.604
Black * upward	--	--	--	0.121	1.290	0.925
Hispanic * nonstructural	0.798	1.266	0.528	--	--	--
Hispanic * lateral/downward	--	--	--	0.107	0.960	0.911
Hispanic * upward	--	--	--	-0.022	1.355	0.987
Asian * nonstructural	-1.640	1.848	0.378	--	--	--
Asian * lateral/downward	--	--	--	0.918	1.255	0.465
Asian * upward	--	--	--	0.026	1.774	0.988
Other race/ethnicity * nonstructural	-1.950	1.770	0.271	--	--	--
Other race/ethnicity * lateral/downward	--	--	--	0.242	1.541	0.876
Other race/ethnicity * upward	--	--	--	1.361	2.639	0.613
SES * nonstructural	0.383	0.618	0.536	--	--	--
SES * lateral/downward	--	--	--	1.002	0.443	**0.025**
SES * upward	--	--	--	0.366	0.531	0.531
IEP * nonstructural	-0.948	1.483	0.524	--	--	--
IEP * lateral/downward	--	--	--	-5.883	1.487	**0.001**
IEP * upward	--	--	--	-5.359	2.083	**0.023**
ELL * nonstructural	-0.495	1.611	0.759	--	--	--
ELL * lateral/downward	--	--	--	-0.467	1.100	0.672
ELL * upward	--	--	--	-0.648	1.530	0.675
Additional student- and school-level covariates included from Table A.1, but not displayed for brevity						
School *n*	4,220			4,280		
Student *n*	10,940			11,060		

Sources: Early Childhood Longitudinal Study, Kindergarten Cohort of 1999-99 and the Common Core of Data

Table III.13, Model 2, does show a few significant student characteristics moderators of the relationship between mobility quality and math achievement. For students who made a lateral or downward school change, this mobility strengthened the association between students' SES background and math achievement. For each additional point on the SES scale, students who made a lateral or downward move scored an additional one point on the math assessment ($p = 0.025$). Upward mobility, however, was not a significant moderator of the relationship between students' SES and their math achievement. This suggests that lateral or downward mobility serves to amplify the association between students' SES and their achievement in math, while upward mobility has no impact on this relationship. Also in Model 2 of Table III.13, significant moderating effects of students' IEP status on the relationship between math achievement and both upward and downward/lateral mobility were also found. Students with IEPs experienced diminished math achievement after experiencing mobility, regardless of whether their school switch was upward in nature or not. For both upward and downward/lateral mobility, students with IEPs experienced, on average, over a five-point reduction in math assessment scores ($p = 0.023$ and $p = 0.001$, respectively).

Table III.14 presents the results from descriptive analysis examining the degree of school quality improvement experienced by upwardly mobile students, broken out by mobility type. The results presented in Table III.10 found that a) the quality of a school change moderates the relationship between student mobility and alters math achievement, and b) structural moves without concurrent residential moves were the only type of mobility found to have a significant association with later math achievement. In an attempt to better understand how these two findings may be related, the rates of upward mobility by mobility type were explored. Further, for students who experienced upward mobility, these findings were further broken down by the degree of the school quality improvement they experienced as a result of their school change. As described in Table III.3, a student is considered to have made an upward school change if they move to a school that is in a higher achievement quintile, as measured by the percent of students scoring on grade level in mathematics. To disaggregate this further, Table III.14 looks at the distribution of students making upward school changes that moved to a school that was one, two, three, or four quintiles above their sending school.

Table III.14

Distribution of Mobility Quality Shifts by Type of Student Mobility

	Percent of School Changes Upward	Percent of Upward School Changes by Size of Shift in School Quality Quartile			
		1 Quartile	2 Quartile	3 Quartile	4 Quartile
Structural moves with concurrent residential moves	33%	48%	38%	12%	3%
Structural moves without concurrent residential moves	31%	54%	28%	14%	4%
Nonstructural moves with concurrent residential moves	48%	55%	20%	17%	9%
Nonstructural moves without concurrent residential moves	42%	47%	25%	19%	8%

Sources: Early Childhood Longitudinal Study, Kindergarten Cohort of 1999-99 and the Common Core of Data
Note. Mobility rates are adjusted with sample weights to provide nationally representative figures.

The descriptive results presented in Table III.14 do not demonstrate that nonstructural moves are more likely to result in upward school changes than structural moves are. However, among upward movers, this research does not find drastic differences in the distribution of school quality changes broken out by degree of the quality shift. Structural moves without concurrent residential moves, the only type of mobility found to have a significant, negative association with later math achievement, do have the lowest rates of upward mobility. What's more, over half of these upward moves result in a change of only one quartile. Though no strong pattern is evident of association between the type of school change and the degree of upward mobility, these descriptive findings suggest that structural, non-residential movers experience lower-quality moves than their peers.

Conclusion

The results from this chapter have demonstrated relationships between student and school characteristics and the occurrence of both residential and student mobility, as well as relationships between mobility and future achievement. The descriptive findings reveal patterns that are consistent with and build upon prior literature. Rates of residential mobility remain relatively stable between third and eighth grades, while rates of student mobility take a sharp jump up between fifth and eighth grades. In particular, rates of structural mobility spike as many students move from elementary to middle schools. Low-SES students are more likely, across waves, to experience residential mobility than their high-SES peers. Across waves, Black and Hispanic students consistently have the highest rates of nonstructural mobility among mobile students, while achievers with high levels of academic achievement have relatively low rates of nonstructural mobility among mobile students, relative to other subgroups. Few significant student- or school-level predictors were identified in the regression models estimated for research question three. In line with descriptive findings, these regression results do suggest that students with lower SES are more likely to experience both residential and nonstructural student mobility.

When predicting future math achievement, structural mobility that occurred without a residential move was found to have a significant negative effect on math achievement. Descriptive results found that this type of mobility was least likely to result in enrollment in a higher quality school. This is in line with recent research that has demonstrated that the move to middle school, in particular, can be detrimental for students (Rockoff & Lockwood, 2010). No other type of mobility had a significant relationship with math achievement, after controlling for student- and school-level variables. When examining mobility quality, only mobility that was not upward in nature had a negative relationship with future math achievement. For students who moved into a better school, their math achievement was statistically indistinguishable from that of their non-mobile peers.

IV. CHAPTER THREE – DO CHARTER SCHOOLS IMPACT RATES OF STUDENT MOBILITY? EVIDENCE FROM A RANDOMIZED CONTROL TRIAL OF CHARTER MIDDLE SCHOOLS

Introduction

In this chapter, I aim to improve our understanding of charter school impacts on rates of student mobility. Using data from the Evaluation of Charter School Impacts (ECSI), which leverages admissions lottery results as a natural experiment, I will explore aspects of the policy- and school-driven causes of student mobility. This chapter will focus on the impact of school choice by exploring the effect of charter schools on student mobility rates. Chapter One outlines the varied causes of student mobility that originate from student/family-, school-, and policy-level factors. While the majority of student mobility incidents are initiated by students and their families (Kerbow, 1996; Rumberger, 2003; Rumberger & Larson, 1998), mobility may also be brought on by the practices and procedures of schools or be an intended or unintended result of larger policies.

As described in greater detail in Chapter One, policies that affect student mobility include those that impact the grade structuring of schools, school closure, housing, accountability, and school choice. This chapter takes a particular focus on the impact of school choice, specifically charter schools, on student mobility. Charter schools, and school choice more broadly, may be theorized to either inflate or diminish rates of student mobility. On the one hand, charter schools may contribute to higher rates of student mobility if students are taking advantage of their additional choices by switching schools more often. On the other hand, charter schools may reduce the incidence of mobility if increased schooling options improve families' satisfaction with their school and thus lead to more stability. Studies using observational methods have generally found rates of student mobility to be lower in charter schools than in TPSs (Ahmed-Ullah & Richards, 2014; Dauter & Fuller, 2011; Roy, 2014; Zimmer & Guarino, 2013). These findings support the theory that school choice leads to greater stability.

A couple of studies that leveraged charter admissions lotteries, as this chapter does, found differences in the mobility rates between students who won admissions and those who did not (Abdulkadiroglu et al., 2011; Angrist et al., 2012). Importantly, however, student mobility was not the primary outcome of interest in these studies, which were designed to explore the impact of charter schools on other outcomes such as academic achievement. Instead, these studies explored mobility as only a supplementary analysis or to demonstrate equivalence in sample attrition. Because mobility was not the primary focus of these studies, these analyses do not thoroughly explore or discuss this outcome. This chapter will utilize lottery-based data in order to explicitly examine the impact of charter schools on student mobility.

Chapter One also outlines the ways in which schools may cause student mobility, either indirectly through practices and conditions that may influence enrollment decisions of students and their families, or directly through disciplinary practices and grade structuring that may lead to involuntary mobility. The actual or perceived quality of either the sending or receiving schools can influence voluntary mobility if students and their families choose to change schools in order to escape poor schooling conditions or to attain higher-quality schooling conditions (Rumberger & Thomas, 2000). Voluntary mobility decisions may also be made based on the programs or services available to students (Rumberger, 2003). This chapter will include an exploration of whether measures of school quality, including student-teacher ratios and per-pupil expenditures, and available programs and services, including gifted and talented programs, moderate the impact that charter schools have on student mobility.

This chapter will also explore whether being admitted to a charter school alters the relationship between student mobility and student characteristics. As discussed in Chapter One, prior research has found many student characteristics that are unlikely to be causally linked with student mobility but are associated with student mobility. These include demographic characteristics, such as race/ethnicity, SES, and prior achievement and engagement in school. This chapter will examine whether being admitted to a charter middle school moderates these relationships with the likelihood of student mobility.

The results from this chapter will address deficits in the current literature on student mobility in charter schools. A primary limitation of other studies exploring student mobility in charters and TPSs is their inability to account for the selection bias that is likely present due to systematic differences between students who attend charter schools and those who do not. Other studies exploring charter impacts on other outcomes have addressed this bias by utilizing admissions lottery results as a natural experiment, but this method has not been applied to study mobility directly. By using the ECSI data to examine student mobility, this chapter will utilize the results of charter admissions lotteries to estimate the impact of charter schools on student mobility. In addition to lottery results, this data contains a rich set of variables on student- and school-level characteristics, which will be used to explore variation in impacts based on prior studies on student mobility and charter schools. The research questions posed, and the data and methods used, for this chapter will provide a contribution to the literatures on student mobility and on charter school impacts.

Research Questions

1. Does winning admissions to or attending a charter school impact the likelihood that a student will be mobile during the subsequent two school years?

2. Do impacts of charter attendance vary based on the quality of a study charter schools?
3. Does winning admissions to a charter school moderate the relationship between student mobility and student characteristics that have been demonstrated to be associated with student mobility?

Data

Data for this chapter come from an evaluation of charter school effectiveness, The Evaluation of Charter School Impacts (ECSI) conducted by Mathematica Policy Research (MPR) for the U.S. Department of Education's Institute of Education Sciences (IES). The data from the ECSI study is made available through restricted licenses provided by IES. The description of the data provided in this section comes from the study's final report, *The Evaluation of Charter School Impacts: Final Report*, by Gleason, Clark, Clark Tuttle, Dwoyer, and Silverberg (2010). This study leveraged the outcome of randomized admissions lotteries from oversubscribed charter schools, with lottery winners comprising the treatment group and lottery losers becoming the control group. Because students are randomly selected for admissions, the outcomes of the lotteries represent a natural experiment, and the treatment and control group should be equivalent on all meaningful characteristics, except for whether they won admissions or not. By generating equivalent groups, randomization controls for endogenous variables that might be related to the outcome of interest (Creswell, 2008). In this way, the use of lottery results yields a high degree of internal validity by addressing selection issues associated with differences between students who do and do not attend charter schools, which are not typically accounted for in other types of charter effectiveness studies.

The analysis sample in the ECSI data consists of 2,330 students—1,400 treatment group students and 930 control group students—who applied to at least one of 29 oversubscribed charter middle schools for admissions to the 2005-06 or 2006-07 school years (see Appendix B for a more detailed description of the methods used to identify the sample and collect original data). Participation on the part of the schools and the students was voluntary. The study's original data include measures collected from six different sources: a baseline survey, administrative records, a parent survey, a student survey, a principal survey, and a charter school authorizer survey. These data were supplemented with data from the Common Core of Data, the Private School Survey, School Data Direct, and school-specific report cards found on state department of education websites. These data provide a rich set of information on students and the schools attended by both lottery winners and losers.

To maintain the size of the student and school samples in their analyses, the authors of the ECSI report imputed student- and school-level variables used as controls in their analyses. For student-level data, continuous variables with missing data were imputed using the mean for value for that student's site and cohort; for dichotomous and categorical variables, missing values were imputed using the modal response by site and cohort. Pre-baseline math and reading scores had the highest rates of missing data, with 47 percent of students having missing values on these measures. For other variables, the degree of missing data is much smaller, ranging from 0 percent for baseline math scores, gender, and type of school attended at baseline to 19 percent for students' IEP status. Missing school-level data from the principal survey (e.g., the racial/ethnic makeup of a school, and the proportion of students receiving free/reduced price lunch) was imputed using data from the Common Core of Data and Private School Survey where possible.

The ECSI data also include student-level sample weights that adjust for a given student's likelihood of winning the admissions lottery at study charter schools. To begin, base weights were calculated for treatment and control group members, which calculate the likelihood of group membership after taking into consideration the number of applicants and the number of available slots in the grade to which a student applied. These base weights for the treatment group are equal to $BW_i^T = \frac{1}{N^T + N}$, where NT is equal to the number of lottery applicants admitted and *N* is equal to the total number of lottery applicants (Gleason et al., 2010). The base weights are equal to $BW_i^C = \frac{1}{1-(N^T + N)}$, for the study's control group. The study's researchers then adjusted these base weights to account for an array of other factors related to a student's likelihood of winning admissions. For example, student weights account for the increased probability of admission to a study charter school for students who applied to more than one, for a school's procedure for giving admissions preference to siblings, and for any stratification procedures schools use during the lottery to assure students from different subgroups are admitted at certain numbers. In order to align analyses in the present study with those conducted in the Mathematica report, the imputed values and weights provided in the ECSI data will be used.

As mentioned earlier, the use of randomized lottery results in the design of this study yields strong internal validity; however, this data has limitations as well. In particular, the findings generated by this study are not generalizable to charter schools as a whole—this study has limited external validity. This is a common limitation of experimental studies, which typically examine a localized condition of a more general phenomenon (Shadish, Cook, & Campbell, 2002). Any conclusions reached with this data are only valid for the 29 charter schools in the analysis sample. Descriptive statistics provided in the report highlight some important measurable differences between charter schools in the study and other charter middle schools across the United States. Study charter schools had student populations that were significantly more advantaged, had fewer racial and ethnic minority students, and had students with higher academic achievement than did other charter middle schools (Gleason et al., 2010). Further, study charter schools were on average less likely to take a traditional approach to instruction and paid teachers a higher salary. These comparisons help to highlight that study charter schools are not representative of charter middle schools in the United States, overall. In addition to the measured differences, other differences not captured in the data for this study may likely prevent study charter schools from being comparable to nonparticipating charter middle schools.

Specific to the present study, another limitation arises from the differential probability of student mobility between the baseline year and year one of the study for the lottery winners and losers. For other outcomes, including student achievement, which is examined in the Mathematica report, randomization at baseline ensures equivalence between the treatment and control groups on the outcome of interest at the start of year one. This is not the case for student mobility, however. Students may experience mobility between the admissions lottery at baseline and the beginning of year one, when the treatment of charter attendance begins and students in the treatment and control groups are not equally likely to experience mobility during this period, which may compromise equivalence on the propensity for mobility during years one and two. It is likely that mobility between baseline and year one will be more prevalent among lottery winners than the lottery losers because taking up the treatment necessarily implies engaging in student mobility, while those in the control group may be more likely to remain in their baseline school after failing to gain admissions to a study charter school. This differential likelihood for mobility based on treatment status threatens internal validity to the extent that mobility between baseline and year one is predictive of mobility during the course of the study. The occurrence of differential mobility prior to year one in the data, as well as procedures that will be used to address this, are discussed further in the measures and methods section below.

Measures and Methods

The primary variable of interest in the present study is a measure of whether a student experienced nonstructural mobility during the first two school years after the lottery, or baseline, school year. This variable captures the three possible time points for mobility available in the data: during the first year after the lottery, between the first and second years, and during the second year after the lottery. The ECSI data contain dichotomous variables indicating whether a student switched schools at each of these time points. The measure of mobility used in this study is also coded as a dichotomous variable, where students are identified as having experienced nonstructural mobility midyear during year one or between years one and two receive a value of one, and students who do not experience a nonstructural mobility event receive a value of zero. Any student who was mobile midyear during year one was considered to have made a nonstructural move.

Students were considered to have made a nonstructural move between years one and two under two conditions: 1) students switched schools between years one and two and they were not enrolled in their school's terminal grade during year one (i.e., they could have remained enrolled in their school during year two), and 2) students were missing data on school switching between years one and two but are likely to have made a nonstructural move. In this later condition, the mobility variable was imputed for students who were not enrolled in their school's terminal grade, were missing data on school switches between years one and two and either 1) were missing all other year-two data, or 2) had their school type changed between years one and two. In the first circumstance, it is assumed that a student who was in the data during the baseline and first years of the study, but not in the second year, is likely to have attrited from the study's sample because they changed schools after the first year and the study's researchers were not able to follow up with them and collect data on year two. In the second circumstance, it is assumed that, since a student's school type changed (e.g., from public to private), they are likely to have changed schools. Starting from the reduced mobility sample (entries from the MPR analysis sample with non-missing mobility data), Figure IV.1 details the number of students in the treatment and control groups that were coded as being non-mobile or mobile under the three conditions just described.

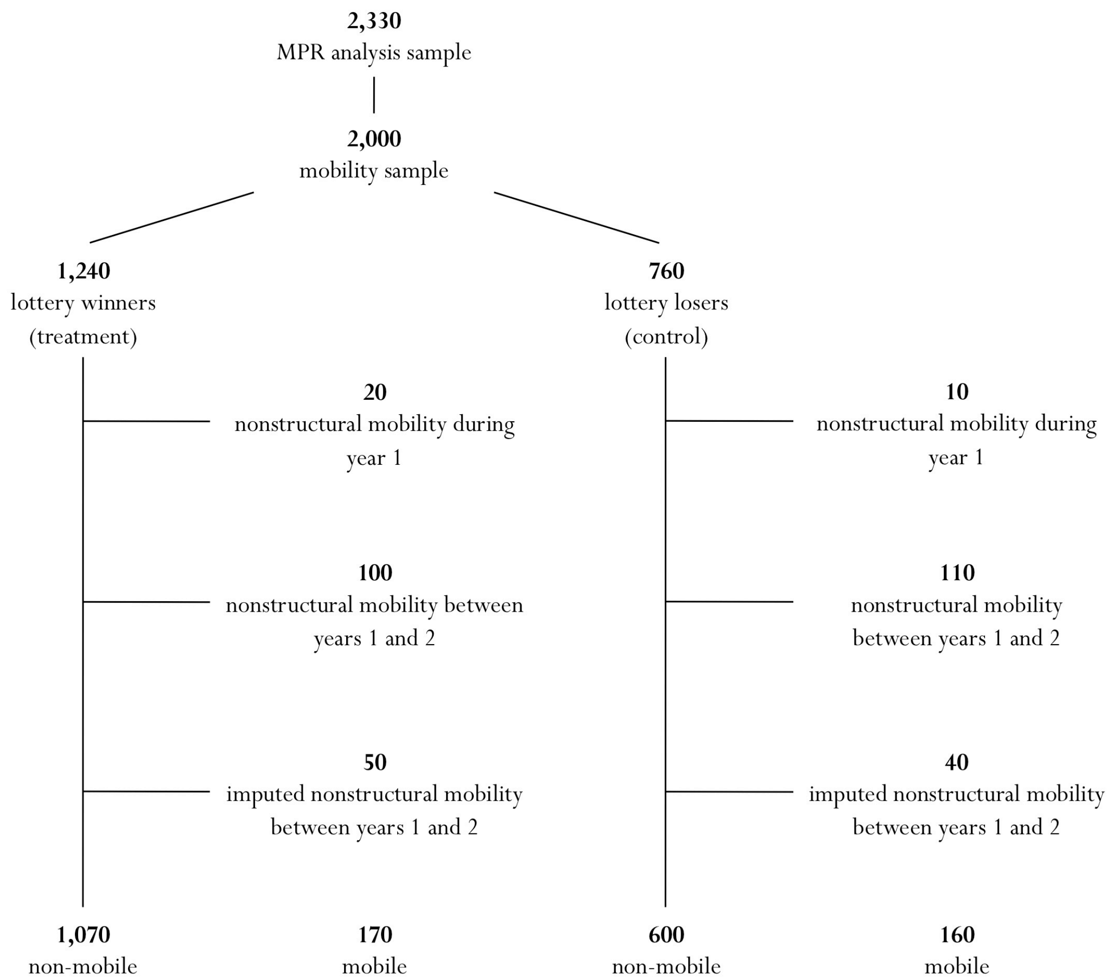

Figure IV.1. Coding diagram for nonstructural mobility variable.

In the data, 2,000 students, or 86 percent of the 2,330 students in the analysis sample, have non-missing data on the mobility variable. The mobility sample is made up of these 2,000 students (as shown in Figure IV.1). Table C.1 describes the student characteristics used in the analyses for this chapter. As described below and demonstrated in Table C.1, this reduced mobility sample retains the equivalence of the treatment and control groups on baseline student characteristics present in the full analysis sample utilized by Mathematica.

Of the 2,000 students in the mobility sample, 16.50 percent experienced a mobility event, as seen in Table IV.1. At the student level, mobility is more prominent among lottery losers than lottery winners, with mobility rates of 21.05 percent and 13.71 percent, respectively. Treatment or control group status is a dichotomous variable provided in the ECSI data and indicating whether a student won or lost admissions to a study charter school as described in the data section.

Table IV.1

Incidence and Rates of Nonstructural Mobility in the Evaluation of Charter School Impacts Data

	Full sample	Treatment group	Control group
Mobile	330 (16.50%)	170 (13.71%)	160 (21.05%)
Non-mobile	1,670 (83.50%)	1,070 (86.29%)	600 (78.95%)
Number of students	2,000	1,240	760

Source: Evaluation of Charter School Impacts

To answer the second research question, exploring variation in impacts across study charter schools with different characteristics, I used additional covariates describing characteristics of the study charter schools to which students applied. The characteristics of interest for this research question are those school-level characteristics related to a school's quality, disciplinary measures, and programs and services offered. Table IV.2 lists the variables associated with study charter school characteristics that are utilized in answering the second research question, and provides descriptive statistics for these variables. Unlike the student-level covariates, the characteristics of study charter schools were not measured at baseline. Student body and operational characteristics were measured in the fall of year one for both the 2005–06 and 2006–07 cohorts of schools. Authorizer characteristics were measured in the fall of 2007—the fall of year two for the 2005–06 cohort and the fall of year one for the 2006–07 cohort. These variables will be used to explore variation in impacts across study charter schools based on the characteristics of these schools at the time in which students in the study were enrolled—the conditions students were exposed to, rather than the conditions that existed at the time of their application.

Table IV.2

Characteristics of Study Charter Schools

	Description	Mean
School Quality		
Student-teacher ratio†	Average student-teacher ratio	15.07 (1.031)
Average daily attendance	Proportion of students in attendance on an average school day	94.87 (.512)
Length of school day	Length of school day in hours	7.24 (.170)
Length of school year	Length of school year in days	180.82 (1.166)
School age	Age of charter school in years	7.12 (.429)
Expenditures per student	Total expenditures per student in dollars	7378.63 (444.36)
Disciplinary Characteristics		
Suspension incident rate	In-school and out-of-school suspension incident rate per 100 students	0.11 (.032)
Suspended student rate	Number of students receiving in-school or out-of-school suspensions per 100 students	0.06 (.013)
Program and Services Availability		
No LEP supports	Dichotomous indicator equal to 1 if the charter school does not offer instruction to support the needs of LEP students, otherwise 0	0.49 (.091)
Gifted and talented program	Dichotomous indicator equal to 1 if the charter school has a gifted and talented program, otherwise 0	0.70 (.085)
Number of Schools*		29

Source: Evaluation of Charter School Impacts

Note. Standard deviations in parenthesis.

* The number of schools with non-missing data varies across measures, with most having data from the full 29 schools and none missing data from more than three schools.

† These variables were created by Mathematica and contain information from both Mathematica surveys and, when missing, from NCES, Common Core of Data.

In answering the third research question, additional student-level covariates will be utilized to determine whether student characteristics moderate the impact of charter admissions on student mobility. The student characteristics of interest are those that have been demonstrated, through prior research, to have a relationship with the likelihood of nonstructural student mobility. Table

C.1 lists the student characteristics utilized in answering the third research question, as well as additional covariates that will be used as controls in the analysis, and provides descriptive statistics for these variables among the sample of students with non-missing mobility data. This table demonstrates that the reduced mobility sample retains balance on student characteristics of interest for the present study.

The only student-level variable presented in Table C.1 that has significantly different values among lottery winners and losers is that for student mobility between the baseline year and year one of the study. This variable includes both structural and nonstructural moves. While the majority of both lottery winners and losers changed schools between baseline and year one, students in the treatment group—those who won admissions to a study charter school—were significantly more likely to change schools between baseline and year one than lottery losers. Because students may be more or less likely to make a move in subsequent years depending on whether they switched schools between baseline and year one, it will be important to account for this imbalance in my analyses.

To answer the research questions, linear probability models (LPMs) with school-level fixed effects will be employed to calculate both the intent-to-treat (ITT) and treatment on the treated (TOT) estimates of charter school impacts on student mobility. By applying the ordinary least squares (OLS) framework in the case of a dichotomous dependent variable, LPMs compute the change in the probability of "success"—the case in which the dichotomous outcome is equal to one—associated with a given variable, controlling for any additional covariates (Wooldridge, 2002). In this case, "success" occurs when a student experiences nonstructural mobility, as defined above. The inclusion of the school-level fixed effects accounts for the study design, where students were randomized into treatment and control groups in each charter site, separately, which amounts to 29 mini-experiments within the larger study.

Because of the application of a linear modeling strategy to a dichotomous dependent variable, limitations are associated with LPMs. For one, LPMs can produce predicted probabilities that have a value greater than one or less than zero for some cases in the sample. This limitation can cause complications when trying to calculate predicted probabilities for various cases in the sample; however, this is not the primary aim of this chapter. As Wooldridge explains, "[p]redicted probabilities outside the unit interval are a little troubling when we want to make predictions, but this is rarely central to an analysis. Usually, we want to know the ceteris paribus effect of certain variables on the probability" (2002, p. 236). In addition to this limitation, LPMs violate the homoskedasticity assumption for OLS models—that the variance of the unobservable error is constant across values of the explanatory variables—which can result in inaccurate test statistics (Wooldridge, 2002). In LPMs, due to the binary dependent variable, heteroskedasticity is inevitable unless the probability does not depend on any of the independent variables. This limitation can be easily addressed by using heteroskedasticity-robust procedures that produce test statistics that "are valid—at least in large samples—whether or not the errors have constant variance, and we do not need to know which is the case" (Wooldridge, 2002, p. 251). Despite the limitations of these models, LPMs are frequently used because they are easy to interpret and provide accurate hypothesis tests in larger samples when robust standard errors are used to account for potential heteroskedasticity (Wooldridge, 2002). In STATA, robust standard errors are automatically computed when sample weights are applied using the **pweight** option, as is the case for the analysis in this chapter. For the analyses in this chapter, LPM models will be estimated with STATA's **reg** command with sample weights and the **vce(cluster)** option at the charter lottery level; this procedure computes robust standard errors and accounts for selection into the treatment group occurring separately for each study charter school.

In calculating the ITT estimate, individuals randomly assigned to the treatment group—all those who won admissions to a study charter school—are included in the impact estimate, regardless of whether or not they actually attended a study charter school. This method retains the random assignment and its associated benefits (Shadish et al., 2002), but this estimate will describe the impact of winning charter admissions on student mobility, rather than that of charter attendance on student mobility. The ITT estimate is of particular importance to policy research because it estimates the impact of a program under the condition of imperfect implementation, which is likely to occur in practice (Shadish et al., 2002). The ITT models estimate the impact of offering a student the option of attending a study charter school.

To estimate the ITT for the first research question, the model depicted in Equation IV.1 will be applied to the ECSI data using the measures described above.

$$\Pr(Y_{ij} = 1) = X_{ij}\beta + \delta_j(admitted_{ij}) + \theta_j + \varepsilon_{ij} \tag{IV.1}$$

In this equation, Pr(Yij = 1) represents the probability of mobility for a student *i* in school *j*. In order to include school-level fixed effects, separate dummy variables are entered into the model for each school, with one school serving as the omitted category. This series of dummies is represented by θj in Equation IV.1. Inclusion of these school-level fixed effects is necessary given the design of the study, where students are randomly assigned to each of the 29 schools separately—this amounts to 29 separate mini-experiments within the larger experimental analysis—with different probabilities of assignment to the treatment group depending on which school a student applied to. A vector of student-level baseline control variables, represented by

$X_{ij}\beta$ in Equation IV.1, includes those listed above in Table C.1. The δj coefficient is equal to the difference in the odds of mobility between the control and treatment groups. If this coefficient is significant, this indicates a significant difference in the odds of student mobility between lottery winners and losers.

In addition to estimating the impact of charter admissions on student mobility, this paper will estimate the impact of charter attendance on student mobility. Simply excluding students who did not comply with their assignment to either the treatment or control group would result in biased findings, since students' compliance is likely associated with other characteristics that may be related to the outcome (Gleason et al., 2010). Instead, in order to estimate the impact of attending a charter school on student mobility, this paper will take an instrumental variable (IV) approach to calculating the TOT impact estimate. An IV is correlated with the outcome only through some other mediating variable(s) (Angrist, Imbens, & Rubin, 1996; Shadish et al., 2002). To estimate the TOT impact, treatment status will be used as an IV for charter school attendance. In this way, the TOT models estimate the impact of attending a study charter school, rather than simply being offered attendance. This method has been used in other charter lottery studies (Abdulkadiroglu et al., 2011; Angrist et al., 2012; Gleason et al., 2010; Hoxby & Murarka, 2009).

The procedure for estimating the TOT impacts using treatment status as an IV involves estimating two-stage least squares models (Gleason et al., 2010). In the first stage, a dichotomous variable indicating whether or not a student attends a study charter school is regressed on treatment status. The model estimated for this first stage is outlined in Equation IV.2.

$$\Pr\left(A_{ij} = 1\right) = X_{ij}\beta + \alpha_j\left(admitted_{ij}\right) + \theta_j + \varepsilon_{ij} \qquad \text{(IV.2)}$$

In this equation, Pr(Aij = 1) represents the probability that student *i* who was admitted to school *j* will attend a charter middle school—either a study charter school or a non-participating charter school. As above, θj is a dummy variable indicating to which charter school a student applied, which serves as a school-level fixed effect, and $X_{ij}\beta$ is a vector of student-level control variables. The difference in the probability of attending a charter middle school between the treatment and control groups is denoted by αj in Equation IV.2. The estimated probability of charter school attendance calculated in stage one is then entered in the second stage into Equation IV.3.

$$\Pr(Y_{ij} = 1) = X_{ij}\beta + \gamma_j(\hat{A}_{ij}) + \theta_j + \epsilon_{ij} \qquad \text{(IV.3)}$$

In this equation, the probability of mobility is regressed on the estimated probability of attending a charter school. The coefficients in Equation IV.3 hold the same interpretation as in Equation IV.1, with γ_j equal to the impact of charter attendance on student mobility.

As Gleason et al. (2010) explain, two assumptions must be made about the ECSI data in order for treatment status to serve as a reasonable instrument for charter school attendance:

1. Admission to a charter school is highly predictive of whether a student attends a charter school.
2. Admission to a charter school is correlated with the outcome variable only through the effects of charter school attendance (Gleason et al., 2010, p. D-11).

The first assumption can be directly tested and is supported by the data. In the ECSI data, 78 percent of lottery winners attend a study charter school, compared to only 6 percent of lottery losers (Gleason et al., 2010). The second assumption, however, cannot be directly tested. If this assumption is violated, having won the lottery would impact student mobility for those students who do not attend a study charter school, and having lost the lottery would impact student mobility for those students who wind up attending a study charter school. If, for example, lottery losers who go on to attend study charter schools begin at the school later in the year than lottery winners, thus being exposed to a small dosage of the treatment, this assumption may be violated. A violation of the second assumption could bias the TOT estimate (Angrist et al., 1996).

The same general procedure outlined in Equations IV.2 and IV.3 will be used to generate TOT estimates for the second research question. The first stage results from Equation IV.2 will be entered as in modified second stage models. These models expand on Equation IV.3 and include an interaction between the probability of attending a study charter school and school-level covariates of study charter schools, with each characteristic added individually in separate models taking the form outlined in Equation IV.4.

$$\Pr\left(Y_{ij} = 1\right) = X_{ij}\beta + \gamma_j\left(\hat{A}_{ij}\right) + \varsigma_j(\hat{A}_{ij} \times schoolchar_{ij}) \qquad \text{(IV.4)}$$

In addition to the parameters present in Equation IV.3, Equation IV.4 includes ς_j, which is an estimate of the moderating effect of a study charter school characteristic on the impact of attending a study charter school on student mobility.4 This coefficient describes whether the impact of charter school attendance on student mobility varies based on the characteristics of study charter schools and is the primary estimate of interest for this research question.

To answer the third research question, ITT estimates will be computed using a model similar to Equation IV.1. This more general model will be modified to include interactions between

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[4] Main effects for the school characteristics are not included in these models because many variables were measured only for study charter schools and not for the schools attended by students who did not win the lottery. This mirrors the modeling procedure used by Gleason et. al (2010).

treatment status—lottery outcome—and student-level covariates that have previously been demonstrated to be associated with student mobility in order to test whether charter admissions moderate the relationship between these characteristics and nonstructural mobility.

$$\Pr(Y_{ij} = 1) = X_{ij}\beta + \delta_j(admitted_{ij}) + \varphi_j(admitted_{ij} \times X'_{ij}) + \theta_j + \varepsilon_{ij} \quad \text{(IV.5)}$$

In Equation IV.5, φ_j is an estimate of the moderating effect of winning admissions to a charter school on the relationship between vector student-level covariates, designated by X'_{ij}, and student mobility. In other words, it identifies the differences between lottery winners and losers in the relationship between the student-level covariates and the probability of mobility; these are the primary coefficients of interest in these models. The vector of student-level covariates represented by X'_{ij} is a subset of those in X_{ij} and includes those variables that prior research has demonstrated to be related to the incidence of mobility, including race, SES, and prior academic achievement and engagement.

Results

Does winning admissions to or attending a charter school impact the likelihood that a student will be mobile? To answer the first research question, LPMs were employed to generate both ITT and TOT estimates of the impact of charter middle schools on nonstructural student mobility. As shown in Models 1 and 3 of Table IV.3, based on both the ITT and TOT models, study charter schools significantly reduced rates of student mobility. Students who won admissions to a study charter school, regardless of whether or not they attended, were 9 percent less likely to engage in a nonstructural move ($p = 0.001$) during the first school year after the lottery or the summer prior to the second school year (see Table IV.3, Model 1). Similarly, as the probability that a student attends a study charter school increases from zero to one, there is a 13 percent decrease in the likelihood of nonstructural student mobility (p = 0.001) during or in the summer after the first school year (see Table IV.3, Model 3). The greater magnitude of the TOT coefficient relative to the ITT coefficient makes sense given that this estimate does not include admitted students who did not attend study charter schools.

Table IV.3

Impact of Charter Middle Schools on Student Mobility: Intent-to-Treat and Treatment on the Treated Linear Probability Model Results

	Model 1		Model 2		Model 3	
	Intent-to-Treat		Treatment on the Treated			
			1st Stage		2nd Stage	
	Coef.	p-value	Coef.	p-value	Coef.	p-value
Treatment (ref. control)	-0.09 (0.024)	**0.001**	0.69 (0.047)	**0.000**		
Prob. attend study charter					-0.13 (0.035)	**0.001**
Changed school btw baseline & year 1	0.06 (0.037)	0.124	0.23 (0.043)	**0.000**	0.09 (0.036)	**0.022**
Constant	-0.08 (0.078)	0.316	0.11 (0.106)	0.310	-0.07 (0.079)	0.413
R-square	0.090		0.595		0.090	
student *n*	1,862		1,862		1,862	
study charter school *n*	29		29		29	

Source: Evaluation of Charter School Impacts
Notes. Robust standard errors in parenthesis.
Standard errors adjusted for clustering at the 29 study charter schools.
All student characteristics from Table C.1 included as controls in the model.

In line with the descriptive results, the findings presented in Table IV.3 demonstrate that, for students who applied to a study charter school, gaining admissions to and attending a charter school reduces the likelihood of student mobility. To elaborate on this finding in the aggregate sample, the results from research questions two and three examine whether this impact varies based on characteristics of the study charter schools or the students who applied to them.

Do impacts of charter admissions vary based on charter school characteristics? To answer the second question, a series of LPM models was estimated to explore whether the characteristics of study charter schools moderate the impact of charter admissions on nonstructural student mobility. Tables IV.6.a and IV.6.b contain results from models examining whether characteristics of the quality of study charter schools moderate the impact of charter admissions and student mobility. As shown in Table IV.4, study charter schools' student-teacher ratios, average daily attendance rates, and expenditures per pupil did not moderate the relationship between charter attendance and nonstructural student mobility.

Table IV.4

Linear Probability Model Results of Study Charter School Quality as a Moderator of Charter School Impacts on Student Mobility

	Model 1		Model 2		Model 3	
	Coef.	p-value	Coef.	p-value	Coef.	p-value
Prob. attend study charter	-0.13 (0.035)	**0.001**	-0.14 (0.034)	**0.000**	-0.14 (0.042)	**0.002**
Prob. attend study charter * avg. student-teacher ratio	-0.00 (0.009)	0.983	--		--	
Prob. attend study charter * avg. daily attendance	--		0.01 (0.010)	0.165	--	
Prob. attend study charter * expenditures per student	--		--		0.00 (0.000)	0.214
Constant	-0.07 (0.079)	0.413	-0.05 (0.080)	0.511	0.02 (0.093)	0.873
R-square	0.090		0.091		0.092	
student *n*	1,862		1,836		1,526	
study charter school *n*	29		28		26	

Source: Evaluation of Charter School Impacts

Notes. Robust standard errors in parenthesis.

Standard errors adjusted for clustering at the 29 study charter schools.

All student characteristics from Table C.1 included as controls in the model.

All student- and school-level continuous variables grand-mean centered.

In Table IV.5, Model 3 also demonstrates that the moderating relationship of the age of study charter schools plays no role in the relationship between charter attendance and student mobility. However, Models 1 and 2 in this table do demonstrate significant moderating relationships. Both the length of the school day and the length of the school year in study charter schools are significantly related to the likelihood of student mobility for lottery winners. As shown in Model 1, as the length of the school day increases by one hour, the likelihood of student mobility among lottery winners sees a statistically significant increase of 7 percent ($p = 0.048$). Similarly, as shown in Model 2, for each additional day in the school year of a study charter school, the likelihood of student mobility among lottery winners increases a statistically significant 1 percent ($p = 0.004$). Of the school quality measures, only those related to the length of the school day and year were found to moderate the likelihood of mobility among students attending study charter schools.

Table IV.5

Linear Probability Model Results of Study Charter School Quality as a Moderator of Charter School Impacts on Student Mobility

	Model 1		Model 2		Model 3	
	Coef.	p-value	Coef.	p-value	Coef.	p-value
Prob. attend study charter	-0.13 (0.034)	**0.001**	-0.14 (0.032)	**0.000**	-0.13 (0.035)	**0.001**
Prob. attend study charter * school day length	0.07 (0.031)	**0.048**	--		--	
Prob. attend study charter * school year length	--		0.01 (0.003)	**0.004**	--	
Prob. attend study charter * school age	--		--		0.01 (0.011)	0.445
Constant	-0.02 (0.083)	0.784	0.01 (0.080)	0.936	-0.05 (0.081)	0.518
R-square	0.095		0.097		0.091	
student *n*	1,853		1,853		1,853	
study charter school *n*	29		29		29	

Source: Evaluation of Charter School Impacts
Notes. Robust standard errors in parenthesis.
Standard errors adjusted for clustering at the 29 study charter schools.
All student characteristics from Table C.1 included as controls in the model.
All continuous variables grand-mean centered.

When looking at study charter schools' disciplinary characteristics and their offerings of programs and services, there was no evidence of significant moderating effects on the impact of charter attendance and student mobility (see Appendix D for regression results). Neither the rate of suspension incidents nor the rate of students who received a suspension was significantly related to the likelihood of mobility among study charter school attendees. In other words, based on these measures, mobility rates among charter attendees were not impacted by rates of discipline within study charter schools. Further, neither the presence of a gifted and talented program nor the absence of support services for LEP students was significantly associated with the likelihood of mobility among study charter school attendees. These findings suggest that study charter school attendees' mobility choices were not influenced by the presence of LEP supports or gifted and talented programs.On the whole, little evidence demonstrates that the quality, discipline practices, or availability of services or programs of charter schools influenced rates of mobility among students who were admitted to study charter schools. The only significant moderating relationships were with the lengths of the school day and school year. While overall, study charter schools have a significant, negative impact on the likelihood of student mobility, each additional hour in the school day and additional day in the school year diminishes the impact of this relationship.

Do charter admissions moderate the relationship between student characteristics and student mobility? To answer the third question, an LPM model, shown in Table IV.6, was estimated to explore whether admissions to a study charter school moderates previously established relationships between student characteristics and the propensity for nonstructural mobility. The treatment group was set as the reference category, so that coefficients can be interpreted relative to their likelihood of mobility. Very few of the student characteristics found in prior studies to be significantly associated with student mobility are significant predictors of nonstructural mobility among this sample, but among those that are significantly associated, the relationship is different for treatment and control group students.

Relative to White lottery winners, Black lottery losers were significantly less likely to experience nonstructural mobility. Black students who lost admissions lotteries were 16 percent less likely to be mobile than While lottery winners ($p = 0.001$). Similarly, relative to non FRL-eligible lottery winners, FRL-eligible lottery losers were less likely to experience mobility. FRL students who lost charter lotteries were 7 percent less likely to be mobile than their better-off peers who won admissions to a study charter school—this relationship verged on statistical significance with $p = 0.055$. On the other hand, FRL-eligible lottery winners were significantly more likely to be mobile than their non-eligible peers who also won lotteries. Lottery winners who were FRL-eligible were 8 percent more likely to experience nonstructural mobility than their better-off peers who also won admissions to study charters ($p = 0.003$).

Table IV.6

Linear Probability Model Results of Charter School Admissions as a Moderator of Association between Student Characteristics and Student Mobility

	Coef.	Robust Std. Error	p-value
Control (ref. treatment)	0.12	(0.036)	**0.003**
White	*Reference*		
Black	0.07	(0.043)	0.134
Black * control	-0.16	(0.042)	**0.001**
Hispanic	0.00	(0.033)	0.891
Hispanic * control	0.03	(0.063)	0.660
Free/reduced lunch eligible	0.08	(0.024)	**0.003**
Free/reduced lunch eligible * control	-0.07	(0.037)	**0.055**
Income/poverty ratio	-0.00	(0.005)	0.607
Income/poverty ratio * control	0.01	(0.012)	0.246
Reading Achievement	-0.01	(0.024)	0.755
Reading Achievement * control	0.03	(0.025)	0.203
Math Achievement	-0.01	(0.014)	0.678
Math Achievement * control	-0.03	(0.027)	0.263
IEP status	0.00	(0.045)	0.977
IEP * control	-0.01	(0.050)	0.781
LEP status	-0.03	(0.049)	0.603
LEP * control	0.03	(0.053)	0.558
Old for grade	-0.00	(0.067)	0.994
Old for grade * control	0.22	(0.113)	0.065
Days absent	0.01	(0.003)	**0.017**
Days absent * control	-0.00	(0.004)	0.278
Suspended	0.21	(0.080)	**0.014**
Suspended * control	-0.31	(0.121)	**0.018**
Changed school btw baseline & year 2	0.06	(0.036)	0.119
Constant	-0.15	(0.073)	0.043
R-square	0.118		
student n	1,862		
study charter school n	29		

Source: Evaluation of Charter School Impacts

Notes. Standard errors adjusted for clustering at the 29 study charter schools.

All student characteristics from Table C.1 included as treatments in the model.

All continuous variables grand-mean centered.

Students' prior educational engagement and disciplinary background increased the likelihood of mobility among lottery winners. Each additional day a student was absent at baseline is associated with a 1 percent increase in the likelihood of nonstructural mobility ($p = 0.017$). Similarly, students who experienced a suspension during the baseline school year were 21 percent more likely to be mobile ($p = 0.014$). Lottery losers who were suspended at baseline, on the other hand, were significantly less likely to be mobile than lottery winners who did not experience a baseline suspension. Previously suspended lottery losers were 31 percent less likely to be mobile than non-suspended lottery winners ($p = 0.018$).

These findings highlight some moderating relationships between admissions to study charter schools and student characteristics that prior research has demonstrated to be associated with student mobility. Both Black and low-income students who lost lotteries were less likely to experience mobility than their White and better-off peers who won charter lotteries, while looking only among lottery winners, FRL-eligible students were significantly more likely to be mobile than their non-eligible peers. Further, students who were admitted to study charter schools and had a history of absenteeism or suspension were more likely to make a nonstructural exit than lottery winners who attended school with greater fidelity and had no history of disciplinary infractions. For students who lost admissions lotteries, a history of disciplinary troubles had the opposite relationship, with those who experienced a suspension at baseline more likely to remain in their school than lottery winners without a suspension history. These comparisons highlight situations where lottery losers from groups that are more likely to experience mobility according to prior research actually have lower mobility rates than their lottery-winning peers from groups that prior research has found to have lower likelihoods of mobility.

Conclusion

Findings from this chapter demonstrate that gaining admissions to or attending a study charter school reduced the likelihood of mobility for students. When exploring whether this relationship was moderated by school quality measures, only the lengths of the school day and school year were significantly associated with the likelihood of student mobility. Among students who attended study charter schools, longer school days and years were associated with higher rates of student mobility. When examining how charter admissions moderate relationships between student characteristics and the likelihood of mobility, results suggest charter admissions do moderate some relationships between student mobility and student background characteristics, namely race and family income. Further, students admitted to study charter schools who had a history of absenteeism or suspension had a significantly higher likelihood of mobility, while no relationship between absenteeism and mobility among lottery losers was found. Further, a negative relationship existed between a history of suspension mobility among these students. In Chapter Five, the discussion chapter, the findings from this chapter will be discussed in the context of the framework laid out in Chapter One, the results from the other two empirical chapters, and previous findings from other literature.

V. CHAPTER FOUR – STUDENT MOBILITY IN COLORADO'S TRADITIONAL PUBLIC AND CHARTER SCHOOLS

Introduction

Using school-level administrative records from the state of Colorado, this chapter aims to describe the occurrence of student mobility in the entire population of traditional public schools (TPSs) and charter schools in a single state. Chapter One outlines causes of student mobility that originate from student/family-, school-, and policy-level factors. As that chapter described, while the majority of student mobility incidents are brought on by the actions and circumstances of students and their families (Kerbow, 1996; Rumberger, 2003; Rumberger & Larson, 1998), mobility may also be caused by school- and policy-level influences. By examining student mobility in the context of charter schools, this chapter will address one of the policy-level causes of student mobility, school choice, that was described in Chapter One. Further, this chapter will explore whether any relationship between school sector and student mobility rates is moderated by other school characteristics, including those related to school quality, one of the school-level causes of student mobility outlined in Chapter One.

Chapter One describes in greater detail the types of policies that affect student mobility, including those concerning the grade structuring of schools, school closure, housing, accountability and school choice. This chapter takes a particular focus on the impact of charter schools, a type of school choice, on student mobility. The implementation of school choice policies, including those that allow for charter schools, may be theorized to either increase or reduce student mobility. Charter schools may contribute to higher rates of student mobility if students change schools more often in order to take advantage of additional schooling options. Conversely, providing increased school options through charter school policies may reduce student mobility by improving student and family satisfaction with their school, which may lead to more stability. Studies of student mobility in charters and TPSs have generally found rates of student mobility to be lower in charter schools than in TPSs (Ahmed-Ullah & Richards, 2014; Dauter & Fuller, 2011; Roy, 2014; Zimmer & Guarino, 2013). These findings support the theory that school choice reduces the occurrence of student mobility. Other studies that leveraged student admissions lottery results to study the impact of charter schools found no difference in mobility rates between students who won lotteries and those who lost (Abdulkadiroglu et al., 2011; Angrist et al., 2012). Unlike in the studies using observational methods, these findings suggest that charter schools may not impact mobility rates; however, other student outcomes were the primary focus of these studies and the analyses were not designed with the intention of studying student mobility. Together, these studies present mixed evidence on the impact of school choice on student mobility and demonstrate the need for future research.

In addition to policy-level causes of mobility, Chapter One discusses ways in which schools may indirectly influence student mobility rates through practices and conditions, including those related to school quality, that may impact voluntary mobility decisions of students and their families. This chapter will explore whether measures of school quality, including school-level academic performance and student-teacher ratios, are predictive of student mobility and whether they moderate any relationships between school sector and student mobility. Students may engage in voluntary mobility motivated by the actual or perceived quality of either their sending or receiving schools (Rumberger & Thomas, 2000). Students and their families may choose to change schools if they are experiencing poor schooling conditions or are able to attain access to a higher-quality school setting.

By examining policy- and school-level causes of student mobility in an entire state, this chapter will contribute to the literature on student mobility, especially in the context of charter schools. The majority of studies examining student mobility in charter schools have focused on a single, typically urban, school district. By using data from the entire state of Colorado, this paper will provide findings from a larger and more varied context than other studies and may thus yield different results. The publicly available school-level administrative data from the state of Colorado that is used for this chapter includes an array of measures of school characteristics, which will allow for the exploration of contextual differences in the relationship between school sector and student mobility, including those related to school quality.

Research Questions

1. What are rates of student mobility in Colorado traditional public and charter schools, overall and for subgroups of students?
2. Are rates of mobility different in the charter and TPS sectors, overall and among subgroups of students, after controlling for measures of school quality, school composition, market density, and regional characteristics? Which measures of school quality are significantly associated with school-level mobility rates?
3. Does school quality moderate the relationship between school sector and student mobility, overall and among subgroups of students?

Data

Data for this chapter come from two sources: administrative records from the Colorado Department of Education (CDE) and the U.S. Department of Education's annual survey of public schools nationwide, the Common Core of Data (CCD). Data from the CDE and CCD were combined to create a comprehensive data set of publicly available data on school-level characteristics. These data, though not without limitations, allow for an exploration of student mobility in the traditional public and charter school sectors across the entire state of Colorado.

Colorado was selected as the focal state for this chapter for two primary reasons. First, the size of the charter school market in the state allows for a comparison between the TPS and charter sectors. According to the National Alliance for Public Charter Schools (n.d.-b), 10.4 percent of public school students were enrolled in charters during the 2012–13 school year (the last year for which mobility data is available from CDE). This is considerably higher than the national average of 6.3 percent of public school students enrolled in charter schools. Table V.1 lists the number of TPS and charter schools in Colorado in each of the six years used in this study. In the first year of data, the 2007–08 school year, 124 brick-and-mortar charter schools—those with a physical campus, as opposed to an online school—were not designated as an alternative school in operation in Colorado;5 by the final year, the 2012–13 school year, 172 such charter schools operated in Colorado. The charter sector in Colorado has grown rapidly in recent years, with 66 charters opening in the state between 2009–10 and 2013–14 (National Alliance for Public Charter Schools, 2014). The relatively large size of the charter school market in Colorado, in terms of the number of charter schools and the proportion of student enrollments, makes Colorado an ideal state for comparing the TPS and charter sectors.

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[5] For the analyses in this chapter, online, home school-focused, alternative, and vocational education schools were excluded from both the charter and TPS samples. The online and home school support schools were excluded so as to focus only on schools with brick-and-mortar campuses, alternative schools were excluded because these schools serve special populations of students, and vocational schools were excluded because no charter schools fell into this category.

Table V.1

Number of Traditional Public and Charter Schools in Colorado from 2006–07 through 2012–13

Year	Charter	TPS	Total
2007–08	124	1525	1649
	(7.5)	(92.5)	(100.0)
2008–09	132	1539	1671
	(7.9)	(92.1)	(100.0)
2009–10	141	1538	1679
	(8.4)	(91.6)	(100.0)
2010–11	152	1535	1687
	(9.0)	(91.0)	(100.0)
2011–12	163	1537	1700
	(9.6)	(90.4)	(100.0)
2012–13	172	1538	1710
	(10.1)	(89.9)	(100.0)

Source. Colorado Department of Education
Note. Row percentages in parentheses.

In addition to the considerable charter school market in Colorado, this state is additionally ideal for this study because the CDE collects relatively detailed data on school-level mobility rates for both TPSs and charter schools. Based on an examination of state department of education websites, Colorado is one of only a handful of states that collect and disseminate data on student mobility. Colorado has seven years of this data available, for the school years 2006–07 through 2012–13.[6] Further, Colorado is one of few of states to compute mobility rates separately for subgroups of students. Massachusetts also does this but had fewer years of data on student mobility available. Colorado also computes two different mobility statistics, unlike other states. They provide data on both school-level mobility rates, which include an unduplicated tally of students who engaged in mobility into or out of a school, and mobility incidence rates, which allow for

[6] Only six years of this data will be used for these analyses—2007–08 through 2012–13—because test score data was unavailable for the 2006–07 school year.

duplication among students who move into or out of a school more than once during the year. In addition to the student mobility statistics, the CDE administrative records contain data on the student composition of public schools in the state, enrollment by grade level, student truancy rates, and student performance on Colorado's standardized test, the Transitional Colorado Assessment Program (TCAP). These measures will be discussed further in the measures and methods section. The detail in the school-level mobility data provided by CDE contributed to the selection of the state of Colorado for this chapter.

To supplement the data available from the CDE, the data from the CCD will be used to provide additional school-level characteristics. As is described on the CCD website, the CCD is an annual survey of "fiscal and non-fiscal data about all public schools, public school districts and state education agencies in the United States" (Common Core of Data [CCD], n.d.). The data available on schools through the CCD contain basic contact information, such as name and address; characteristics of students and staff, including demographics; and fiscal information on revenues and expenditures. As described below in the measures and methods section, CCD data on student-teacher ratios and alternative school designation for the school years corresponding with the CDE data will be used in these analyses.

The primary limitation of the data used for this study is that student-level data will not be used. Without student-level data, it will not be possible to control for relevant student characteristics related to the likelihood of mobility for a given student, nor will it be possible to do a detailed examination of students who are mobile in TPS and charter schools in Colorado. These consequences limit the accuracy of estimates and the capacity to interpret the findings. The ability to control for school-level demographics, and to examine mobility by subgroups of students separately, helps to address these limitations but cannot overcome them entirely. Like the disaggregation of the mobility measures across student subgroups, this data has other strengths, including that it contains data from the entire state of Colorado, that six years of data are available, and that by combing two publicly available data sets, it is possible to control for an array of school characteristics. Due to these strengths, and despite the limitations of this data described above, this chapter will contribute to the literature on student mobility, particularly in the context of charter schools, by examining this topic in a statewide context, which few studies have done before.

Measures and Methods

The primary outcome of interest for each of the research questions comes from the CDE data and measures student mobility within Colorado TPSs and charter schools, overall and for subgroups of students. In 2007–08 through 2010–11, the student mobility measures capture nonstructural mobility into or out of a school during the school year or over the prior summer, as well as midyear grade advancements. In the 2011–12 school year, CDE altered the mobility measures to exclude mobility that occurs over the summer or prior to October 1st, except in the case of intra-district transfers or if a student made more than one transfer between the start of the school year and October 1st. In the 2012–13 school year, CDE again updated the mobility measures, excluding intra-district mobility occurring over the summer or prior to October 1st.

Table V.2

Types of School Moves Included in Mobility Measures across Years

	2007–08 through 2010–11	2011–12	2012–13
Nonstructural mobility after October 1st	X	X	X
Nonstructural, intra-district mobility between the start of the school year and October 1st if student has already made at least one intra-district transfer over this period	X	X	X
Nonstructural, intra-district mobility during summer or prior to October 1st	X	X	
Nonstructural, inter-district mobility during summer or prior to October 1st	X		
Midyear grade advancement	X	X	X

Across all years of the data, CDE operationalizes student mobility in two ways. First, the student mobility rate is a measure of the rate per 100 students of the unduplicated number of students who moved into or out of a school in a given year. The mobility incidence rate, on the other hand, is a measure of the rate per 100 students of the total number of moves into and out of a school in a given year, allowing for duplication if a single student makes multiple moves. These measures are computed for the aggregate student population, as well as for subgroups of students based on race/ethnicity, gender, free/reduced-price lunch (FRL) status, English language learner (ELL) status, disability status, and gifted/talented status. Table V.3 provides descriptive information on the occurrence of student mobility in the aggregate sample of TPSs and charter schools in Colorado. In 2007–08 through 2010–11, the average annual rate of school-level student mobility is 31.5 percent, and the rate of mobility incidence is only slightly higher at 32.9 percent.

This pattern in which mobility incidence rates are slightly higher than student mobility rates persists in 2011–12 and 2012–13, when the mobility measures were updated by CDE.

Table V.3

Average Annual School-Level Student Mobility and Mobility Incidence

	2007–08 through 2010–11		2011–12		2012–13	
	Count	Rate	Count	Rate	Count	Rate
Student Mobility	173.84 (160.93)	0.315 (0.15)	131.18 (130.61)	0.240 (0.12)	80.02 (82.68)	0.144 (0.08)
Mobility Incidence	182.68 (174.58)	0.329 (0.16)	139.05 (141.92)	0.252 (0.12)	85.14 (90.27)	0.152 (0.09)
n schools (unique)	6686 (1687)	6686 (1687)	1700 (1700)	1700 (1700)	1710 (1710)	1710 (1710)

Source. Colorado Department of Education

Note. Standard deviations in parentheses.

Count is a measure of the average number of students in a school to experience mobility or the average number of mobility incidents in a school; rate is equal to the average proportion of students experiencing mobility or the average proportion of mobility incidence per 100 students.

For 2007–08 through 2010–11 descriptive statistics, each school in the sample was given equal weight regardless of how many years of data were available.

Because the student mobility and mobility incidence measures are so similar, as demonstrated by the descriptive statistics in Table V.3, the analyses in this chapter will use only one as an outcome measure. The student mobility rate provides a clean measure of the rate at which students in a given school directly experience mobility, whereas the mobility incidence rate can be clouded by the presence of students who experience multiple mobility events in a school year. Given the greater degree of clarity in the student mobility rate measure, this will be used as the outcome in the following analyses.

As described above, additional covariates to be used in this chapter come from two sources: administrative records from CDE and additional school-level variables from the CCD.

Table E.1 provides a description of each of the measures that will be used from these data sets, as well as descriptive statistics and t-test results comparing the means in charters and TPSs used in the analysis for this chapter.

Market density variables were generated using ArcGIS to determine the number of public schools of choice—charter or magnet schools—near each school in the sample. A radius was drawn around the geographic location of each school (established using longitude and latitude coordinates from the CCD), and all charter and magnet schools serving the same grades—elementary, middle, or high school—that fell into that radius were included in a count variable of market density. Several different measures with differing radii were computed and examined. The distribution of these measures is presented in Figure V.1. In the regression analysis for the aggregate sample (described in further detail below), market density was found to be a significant predictor of student mobility at the three-mile, four-mile, and five-mile radius dimensions—smaller geographic bands did not significantly predict mobility rates. For the analyses presented below, a five-mile radius measure will be used. This measure was selected because of its association with student mobility and because this measure captures more variance than the three- and four-mile measures—there are more schools in the sample with at least one neighboring charter or magnet school, and the range in school counts is larger—as demonstrated in Figure V.1.

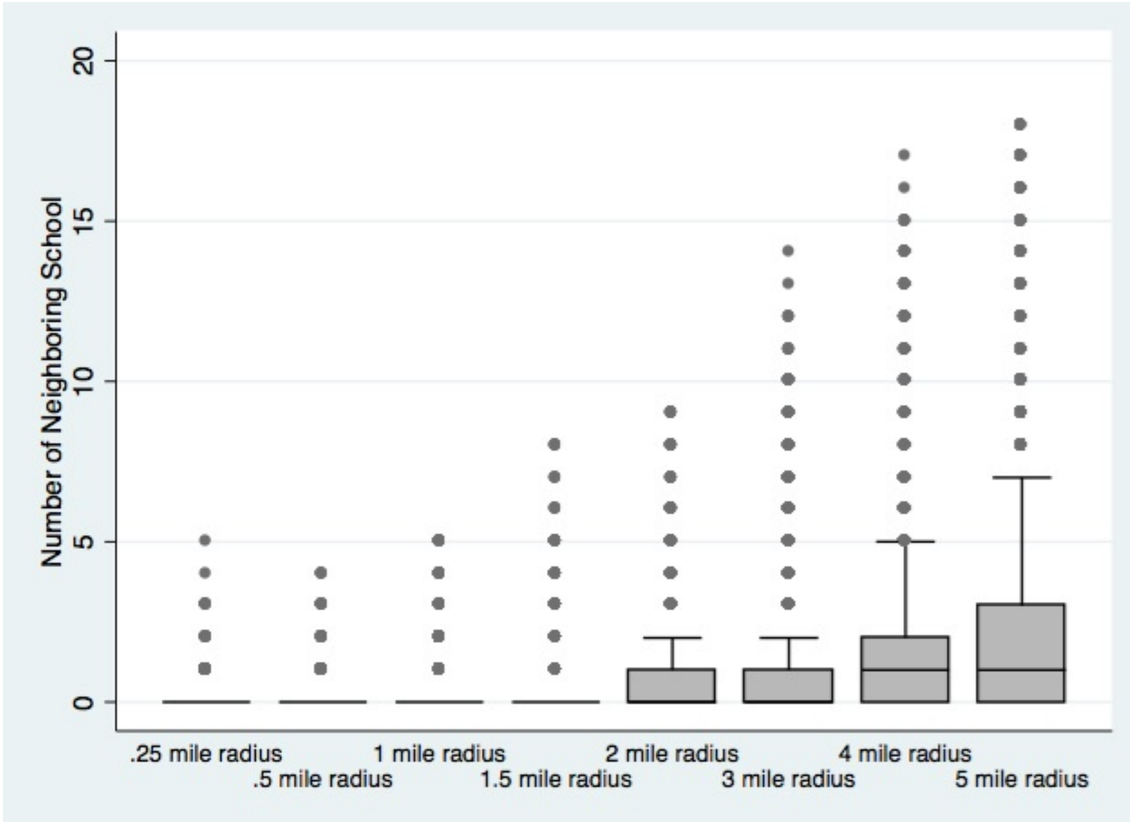

Figure V.1. Box plots of market density measures of varying radii.

To further explore the education market context surrounding each school, an additional market density measure was calculated to be used in regression analyses. This measure captures the number of *new* schools surrounding a given school. The presence of schools that are new to an education market may be more or differently influential over the churn of students within a district since these schools represent new options not previously available. As with the market density variable described above, this measure was derived by plotting schools based on their longitude and latitude and using spatial software to count the number of newly opened schools within a five-mile radius of a given school.

To answer the first research question, descriptive analyses will be used to compare and contrast annual rates of student mobility in 2007–08 through 2010–11 in the TPS and charter sectors. Data from 2011–12 and 2012–13 will not be utilized in these analyses, given adjustments in how mobility was measured in these years. Descriptive methods will be used to examine aggregate mobility rates in these sectors, as well as disaggregated rates for subgroups of students based on race/ethnicity, FRL eligibility, IEP status, LEP status, and gifted/talented status.7

To answer the second research question, I will expand on the first research question by employing ordinary least squares (OLS) regression with year and county-level fixed effects. These analyses will control for observed school-level characteristics, including measures of school quality, and unobserved county-level characteristics that may contribute to the incidence of student mobility in TPSs and charter schools. I will use all seven years of available data and I will account for unobserved trends over time that may be related to both the charter school and student mobility rate measures, as well as variation in how the mobility measure is operationalized across years, by including year fixed effects in the OLS models. Because multiple entries may be included for a single school across years, I will use clustered standard errors at the school level to address correlations across repeated measures (Andreß, Golsch, & Schmidt, 2013). Separate regression analyses will be run with aggregate mobility rates and mobility rates for subgroups of students as the outcome variables.

Equation V.1 represents the model for answering the second research question.

$$Y_{ijt} = \pi + \delta(charter_i) + \beta Q_{ijt} + \phi X_{ijt} + \theta_j + \mu_t + \varepsilon_{ijt} \qquad \text{(V.1)}$$

[7] Because the TPS and charter schools used for these analyses comprise the entire population of brick-and-mortar schools in these sectors in the state of Colorado, inferential statistics will not be used to test comparisons.

In this equation, Y_{ijt} represents the rate of mobility (for either the full student population or a subgroup of students) for school *i* in county *j* at time *t*. The term θ_j represents the county-level fixed effect, entered as a series of dummy variables for each county in the data set, excluding one reference category. Similarly, the μ_t term represents the year fixed effect, which is also entered as a series of dummy variables, one for each year excluding one reference category. The average mobility rate for TPSs in the reference county and year is equal to π, when all other school-level covariates are equal to zero. For other counties and years, the average mobility rate for TPSs when all covariates are equal to zero is π plus the values of θ_j for that county and μ_t for that year. The average difference in school mobility associated with being a charter, across counties and years, is equal to δ, controlling for other covariates in the model. This parameter is of primary interest for this analysis—a significant coefficient will demonstrate a relationship between school sector and student mobility. The average mobility rate for charter schools in the reference group county and year is equal to $\pi + \delta$, when all other school-level covariates are equal to zero. The average mobility rate for charter schools in other counties and years, when all other covariates are equal to zero, is computed by adding π, δ, θ_j, and μ_t. In addition, these models include two vectors of school-level covariates, Q_{ijt} and X_{ijt}. The average change in a school's mobility rate associated with a vector of school-level covariate measuring school quality is represented by βQ_{ijt}. The average change in a school's mobility rate associated with a vector of additional school-level covariates—the remainder of those presented in E.1—is represented by ϕX_{ijt}. The random error in the estimated school mobility rate for school *i* in county *j* at time *t* is represented by ε_{ijt}. The modeling approach outlined in Equation V.1 was be estimated in Stata using the **regress** command, with the **vce(cluster)** option to cluster standard errors at the school level.

In answering the third research question, I will employ a similar approach to that used for the second research question, with the addition of interactions between the school sector variable and measures of school quality. By employing this technique, it will be possible to explore whether these measures of school quality moderate any relationship between school sector and the incidence of student mobility, overall and for subgroups of students. This modeling approach is represented by Equation V.2.

$$Y_{ijt} = \pi + \delta(charter_i) + \beta Q_{ijt} + \varphi\left(charter_i \times Q_{ijt}\right) + \phi X_{ijt} + \theta_j + \mu_t + \varepsilon_{ijt} \qquad \text{(V.2)}$$

The π , δ, ϕ, θ, μ, and ε parameters retain the same interpretation as above. In addition, Equation V.2 includes a vector of interaction terms, $\varphi(charter_i \times Q_{ijt})$, that represents the charter-specific average change in mobility rates associated with values of the school quality covariates in the model, across counties and years. With the inclusion of these interactions, β becomes the TPS-specific change in mobility rates associated with values of the school quality covariates, across counties and years. As above, the **regress** command, with the **vce(cluster)** option in Stata was employed to conduct this analysis.

Results

What are rates of student mobility in Colorado traditional public and charter schools, overall and for subgroups of students? Results from descriptive analyses demonstrate that student mobility rates in Colorado are higher in charter schools than in TPSs. Table V.4 displays rates of student mobility in brick-and-mortar charter schools and TPSs for the entire student population, as well as for subgroups of students. Charter schools had an average annual student mobility rate of 43 percent during the 2007–08 through 2010–11 school years, while in TPSs the average mobility rate was 30 percent each school year. The schools in the charter sector have an average rate of student mobility that is 12 percentage points higher than the schools in the TPS sector, equal to a 28 percent difference relative to the charter school mobility rate (see Table V.4).

Table V.4

Average Annual Rates of Student Mobility in Charter and Traditional Public Schools from 2007–08 through 2010–11

	Charter	TPS	Point difference	Percent difference
All students	0.425 (0.236)	0.304 (0.135)	0.121	28.47%
Male students	0.423 (0.239)	0.306 (0.138)	0.117	27.66%
Female students	0.422 (0.237)	0.303 (0.139)	0.119	28.20%
White students	0.429 (0.248)	0.307 (0.163)	0.122	28.44%
Black students	0.449 (0.323)	0.371 (0.287)	0.078	17.37%
Hispanic students	0.432 (0.258)	0.329 (0.155)	0.103	23.84%
Asian students	0.371 (0.319)	0.283 (0.272)	0.088	23.72%
Students with disabilities	0.410 (0.284)	0.292 (0.161)	0.118	28.78%
English language learners	0.396 (0.326)	0.310 (0.214)	0.086	21.72%
FRL-eligible students	0.459 (0.285)	0.335 (0.148)	0.124	27.02%
Gifted/talented students	0.328 (0.332)	0.148 (0.177)	0.180	54.88%
n schools	175	1,671		

Source. Colorado Department of Education
Note. Standard deviations in parentheses.
Percent difference calculated relative to charter school mobility rates for each group.
Each school in the sample is given equal weight regardless of how many years of data available.

As with the aggregated student population, each student subgroup experienced higher rates of student mobility in charter schools than in TPSs. In both settings, students classified as gifted and talented are the subgroup of student with the lowest rates of student mobility. This group also experiences the highest discrepancy in mobility rates across the two sectors. Charter schools had an average mobility rate of 33 percent among gifted and talented students, while in TPSs these students were mobile at an average rate of 15 percent. This difference of 18 percentage points is equal to a 55 percent difference, relative to the mobility rate in charters.

Black students are the only subgroup where the difference in mobility rates for charter schools and TPSs is below 20 percent (see Table V.4). The cross-sector difference of 8 percentage points is 17 percent of the mobility rate of 45 percent in charter schools. In the case of Black students, this reduction in the difference between sectors results from higher-than-average rates of mobility for Black students in the TPS sector. Among charter schools, the average mobility rate for Black students was approximately 45 percent, about equal to the rate of mobility for the aggregate student population in this sector. In TPSs, on the other hand, the average mobility rate for Black students was 37 percent, which is higher than the aggregate average of 30 percent. For ELLs, on the other hand, the reduction in the cross-sector difference is attributable to lower rates of mobility in the charter sector, relative to the aggregate sample. In the charter sector, the average mobility rate for ELLs was 40 percent, relative to 43 percent in the aggregate sample in charters. In the TPS sector, the average mobility rate for ELLs was 31 percent, more similar to the aggregate rate of 30 percent (see Table V.4). The difference in mobility rates between the charter and TPS sectors for ELL students is 8.6 percentage points, compared to 12.1 percentage points in the aggregate population.

The difference between the mobility rates of White and Black students in the charter sector is two percentage points. In the TPS sector, the difference between the mobility rates of White and Black students is over six percentage points. In both sectors, Black students are the subgroup with the highest rate of student mobility—44.9 percent in charters and 37.1 percent in TPSs (see Table V.4).

In both the charter and TPS sectors, students who are FRL-eligible are among the groups with the highest rates of mobility. In both sectors, this group of students has above-average rates of mobility. With an average mobility rate of 45.9 percent in charter schools, FRL-eligible students have a mobility rate that is three percentage points higher than the aggregate mobility rate for this sector (see Table V.4). In the TPS sector, FRL-eligible students' average mobility rate is 33.5 percent, also around three percentage points higher than the aggregate mobility rate for that sector.

Table V.5 presents mobility rates in charter schools and TPSs, disaggregated by grade configuration and student characteristics in order to determine whether patterns of mobility in charter schools and TPSs differ based on these attributes. The pattern of higher rates of student mobility in charter schools observed in Table V.4 is again present for the full student populations of charter and TPSs. The magnitude of this pattern varies based on the school level, increasing with the level of the school, with charter elementary schools' mobility rate 6.1 percentage points higher than that of TPS elementary schools; charter middle schools' mobility rate 14.3 percentage points higher than that of TPS middle schools; and charter high schools' mobility rate 21 percentage points higher than that of TPS high schools. For charter schools, a pattern exists of higher rates of mobility for the higher level of schools for the full student population—the rates of mobility in elementary, middle, and high school are 37.1 percent, 43.0 percent, and 51.3 percent, respectively. In TPSs, the mobility rates are highest in elementary schools and lowest in middle schools—the rates in elementary, middle, and high school are 31.0 percent, 28.7 percent, and 30.3 percent, respectively.

Table V.5

Rates of Student Mobility across Subgroups in Charter and Traditional Public Schools, by School Level

	Elementary				Middle School				High School			
	Charter	TPS	Point diff.	% diff.	Charter	TPS	Point diff.	% diff.	Charter	TPS	Point diff.	% diff.
All students	0.371 (0.200)	0.310 (0.138)	0.061	16.44%	0.430 (0.242)	0.287 (0.108)	0.143	33.26%	0.513 (0.265)	0.303 (0.148)	0.21	40.94%
Male students	0.376 (0.204)	0.311 (0.141)	0.065	17.29%	0.388 (0.254)	0.289 (0.111)	0.099	25.52%	0.516 (0.266)	0.302 (0.149)	0.214	41.47%
Female students	0.367 (0.200)	0.308 (0.141)	0.059	16.08%	0.439 (0.250)	0.284 (0.112)	0.155	35.31%	0.509 (0.267)	0.303 (0.155)	0.206	40.47%
White students	0.371 (0.208)	0.317 (0.169)	0.054	14.56%	0.485 (0.274)	0.290 (0.141)	0.195	40.21%	0.508 (0.278)	0.293 (0.159)	0.215	42.32%
Black students	0.396 (0.325)	0.385 (0.288)	0.011	2.78%	0.483 (0.285)	0.362 (0.274)	0.121	25.05%	0.525 (0.321)	0.335 (0.295)	0.190	36.19%
Hispanic students	0.378 (0.237)	0.332 (0.155)	0.046	12.17%	0.423 (0.248)	0.307 (0.123)	0.116	27.42%	0.527 (0.272)	0.341 (0.175)	0.186	35.29%
Asian students	0.327 (0.288)	0.283 (0.265)	0.044	13.46%	0.378 (0.346)	0.271 (0.261)	0.107	28.31%	0.444 (0.352)	0.293 (0.304)	0.151	34.01%
Students with disabilities	0.382 (0.260)	0.292 (0.160)	0.090	23.56%	0.380 (0.308)	0.284 (0.141)	0.096	25.26%	0.467 (0.311)	0.296 (0.178)	0.171	36.62%
English language learners	0.331 (0.313)	0.309 (0.202)	0.022	6.65%	0.396 (0.315)	0.309 (0.203)	0.087	21.97%	0.506 (0.326)	0.317 (0.257)	0.189	37.35%
FRL-eligible students	0.433 (0.294)	0.339 (0.151)	0.094	21.71%	0.440 (0.261)	0.321 (0.121)	0.119	27.05%	0.507 (0.276)	0.335 (0.160)	0.172	33.93%
Gifted/talented students	0.300 (0.332)	0.158 (0.181)	0.142	47.33%	0.393 (0.311)	0.142 (0.140)	0.251	63.87%	0.355 (0.340)	0.121 (0.191)	0.234	65.92%
n schools	94	999			19	285			71	389		

Source. Colorado Department of Education

Note. Standard deviations in parentheses. Percent difference calculated relative to charter school mobility rates for each group. Each school in the sample was given equal weight regardless of how many years of data were available.

The patterns based on school-level characteristics observed among the full student population generally persist among student subgroups—the extent to which charter school mobility rates surpass TPS mobility rates is highest among high schools and lowest among elementary schools. For each student subgroup, charter schools have higher rates of student mobility than TPSs, but the extent of the cross-sector disparity varies across school levels. In particular, among elementary schools, the cross-sector difference in mobility rates for Black students is quite small—just over one percentage point. In charter elementary schools, Black students are mobile at a rate of 39.6 percent, compared to 38.5 percent in TPSs. In higher-level schools, this disparity grows. Black students in charter middle schools are mobile at a rate 12.1 percentage points higher than their peers in traditional public middle schools, and by high school this difference has grown to 19 percentage points.

Table V.6 highlights important differences in mobility rates in charter schools and TPSs based on the size of the locality where a school is situated. Similar to the findings from the aggregated sample of schools, charter school mobility rates exceed those of TPSs in every instance in cities, towns and suburbs, and rural areas. Among the full student population and every student subgroup in charter schools, mobility rates are highest in cities and, in most cases, rates are lowest in towns/suburbs. For the full sample of students in charter schools, mobility rates were 51.9 percent in cities, 38.8 percent in rural areas, and 35.0 percent in towns and suburbs. Among TPSs, rates of mobility were highest in cities and lowest rates in towns and suburbs in some instances and in rural areas in others. Among the full student population, mobility rates for TPSs were 37.6 percent in cities, 27.4 percent in towns and suburbs, and 27.8 percent in rural areas. Both White and Black students have particularly high rates of mobility in cities, with rates in charter schools of 54.1 percent and 56.2 percent, respectively, and rates in TPS of 40.0 percent and 46.8 percent, respectively. As in the aggregate school sample, Black students have the highest rates of mobility in both sectors.

Table V.6

Rates of Student Mobility across Subgroups in Charter and Traditional Public Schools, by Size of Locality

	City				Town/Suburb				Rural			
	Charter	TPS	Point difference	Percent difference	Charter	TPS	Point difference	Percent difference	Charter	TPS	Point difference	Percent difference
All students	0.519 (0.214)	0.376 (0.140)	0.143	27.55%	0.350 (0.240)	0.274 (0.131)	0.076	21.71%	0.388 (0.220)	0.278 (0.112)	0.110	28.35%
Male students	0.509 (0.226)	0.379 (0.141)	0.13	25.54%	0.355 (0.242)	0.277 (0.132)	0.078	21.97%	0.391 (0.224)	0.276 (0.117)	0.115	29.41%
Female students	0.519 (0.214)	0.373 (0.143)	0.146	28.13%	0.345 (0.241)	0.271 (0.134)	0.074	21.45%	0.384 (0.222)	0.279 (0.120)	0.105	27.34%
White students	0.541 (0.227)	0.400 (0.189)	0.141	26.06%	0.337 (0.244)	0.270 (0.143)	0.067	19.88%	0.389 (0.225)	0.272 (0.126)	0.117	30.08%
Black students	0.562 (0.251)	0.468 (0.208)	0.094	16.73%	0.388 (0.339)	0.363 (0.261)	0.025	6.44%	0.369 (0.352)	0.297 (0.346)	0.072	19.51%
Hispanic students	0.523 (0.220)	0.382 (0.128)	0.141	26.96%	0.370 (0.256)	0.301 (0.137)	0.069	18.65%	0.384 (0.277)	0.317 (0.182)	0.067	17.45%
Asian students	0.458 (0.323)	0.363 (0.253)	0.095	20.74%	0.327 (0.289)	0.272 (0.235)	0.055	16.82%	0.309 (0.331)	0.226 (0.309)	0.083	26.86%
Students with disabilities	0.493 (0.265)	0.359 (0.157)	0.134	27.18%	0.329 (0.281)	0.262 (0.131)	0.067	20.36%	0.395 (0.288)	0.268 (0.177)	0.127	32.15%
English language learners	0.466 (0.273)	0.373 (0.162)	0.093	19.96%	0.397 (0.340)	0.314 (0.194)	0.083	20.91%	0.299 (0.354)	0.252 (0.257)	0.047	15.72%
FRL-eligible students	0.510 (0.241)	0.388 (0.140)	0.122	23.92%	0.432 (0.326)	0.311 (0.145)	0.121	28.01%	0.420 (0.281)	0.317 (0.148)	0.103	24.52%
Gifted/talented students	0.437 (0.329)	0.228 (0.183)	0.209	47.83%	0.246 (0.281)	0.125 (0.156)	0.121	49.19%	0.281 (0.359)	0.107 (0.174)	0.174	61.92%
n schools	73	489			62	698			52	579		

Sources. Colorado Department of Education and the Common Core of Data

Note. Standard deviations in parentheses. Percent difference calculated relative to charter school mobility rates for each group. Each school in the sample was given equal weight regardless of how many years of data were available.

Cross-sector differences are particularly high for White students and students with disabilities in rural settings. Rural charter schools had a mobility rate of 38.9 percent among White students, while rural TPSs had a mobility rate of 27 percent for White students—a difference of 11.7 percentage points, or 30.1 percent of the charter mobility rate. Similarly, students with disabilities in rural charter schools saw a mobility rate of 39.5 percent, while TPSs had a rate of 26.8 percent, for a difference of 12.7 percentage points, or 32.2 percent of the charter mobility rate.

Does school sector predict school-level rates of student mobility and which measures of school quality are significantly associated with school-level mobility rates? The predictive results mirror the descriptive findings presented above, with significantly higher annual student mobility rates in charter schools than TPSs, after controlling for other school-level characteristics, among the full sample and many of the student subgroups (see Tables V.8–V.10). Among the aggregate sample of students, as well as among males and females, separately, charter schools have school-level mobility rates that were just over two percentage points higher ($p = .003$, $p = .008$, and $p = .003$, respectively), after controlling for measures of school quality, market density, and other school-level characteristics (see Table V.7). These results suggest that cross-sector differences found through descriptive analyses were not merely the result of variation in observed school characteristics between Colorado's charters and TPSs.

Table V.7

School Sector as a Predictor of Student Mobility among the Full Sample and by Gender

	Model 1: Full sample		Model 2: Male students		Model 3: Female students	
	Coef.	p-value	Coef.	p-value	Coef.	p-value
School sector (ref. TPS)						
Charter school	0.023	**0.003**	0.022	**0.008**	0.023	**0.003**
	(0.008)		(0.008)		(0.008)	
School quality						
Attendance rate	-0.103	0.134	-0.093	0.178	-0.111	0.121
	(0.069)		(0.069)		(0.071)	
Truancy rate	0.853	**0.000**	0.862	**0.000**	0.849	**0.000**
	(0.143)		(0.141)		(0.148)	
Days in school year	0.001	**0.000**	0.002	**0.000**	0.001	**0.000**
	(0.000)		(0.000)		(0.000)	
Student-teacher ratio	0.003	**0.000**	0.003	**0.000**	0.003	**0.000**
	(0.000)		(0.000)		(0.000)	
Pct. proficient or advanced reading	-0.065	**0.001**	-0.058	**0.004**	-0.073	**0.000**
	(0.019)		(0.020)		(0.020)	
Pct. proficient or advanced math	-0.002	0.902	-0.014	0.445	0.010	0.594
	(0.018)		(0.019)		(0.018)	
Market density						
Num. choice schools in 5 miles	-0.003	**0.000**	-0.003	**0.002**	-0.003	**0.000**
	(0.001)		(0.001)		(0.001)	
Num. new choice schools in 5 miles	0.003	**0.047**	0.002	0.165	0.003	**0.018**
	(0.001)		(0.001)		(0.001)	
Constant	0.450	**0.000**	0.458	**0.000**	0.416	**0.000**
	(0.096)		(0.105)		(0.101)	
All additional school-level covariates from Table E.1 and county- and year-fixed effects included in model but not presented for brevity.						
R-square	0.647		0.625		0.623	
n school observations (unique)	9,497 (1,742)		9,497 (1,742)		9,497 (1,742)	

Sources. Colorado Department of Education and the Common Core of Data
Notes. Standard errors in parenthesis.

Standard errors adjusted for clustering at the school level.

The regression models run for this research not only demonstrate cross-sector differences in mobility rates, but also identify measures of school quality that significantly predict school-level mobility rates. For the aggregate group of students, truancy rates, the length of the school year, and the student-teacher ratio were positively and significantly associated with mobility, and the percentage of students who scored proficient or advanced on the Colorado state assessment for reading was negatively and significantly associated with mobility (see Table V.7, Model 1). A 10-percentage point increase in the truancy rate of a school is associated with an 8.5-percentage point increase in the student mobility rate at a school ($p = .000$). Each additional day in a school's academic calendar is associated with a 0.1-percentage point increase in the school-level mobility rate ($p = .000$). An increase of one in the student-teacher ratio—that is, for each additional student a teacher is responsible for—is associated with a 0.3-percentage point increase in the school-level mobility rate ($p = .000$). A 10-percentage point increase in the number of students scoring proficient or above in reading is associated with a 0.65-percentage point decrease in the proportion of students mobile in a school ($p = .001$). The proportion of students performing at the proficient or advanced level in math was not a significant predictor of mobility rates among the aggregate sample in the regression model that also includes reading achievement. However, when math achievement was included as the only measure of student achievement, this measure had a relationship with mobility rates among the aggregate sample that was similar in magnitude, direction, and significance as students' reading achievement in Table V.7, Model 1. The attendance rate did not significantly predict school-level mobility rates among the aggregate sample. The pattern of relationships between school quality covariates and student mobility rates found in the aggregate sample is mirrored among the disaggregated male and female student samples (see Table V.7, Models 2 and 3). In addition to relationships between mobility rates and school sector and school quality, Models 1–3 of Table V.7 also demonstrate relationships between market density and school-level mobility rates in Colorado. An increase of one in the number of choice schools—charter or magnet—within five miles of a school is associated with a 0.3-percentage point decrease in school-level mobility rates among the aggregate sample of students, as well as among male and female students, separately (p = .000, p = .002 and p = .000, respectively). This suggests that mobility rates are lower in more choice-dense regions of Colorado. When looking specifically at the number of new choice schools nearby—those that opened within five years—a different pattern emerges. Among the aggregate sample, and among female students, each new choice school within five miles is associated with a 0.3-percentage point increase in school-level mobility rates (p = .047 and p = .018, respectively). This suggests that when new choice schools enter the market, mobility rates in surrounding schools increases. For male students, no significant association was found between the number of new choice schools and school-level mobility rates.

When looking at mobility rates among student subgroups based on race/ethnicity, notable departures arose from what was found among the aggregate sample. Only among White students is school sector a significant predictor of mobility rates; for Black, Hispanic, and Asian students, no such significant relationship exists (see Table V.8, Models 1–4). For White students, school-level mobility rates in charter schools are 2.7 percentage points higher than in TPSs, after controlling for other school characteristics (p = .001).

Table V.8

School Sector as a Predictor of Student Mobility by Race/Ethnicity

	Model 1: Black students		Model 2: White students		Model 3: Hispanic students		Model 4: Asian students	
	Coef.	p-value	Coef.	p-value	Coef.	p-value	Coef.	p-value
School sector (ref. TPS)								
Charter school	-0.000	0.988	0.027	**0.001**	0.008	0.414	0.014	0.278
	(0.015)		(0.008)		(0.009)		(0.013)	
School quality								
Attendance rate	-0.088	0.475	-0.023	0.772	-0.110	0.191	-0.129	0.364
	(0.123)		(0.081)		(0.084)		(0.143)	
Truancy rate	0.844	**0.000**	0.797	**0.000**	1.006	**0.000**	0.525	**0.032**
	(0.225)		(0.157)		(0.162)		(0.245)	
Days in school year	-0.000	0.704	0.001	**0.000**	0.001	**0.001**	0.001	0.067
	(0.001)		(0.000)		(0.000)		(0.001)	
Student-teacher ratio	0.002	**0.000**	0.003	**0.000**	0.003	**0.000**	0.002	**0.000**
	(0.000)		(0.000)		(0.000)		(0.000)	
Pct. proficient or advanced reading	-0.023	0.632	-0.078	**0.000**	-0.018	0.535	0.106	**0.034**
	(0.048)		(0.021)		(0.029)		(0.050)	
Pct. proficient or advanced math	0.065	0.137	0.004	0.831	-0.008	0.744	-0.040	0.392
	(0.044)		(0.020)		(0.025)		(0.047)	
Market density								
Num. choice schools in 5 miles	-0.002	0.332	-0.004	**0.001**	-0.003	**0.000**	-0.001	0.682
	(0.002)		(0.001)		(0.001)		(0.002)	
Num. new choice schools in 5 miles	0.001	0.725	0.002	0.246	0.003	0.019	0.000	0.969
	(0.003)		(0.002)		(0.001)		(0.003)	
Constant	0.211	0.357	0.336	**0.001**	0.342	**0.006**	0.459	0.069
	(0.229)		(0.105)		(0.123)		(0.252)	
All additional school-level covariates from Table E.1 and county- and year-fixed effects included in model but not presented for brevity.								
R-square	0.196		0.644		0.449		0.148	
n school observations (unique)	9,497 (1,742)		9,497 (1,742)		9,497 (1,742)		9,497 (1,742)	

Sources. Colorado Department of Education and the Common Core of Data

Notes. Standard errors in parenthesis.

Standard errors adjusted for the inclusion of multiple observations of individual schools.

The relationship between school quality measures and student mobility rates for White students is also similar to what was observed among the aggregate sample, but notable differences among other race/ethnicity subgroups remained. Unlike among the full sample, the number of days in a school year did not significantly predict mobility rates among Black or Asian students (see Table V.8, Models 1 and 4). Among these subgroups, student-teacher ratios and math assessment performance are not significantly associated with student mobility, as is the case for school attendance rates, unlike what was found among the aggregate sample. Similarly, the percent of students scoring proficient or advanced in reading was not significantly associated with mobility rates among Black and Hispanic students (see Table V.8, Models 1 and 4). Among Asian students, the proportion of students scoring proficient or advanced in reading had the opposite relationship with mobility rates, as was observed among the full sample (see Table V.8, Model 4). For these students, a 10-percentage point increase in the number of students scoring proficient or advanced in reading is associated with a one-percentage point increase in school-level mobility rates (p = .034).

Race/ethnicity subgroup differences also inform the relationship between market density and student mobility. Only among Hispanic students is the pattern observed among the aggregate sample present; the number of choice schools within five miles is negatively and significantly associated with mobility rates for this group, while the number of new choice schools within five miles is positively and significantly associated with mobility rates (see Table V.8, Model 3). White students also demonstrate a significant, negative relationship between the number of choice schools within five miles and mobility rates, but no other race/ethnicity subgroups demonstrate a significant relationship between the number of new choice schools nearby and student mobility (see Table V.8, Models 1, 2 and 4).

When looking at other student subgroups, FRL-eligible students, students with disabilities, and gifted/talented students all experience higher rates of student mobility in charter schools than in TPSs after controlling for school-level characteristics (see Table V.9, Models 1, 2 and 4). This relationship is particularly pronounced for gifted/talented students (Table V.9, Model 4). Gifted/talented students enrolled in charter schools are 10 percentage points more likely to be mobile than their peers in TPSs (p = .000). For school-level rates of mobility among English language learners, there is no significant relationship with school sector (see Table V.9, Model 3).

Regarding relationships between school quality and mobility rates, each of the student subgroup models in Table V.9 demonstrates significant, positive relationships between the length of the school year and student-teacher ratio, consistent with what was found among the aggregate sample (see Table V.9, Models 1-4). The significant, positive relationship between the truancy rate and school-level mobility rates observed among the aggregate sample is also consistent among each of the subgroups except for gifted/talented students. While among the aggregate sample a significant, negative relationship was discovered between the percent of students scoring proficient or advanced in reading and student mobility rates, no significant relationships between these measures for FRL-eligible students, students with disabilities, or gifted/talented students were found. The research showed that for English language learners, a significant relationship existed with school-level reading achievement, but it was in the opposite direction from that observed among the aggregate sample (see Table V.9, Model 3). As the percentage of students in a school scoring proficient or advanced in reading increased by one percentage point, the mobility rate among English language learners increased by 0.9 percentage points (p = .023). Also differing from what was observed among the aggregate sample, FRL-eligible students' mobility rates were lower in schools with higher attendance rates (see Table V.9, Model 1). As a school's attendance rate increases by 10 percentage points, the mobility rate among FRL-eligible students decreases by two percentage points.

Table V.9

School Sector as a Predictor of Student Mobility by FRL, Disability, ELL, and Gifted/Talented Status

	Model 1: FRL-Eligible Students		Model 2: Students w/Disabilities		Model 3: English Language Learners		Model 4: Gifted/Talented Students	
	Coef.	p-value	Coef.	p-value	Coef.	p-value	Coef.	p-value
School sector (ref. TPS)								
Charter school	0.022	**0.046**	0.025	**0.005**	0.004	0.762	0.101	**0.000**
	(0.011)		(0.009)		(0.012)		(0.012)	
School quality								
Attendance rate	-0.204	**0.034**	-0.066	0.430	-0.062	0.661	-0.233	**0.012**
	(0.096)		(0.084)		(0.142)		(0.093)	
Truancy rate	0.758	**0.000**	0.658	**0.000**	0.935	**0.000**	0.421	0.104
	(0.158)		(0.170)		(0.223)		(0.259)	
Days in school year	0.002	**0.000**	0.001	**0.004**	0.002	**0.000**	0.002	**0.000**
	(0.000)		(0.000)		(0.000)		(0.000)	
Student-teacher ratio	0.002	**0.000**	0.003	**0.000**	0.002	**0.000**	0.001	**0.000**
	(0.000)		(0.000)		(0.000)		(0.000)	
Pct. proficient or advanced reading	-0.032	0.181	0.005	0.850	0.089	**0.023**	0.005	0.856
	(0.024)		(0.026)		(0.039)		(0.030)	
Pct. proficient of advanced math	0.006	0.812	-0.043	0.058	0.012	0.742	-0.015	0.611
	(0.024)		(0.023)		(0.036)		(0.029)	
Market Density								
Num. choice schools in 5 miles	-0.002	0.117	-0.003	**0.006**	-0.000	0.880	0.001	0.577
	(0.001)		(0.001)		(0.002)		(0.001)	
Num. new choice schools in 5 miles	0.000	0.890	0.002	0.202	0.002	0.309	0.000	0.923
	(0.001)		(0.001)		(0.002)		(0.002)	
Constant	0.255	0.059	0.449	**0.007**	-0.049	0.786	0.115	0.408
	(0.135)		(0.167)		(0.181)		(0.139)	
All additional school-level covariates from Table E.1 and county- and year-fixed effects included in model but not presented for brevity.								
R-square	0.420		0.446		0.232		0.238	
n school observations (unique)	9,497 (1,742)		9,497 (1,742)		9,497 (1,742)		9,497 (1,742)	

Sources. Colorado Department of Education and the Common Core of Data
Notes. Standard errors in parenthesis.

Standard errors adjusted for the inclusion of multiple observations of individual schools.

Unlike among the aggregate sample, only one instance of a significant relationship between market density and mobility among the subgroups of students explored in Table V.9 was found. As among the full sample, students with disabilities experienced lower rates of mobility as the number of choice schools within five miles increased (see Table IV.9, Model 2). For each additional choice school within five miles, mobility rates among students with disabilities decreased by 0.3 percentage points (p = .006). The number of choice schools in five miles was not significantly associated with mobility rates among FRL-eligible students, English language learners, or gifted/talented students. Further, the number of new choice schools was not a significant predictor of mobility for any of the student subgroups in Table V.9.

Does school quality moderate the relationship between school sector and student mobility, overall and among subgroups of students? When interaction terms between sector and school quality measures were added to regression models to explore moderating relationships between school quality and school sector, the main effect of charter school sector was no longer significant among the aggregate sample or for any of the subgroups (see Tables V.11–V.13). This suggests that the relationship between sector and mobility rates is explained by cross-sector differences in the relationship between school quality measures and student mobility. The inclusion of moderating relationships highlights differences between the charter and TPS sectors in how school quality measures are related to mobility rates.

Among the aggregate population of students, school quality measures have different relationships with student mobility based on school sector (see Table V.10, Model 1). Among TPSs, a 10-percentage point increase in the truancy rate is associated with an 8.6-percentage point increase in the student mobility rate (p =.000). In charter schools, however, no significant association exists between truancy rates and student mobility. Student achievement measures also have different relationships with mobility rates across sectors. In TPSs, a 10-percentage point increase in the number of students who scored proficient or advanced on the reading assessment is associated with a 0.8-percentage point decrease in mobility rates among the aggregate population ($p = .000$). In TPSs, no significant association between math scores and student mobility rates was found for the full sample. For charter schools, on the other hand, no significant relationship between reading achievement and mobility rates was shown, but a significant association between math performance and student mobility did appear in the data. As the percent of students scoring proficient or advanced in reading increased by 10 percentage points in charter schools, the likelihood of mobility decreased by 1.8 percentage points ($p = .004$). Among male and female student subgroups, the pattern of moderating relationships largely follows the same pattern observed among the aggregate sample (see Table V.10, Models 1 and 2).

Table V.10

Regression Results with School Quality as Moderators of Sector on Student Mobility Rates—Full Sample and by Gender

	Model 1: Full sample		Model 2: Male students		Model 3: Female students	
	Coef.	p-value	Coef.	p-value	Coef.	p-value
School sector (ref. TPS)						
Charter school	0.037 (0.132)	0.777	0.057 (0.129)	0.658	0.019 (0.140)	0.892
School quality & moderating relationships						
Attendance rate	-0.059 (0.055)	0.280	-0.041 (0.055)	0.458	-0.072 (0.059)	0.222
Charter * attendance rate	-0.072 (0.124)	0.562	-0.096 (0.119)	0.422	-0.057 (0.134)	0.668
Truancy rate	0.856 (0.145)	**0.000**	0.867 (0.141)	**0.000**	0.858 (0.154)	**0.000**
Charter * truancy rate	-0.202 (0.271)	0.455	-0.228 (0.264)	0.386	-0.196 (0.282)	0.489
Days in sch. year	0.001 (0.000)	**0.000**	0.001 (0.000)	**0.000**	0.001 (0.000)	**0.000**
Charter * days in sch. year	0.000 (0.000)	**0.000**	0.000 (0.000)	**0.000**	0.000 (0.000)	**0.000**
Student-teacher ratio	0.002 (0.000)	**0.000**	0.002 (0.000)	**0.000**	0.002 (0.000)	**0.000**
Charter * student-teacher ratio	0.004 (0.002)	**0.047**	0.004 (0.002)	**0.038**	0.004 (0.002)	0.055
Pct. proficient or advanced reading	-0.076 (0.019)	**0.000**	-0.066 (0.020)	**0.001**	-0.086 (0.020)	**0.000**
Charter * pct. proficient or advanced reading	0.107 (0.067)	0.109	0.088 (0.069)	0.206	0.123 (0.065)	0.059
Pct. proficient or advanced math	0.021 (0.017)	0.229	0.007 (0.018)	0.689	0.033 (0.018)	0.057
Charter * pct. proficient or advanced math	-0.180 (0.062)	**0.004**	-0.166 (0.063)	**0.009**	-0.187 (0.063)	**0.003**
Constant	0.407 (0.088)	**0.000**	0.409 (0.096)	**0.000**	0.378 (0.093)	**0.000**
R-square	0.655		0.633		0.630	
n school observations (unique)	9,497	(1,742)	9,497	(1,742)	9,497	(1,742)

Sources. Colorado Department of Education and the Common Core of Data

Notes. Standard errors in parenthesis; Standard errors adjusted for the inclusion of multiple observations of individual schools.

All additional school-level covariates in Table E.1 and county- & year-fixed effects included in models but not displayed.

For each of the student subgroups based on race/ethnicity, there is evidence of moderating relationships between school sector and school quality with the outcome of student mobility. Among Black students, no school quality measures operate the same way, in terms of significance and direction of relationships, in both the charter schools and TPSs (see Table V.11, Model 1). Truancy rates have a significant, positive relationship with mobility in TPSs but no significant relationship in charter schools. Conversely, the length of the school year has a significant, positive relationship with mobility in charter schools and has no significant relationship in TPSs. The relationship between student mobility among Black students and the percent of students scoring proficient or advanced in math is significant in opposing directions between the two sectors (see Table V.11, Model 1). In TPSs, as the percent of students scoring proficient or above in math increases by 10 percentage points, the mobility rate among Black students increases by 0.9 percentage points ($p = .038$). In charter schools, on the other hand, an increase of 10 percentage points in the rate of math proficiency reduces the rate of mobility among Black students by 2.7 percentage points ($p = .004$).

Table V.11

Regression Results with School Characteristics as Moderators of Sector Relationships with Student Mobility by Race/Ethnicity

	Model 1: Black students		Model 2: White students		Model 3: Hispanic students		Model 4: Asian students	
	Coef.	p-value	Coef.	p-value	Coef.	p-value	Coef.	p-value
School sector (ref. TPS)								
Charter school	-0.043 (0.239)	0.857	0.182 (0.130)	0.163	-0.085 (0.194)	0.663	0.184 (0.262)	0.483
Sch. quality & moderating relationships								
Attendance rate	-0.091 (0.155)	0.557	0.059 (0.067)	0.375	-0.090 (0.082)	0.275	-0.026 (0.140)	0.854
Charter * attendance rate	0.050 (0.236)	0.834	-0.237 (0.120)	**0.049**	0.042 (0.186)	0.822	-0.264 (0.262)	0.314
Truancy rate	0.719 (0.291)	0.014	0.984 (0.152)	**0.000**	0.878 (0.165)	**0.000**	0.343 (0.274)	0.210
Charter * truancy rate	0.168 (0.474)	0.723	-0.635 (0.278)	**0.022**	0.109 (0.361)	0.762	0.288 (0.462)	0.533
Days in sch. year	-0.000 (0.001)	0.485	0.001 (0.000)	**0.000**	0.001 (0.000)	**0.001**	0.001 (0.001)	0.065
Charter * days in sch. year	0.000 (0.000)	0.004	0.000 (0.000)	**0.000**	0.000 (0.000)	0.055	0.000 (0.000)	0.125
Student-teacher ratio	0.002 (0.000)	0.000	0.002 (0.000)	**0.000**	0.002 (0.000)	**0.000**	0.002 (0.000)	**0.000**
Charter * student-teacher ratio	0.000 (0.002)	0.822	0.004 (0.002)	**0.049**	0.005 (0.002)	**0.028**	0.002 (0.002)	0.385
Pct. proficient/ advanced reading	-0.035 (0.049)	0.478	-0.098 (0.021)	**0.000**	-0.025 (0.029)	0.395	0.090 (0.051)	0.082
Charter * pct. proficient/ advanced reading	0.170 (0.107)	0.113	0.150 (0.067)	**0.026**	0.081 (0.073)	0.265	0.158 (0.111)	0.154
Pct. proficient/ advanced math	0.093 (0.045)	**0.038**	0.032 (0.019)	0.095	0.010 (0.025)	0.702	-0.034 (0.048)	0.479
Charter * pct. proficient/ advanced math	-0.272 (0.094)	**0.004**	-0.193 (0.065)	**0.003**	-0.164 (0.061)	**0.008**	-0.134 (0.104)	0.198
Constant	0.213 (0.249)	0.393	0.264 (0.094)	**0.005**	0.310 (0.122)	**0.011**	0.352 (0.254)	0.165
R-square	0.199		0.650		0.454		0.150	
n school observations (unique)	9,497 (1,742)		9,497 (1,742)		9,497 (1,742)		9,497 (1,742)	

Sources. Colorado Department of Education and the Common Core of Data
Notes. Standard errors in parenthesis.
Standard errors adjusted for the inclusion of multiple observations of individual schools.
All additional school-level covariates from Table E.1 and county- and year-fixed effects included in model but not presented in table.

Among White students, the research shows further examples of instances where the direction of a relationship between school quality measures and mobility changes based on school. A significant, positive relationship exists between truancy rates in TPSs and mobility rates among White students (see Table V.11, Model 2). As the truancy rate increases by 10 percentage points in TPSs, mobility rates among White students increase by 9.8 percentage points (p = .000). The relationship between truancy rates and mobility rates among White students operates differently in the charter sector (see Table V.11, Model 2). As the truancy rate increases by 10 percentage points in charter schools, mobility rates among White students decrease by 6.4 percentage points (p = .022). Furthermore, the percent of students scoring proficient or advanced in reading is significantly, negatively associated with mobility rates among White students in TPSs, and significantly, positively associated with mobility rates among White students in charter schools. As the percent of students scoring proficient or above in reading increases by 10 percentage points in TPSs, White students experience school-level mobility rates that are one percentage point lower (p = .000). In charter schools, when the percent of students scoring proficient or advanced in reading increases by 10 percentage points, the rate of mobility among White students increases by 1.5 percentage points (p = .026).

For Asian students, among the school quality and sector moderator variables in the model, only the student-teacher ratio in TPSs was a significant predictor of mobility rates (see Table V.11, Model 4). For every additional student in a classroom, the rate of mobility among Asian students in TPSs increases by 0.2 percentage points (p = 000). No significant relationships between school quality measures and mobility rates were found among Asian students in charter schools.

Among FRL-eligible students, the only school quality measure related to mobility rates in charter schools was the length of the school year (see Table V.12, Model 1). As the length of the school year increases by one day, the rate of mobility among FRL-eligible students in charter schools increases by less than 0.1 percentage points (p = .000). The length of the school year is also significantly, positively associated with mobility rates among FRL-eligible students in TPSs. In addition, significant, positive relationships were also discovered between student mobility rates among FRL-eligible students and both truancy rates and student-teacher ratios in TPSs.

Among English language learners, a notable difference can be demonstrated in how student achievement is related to mobility rates in the charter and TPS sectors (see Table V.12, Model 3). Among TPSs, a significant, positive relationship was found between the percent of students scoring proficient or advanced in reading and mobility rates among English language learners. As the percent of students scoring proficient or advanced in reading increases by 10 percent, mobility rates among English language learners increase by 0.9 percentage points (p = .031). In charter schools, on the other hand, no significant relationship exists between mobility rates among English language learners and reading achievement, but a significant, negative relationship does occur with math achievement. As the percent of students in charter schools scoring proficient or advanced in math increases by 10 percentage points, the mobility rates among English language learners decrease by 1.6 percentage points (p = .035).

Table V.12

Regression Results with School Characteristics as Moderators of Sector Relationships with Student Mobility by FRL, Disability, ELL, and Gifted and Talented Status

	Model 1: FRL-eligible students		Model 2: Students w/disabilities		Model 3: English language learners		Model 4: Gifted/talented students	
	Coef.	p-value	Coef.	p-value	Coef.	p-value	Coef.	p-value
School sector (ref. TPS)								
Charter school	0.043 (0.179)	0.811	0.244 (0.136)	0.072	0.336 (0.228)	0.140	0.486 (0.196)	**0.013**
School quality moderating relationships								
Attendance rate	-0.158 (0.103)	0.125	0.021 (0.071)	0.766	0.078 (0.133)	0.558	-0.107 (0.107)	0.314
Charter * attendance rate	-0.078 (0.177)	0.657	-0.201 (0.122)	0.101	-0.363 (0.225)	0.108	-0.468 (0.195)	**0.017**
Truancy rate	0.655 (0.177)	**0.000**	0.646 (0.162)	**0.000**	0.630 (0.230)	**0.006**	0.702 (0.225)	**0.002**
Charter * truancy rate	0.061 (0.292)	0.834	-0.391 (0.288)	0.175	0.428 (0.400)	0.285	-0.759 (0.456)	0.096
Days in sch. year	0.002 (0.000)	**0.000**	0.001 (0.000)	**0.014**	0.002 (0.000)	**0.000**	0.002 (0.000)	**0.000**
Charter * days in sch. year	0.000 (0.000)	**0.000**	0.000 (0.000)	**0.007**	0.000 (0.000)	0.368	0.000 (0.000)	**0.001**
Student-teacher ratio	0.002 (0.000)	**0.000**	0.002 (0.000)	**0.000**	0.001 (0.000)	**0.000**	0.001 (0.000)	**0.000**
Charter * student-teacher ratio	0.003 (0.002)	0.156	0.005 (0.002)	**0.047**	0.001 (0.002)	0.623	0.000 (0.002)	0.979
Pct. proficient/ advanced reading	-0.035 (0.024)	0.141	0.023 (0.026)	0.379	0.086 (0.040)	**0.031**	-0.023 (0.028)	0.422
Charter * pct. proficient/ advanced reading	0.074 (0.078)	0.340	-0.068 (0.077)	0.378	0.105 (0.080)	0.192	0.234 (0.104)	**0.025**
Pct. proficient/ advanced math	0.020 (0.024)	0.390	-0.025 (0.022)	0.256	0.016 (0.036)	0.653	0.012 (0.026)	0.643
Charter * pct. proficient/ advanced math	-0.139 (0.074)	0.059	-0.128 (0.064)	**0.045**	-0.162 (0.077)	**0.035**	-0.206 (0.096)	**0.032**
Constant	0.221 (0.141)	0.116	0.356 (0.136)	0.009	-0.210 (0.172)	0.221	0.022 (0.144)	0.876
R-square	0.427		0.457		0.236		0.244	
n school observations (unique)	9,497 (1,742)		9,497 (1,742)		9,497 (1,742)		9,497 (1,742)	

Sources. Colorado Department of Education and the Common Core of Data

Notes. Standard errors in parenthesis; Standard errors adjusted for the inclusion of multiple observations of individual schools. All additional school-level covariates from Table E.1 and county- and year-fixed effects included in model but not presented in table.

Among gifted and talented students, no relationship has been found between mobility rates and achievement levels in either math or reading in TPSs (see Table V.12, Model 4). In charter schools, however, significant and opposing effects of math and reading achievement rates influence the incidence of mobility among gifted/talented students. As the percent of students scoring proficient or above in reading in charter schools increase by 10 percentage points, mobility rates among gifted/talented students increase by 2.3 percentage points ($p = .025$). Conversely, as the percent of charter school students scoring proficient or advanced in math increases by 10 percentage points, mobility rates among gifted/talented students decrease by 2.1 percentage points ($p = .032$).

Conclusion

The findings from this chapter demonstrate a clear relationship between school sector and student mobility rates. Results from descriptive analyses demonstrate that, in the aggregate, student mobility rates in Colorado are higher in charter schools than in TPSs. This pattern holds for nearly every student subgroup in nearly every observed school setting. Findings from the regression analyses suggest that these cross-sector differences are not explained by the observed school characteristics included in the models. Even after controlling for measures of school quality and school composition, among other school-level variables, a significant difference remains in mobility rates between charter schools and TPSs for the full sample and nearly every subgroup of students. When adding interactions between school-quality measures and school sector, however, the main effects of sector on mobility rates are no longer significant for any group. Results from this chapter also demonstrate important differences among student subgroups when it comes to how measures of school quality act as predictors of student mobility. What's more, findings from the moderator analyses demonstrate that the relationship between mobility and school quality measures varies between the charter and TPS sectors.

VI. CHAPTER FIVE – DISCUSSION

Introduction

Results from the empirical analyses presented in Chapters Two, Three, and Four provide evidence to evaluate the framework outlined in the first chapter. In this chapter, the framework will be used to structure the discussion of these findings. Each relationship from the framework that was investigated in the empirical analyses will be examined to determine whether findings support the presence of this relationship or not. Findings from prior research will also be incorporated to provide context and establish whether results are consistent with prior research.

Structural Mobility

To begin, I discuss the elements of the framework relating to structural mobility and the empirical findings investigating these relationships. Of the empirical chapters, only Chapter Two, which uses the ECLS-K data, examines structural mobility and its correlates. The portion of the framework pertaining to structural mobility is presented in Figure VI.1, with the elements of relationships that were tested in Chapter Two bolded for emphasis, while those that were not examined are colored in gray. The findings from Chapter Two address the relationship between grade structuring and the occurrence of structural mobility, as well as the proximal relationship between structural mobility and a change in school quality for mobile students and the distal relationship between structural mobility and student achievement for mobile students.

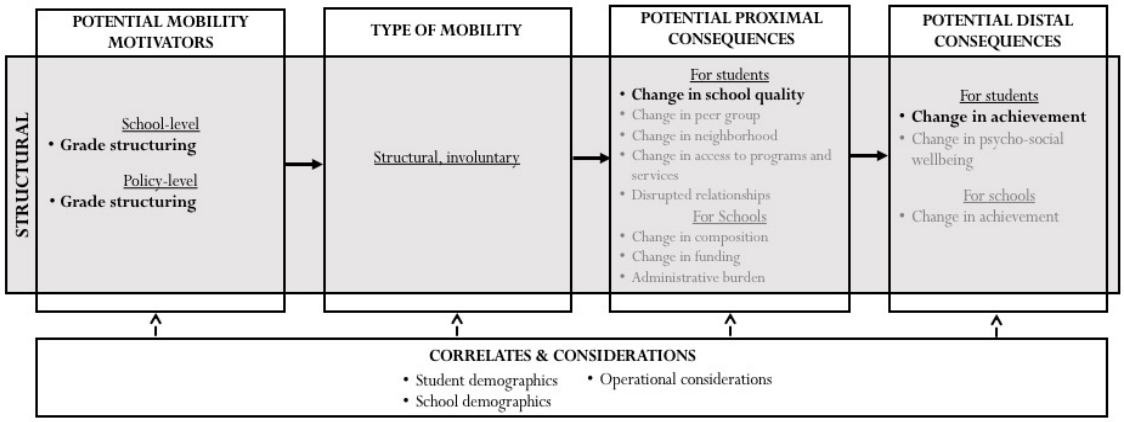

Figure VI.1. Elements of the structural mobility framework tested in empirical analyses.

Motivators. Results from the ECLS-K analysis demonstrate that small rates of structural mobility occurred throughout elementary school, but between fifth and eighth grades, the majority of students experienced a nonstructural move. The large spike in structural mobility rates between the fifth and eighth grades is unsurprising given that the primary grade structure imposed by the policy of schools and districts includes separate elementary schools—typically serving students through the fourth, fifth, or sixth grades—and middle or junior high schools—generally serving students beginning in grades five, six, or seven, through grade eight (Meyer, 2011; Rockoff & Lockwood, 2010). In fact, according to Meyer (2011), the number of middle schools in the country peaked in 2005—just when the children in the ECLS-K would be entering middle school. It is evident, from this nationally representative data, that grade structuring motivates large numbers of school switches in the primary grades, with the vast majority of these structural moves occurring between elementary and middle school.

Proximal consequences. The analysis using the ECLS-K did not include an investigation of proximal consequences of structural student mobility for schools, but it did examine one aspect of potential proximal consequences for students. By examining rates of upward mobility among structural movers, Chapter Two explored the relationship between structural mobility and a change in school quality for structurally mobile students. For this chapter, upward mobility occurs when the receiving school has a higher proportion of students performing on grade level than the sending school.

The majority of structural moves early in elementary school is upward. In the aggregate sample, and across subgroups, 56 to 83 percent of structural moves between the first and third grades result in an upward school change. In later grades, rates of upward mobility for students experiencing structural mobility decrease. Among the full ECLS-K sample, only half of structural moves result in an upward school change between the third and fifth grade waves, and between fifth and eighth grade, only 48 percent of structural mobility was upward. As a comparison, 62 percent of nonstructural moves between third and fifth grade were upward, as were 60 percent of nonstructural school switches between fifth and eighth grade.

The decreased likelihood of upward mobility among structural movers relative to nonstructural movers between third and fifth grades, and in particular between the fifth and eighth grades, may be explained by differences in the quality of elementary and middle schools. In their study of structural moves to middle school, Rockoff and Lockwood (2010) found that parents and students rated the quality of their children's school lower if their child attended a middle school, compared to parents of children who attended a K–8 school. Their study also found that students who moved to middle schools had lower achievement than their peers who remained in K–8 settings. Given that this chapter defines school quality based on the proportion of students performing on grade level, systematically lower achievement in middle schools, relative to K–8 schools, may explain why the majority of structural moves in the later waves of the ECLS-K were lateral or downward in nature, while the majority of nonstructural moves remain upward across all waves.

Distal consequences. When looking at the relationship between mobility of differing types—residential, nonstructural, and structural—structural mobility that occurred without a concurrent residential move was the only type of mobility found to have a significant relationship with later achievement. Students who experienced structural mobility in the absence of concurrent residential mobility had significantly lower math achievement in the following wave of data collection than their non-mobile peers. Students who experienced both a residential and structural move had math achievement that did not differ significantly from their non-mobile peers, and structural mobility with or without concurrent residential mobility was not significantly associated with reading achievement. Descriptive results demonstrate that structural moves without concurrent residential moves were the least likely of all the mobility types explored to result in an upward school change, which may contribute to this finding.

To better understand the relationship between structural mobility and math achievement, an additional analysis was done to explore potential moderating effects of the timing of structural moves. Based on these results, structural mobility occurring between the first and third grade did not significantly predict math achievement. Relative to the impact of structural mobility between first and third grade, however, structural mobility that occurred between the third and fifth grades was associated with a significant reduction in math scores. The relationship between structural mobility occurring between fifth and eighth grade and math achievement was negative but not significant, relative to the impact of structural mobility occurring between first and third grade. In other words, over the course of the primary school grades in the ECLS-K sample, only structural mobility that took place between third and fifth grades was associated with significantly diminished subsequent math achievement.

The findings regarding structural mobility's impact across time in the ECLS-K sample are somewhat inconsistent with other research that has demonstrated a negative relationship between structural mobility between elementary and middle school and student achievement for both math and reading. Studies have found that, relative to students who remain in K–8 schools, students' math and reading achievement levels drop when they enter middle or junior high schools and that this disadvantage persists and continues to worsen throughout the middle school grades (Rockoff & Lockwood, 2010; Schwerdt & West, 2013). The finding of a significant reduction in achievement for students who were mobile prior to the spring of fifth grade may support this prior work, given that some middle schools begin in the fifth grade. However, structural mobility in the ECLS-K sample occurs predominantly between the fifth and eighth grade waves, and the structural mobility during this period is likely to capture the majority of transitions from elementary to middle schools. Therefore if the negative association between structural mobility and math achievement is capturing some negative effects of middle school attendance, we would expect the relationship might be strongest during this time.

One potential explanation for this discrepancy may result from the timing of the data collections for the ECLS-K data and variation in students' grade of entry into middle or junior high schools, which start in fifth, sixth, or seventh grades. Students who entered middle school at the start of fifth grade would have experienced structural mobility during the same school year when the math assessment was administered in the spring of fifth grade. On the other hand, students who moved into middle school at the start of the sixth or seventh grades would have experienced their structural move between 1.5 and 2.5 years prior to taking the math assessment in the spring of eighth grade. If the negative effects for student achievement of a structural move into middle or junior high schools is short term, then it may no longer be possible to detect this relationship by the spring of eighth grade.

Nonstructural Mobility

Each of the empirical chapters in this dissertation examines some aspect of nonstructural mobility's potential motivators and/or consequences. The portion of the framework pertaining to nonstructural mobility is presented in Figure VI.2, with the elements of relationships that were tested in Chapters Two, Three, or Four bolded for emphasis, while those that were not examined are colored in gray. Given the data used in each of these chapters, it is not possible to distinguish between nonstructural mobility that is voluntary vs. involuntary, or nonstructural mobility that is strategic vs. reactive; however, each chapter uses data that is well suited to investigate some aspect of the framework. The findings from Chapter Two address relationships between student- and school-level motivators and nonstructural mobility, as well as the relationship between nonstructural mobility and both proximal and distal consequences for mobile students. And results from Chapters Three and Four focus on school- and policy-level motivators of student mobility.

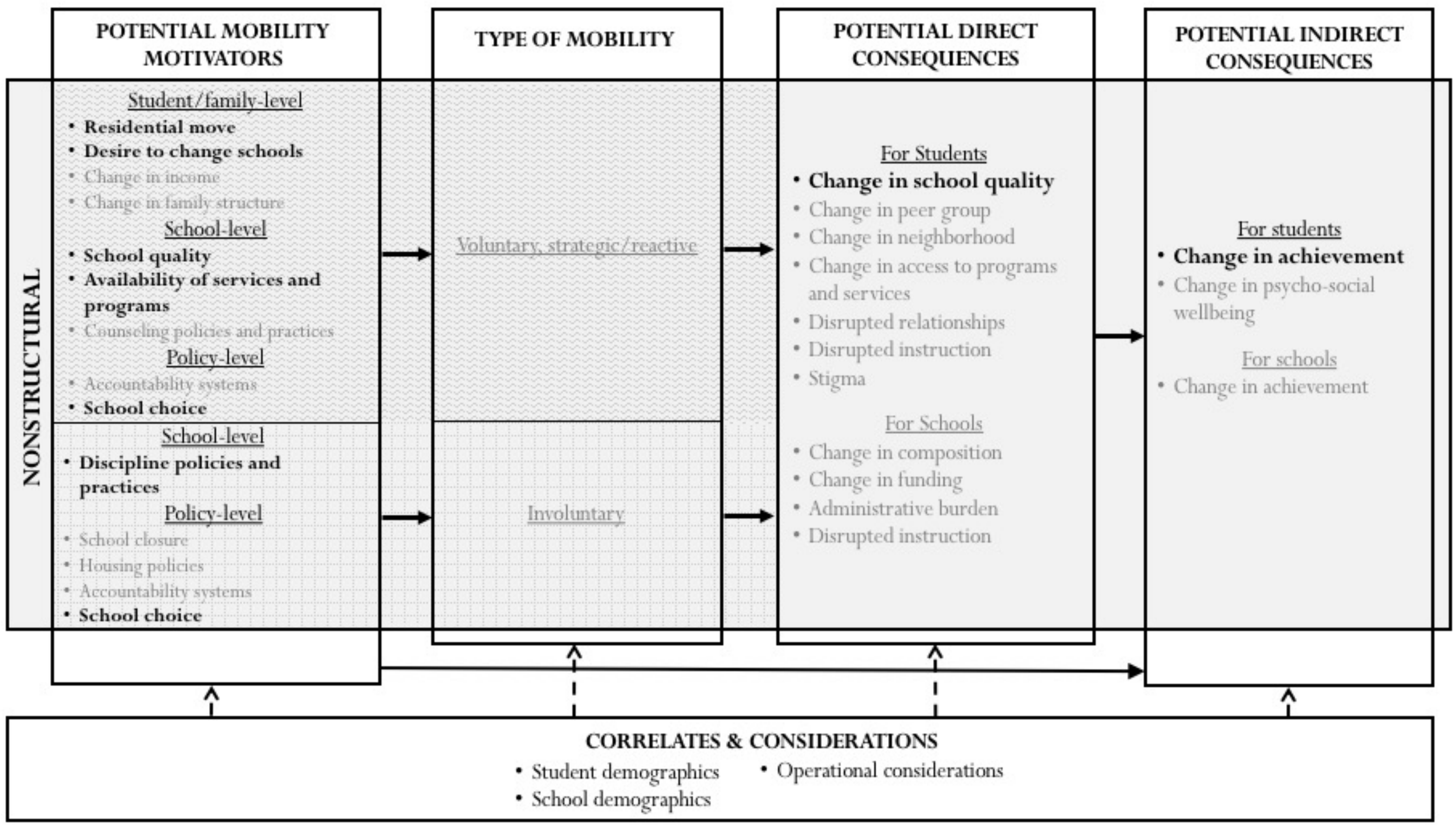

Figure VI.2. Elements of the nonstructural mobility framework tested in empirical analyses.

Motivators. Each of the empirical chapters explores multiple motivators of nonstructural student mobility. Only Chapter Two, using the ECLS-K data, examines nonstructural mobility motivators that originate from students or their families. In particular, this chapter incorporates analyses that examine residential mobility and students' or families' desire to change schools as motivators of nonstructural mobility.

Residential mobility. Results from the ECLS-K data demonstrate that the majority of residential mobility incidents are concurrent with a school switch and that rates of residential mobility are relatively consistent throughout the primary grades. Rates of school switches that occurred during the same period as residential moves increased over the course of the primary school grades in the ECLS-K sample. Among the full sample, 53 percent of students experiencing a residential move between the first and third grades also experienced a school change during that period; this rate grew to 75 percent of students who were residentially mobile between the fifth and eighth grade waves. The high rates of concurrent school switches among students who moved residences suggests that residential mobility is a major contributor to nonstructural student mobility. This finding is consistent with prior research. Studies of mobility across different contexts—high school students in California and nationally and elementary students in Chicago—have found that 58 to 70 percent of nonstructural mobility is motivated by a residential move (Kerbow, 1996; Rumberger, 2003; Rumberger & Larson, 1998).

Descriptive findings among the full sample demonstrate that between 16 and 18 percent of students experienced residential mobility prior to each data collection. Some subgroups had notably high or low rates of residential mobility. High-SES students had the lowest rates of residential mobility across each wave, with only 11 to 13 percent of these students experiencing a residential move. Low-SES students, on the other hand, had rates of residential mobility that ranged between

21 and 23 percent across waves. Black and Hispanic students also had high rates of residential mobility, relative to the aggregate sample.

The association between students' SES background and the likelihood of mobility identified in descriptive results remains after controlling for additional student- and school-level covariates in a linear probability model predicting residential mobility. In this model, SES was one of only three student-level covariates found to significantly predict residential mobility. As students' family SES—as measured by ECLS-K's continuous SES measure that accounts for parents' or guardians' income, education, and occupation—increased, the likelihood of experiencing residential mobility significantly decreased. The relationship between students' SES and residential mobility is consistent with prior research. Ihrke and Faber (2012) found higher rates of residential mobility among individuals with lower income in their descriptive study using data from the 2010 US Census. Further, this study also identified higher rates of residential mobility among renters and unemployed individuals (Ihrke & Faber, 2012), which may also contribute to higher rates of residential mobility among lower-SES individuals.

Also in the LPM results, the number of days a student was absent and the number of days a student was tardy in the prior wave were both significant predictors of residential mobility. The more days a student was absent or tardy, the greater his or her likelihood of residential mobility, after controlling for other student- and school-level covariates. These measures may capture a greater degree of instability within students' households, and this increased instability may result in increased rates of residential instability.

In the LPM model, only one school-level covariate was significantly associated with the likelihood of residential mobility. The proportion of a student's peers at his or her sending school who were Hispanic was significantly, positively associated with the probably of residential mobility—students who attended schools serving larger proportions of Hispanic students were more likely to experience a residential move. As explained in Chapter One, the demographic make-up of the school is not likely to be a direct cause of residential mobility but is likely instead associated with some other factors that are causally linked to residential mobility. Students attending schools that serve larger populations of Hispanic students may be more residentially transitory as a result of factors related to geography, urbanicity/rurality, wealth, industry, etc., that may be the direct causes of increased residential mobility. No other school-level measures were significant predictors of residential mobility. This may be because residential moves are a family-motivated cause of mobility; descriptive results suggest that a desire to change schools was a motivator of residential moves in only a small proportion of cases. Further, significant relationships with school characteristics may be few in part because not all residential moves prompt a school switch.

Desire to change schools. Further analysis using the ECLS-K examines the relationship between a desire to change schools and residential mobility, which, as described above, is accompanied by a school switch in a majority of instances. Among students who made a residential move, only 7 to 11 percent of parents across waves indicated that they moved residences so that their child could attend a better school. To the extent that this measure captures the majority of residential mobility motivated by a desire to change schools, these descriptive findings demonstrate that this is a motivation for residential mobility in a relatively small proportion of cases. Finding that a desire to change schools is not a primary motivation for residential mobility is consistent with prior research that has found that residential moves are most frequently motivated by housing-related decisions, as well as changes in employment and family structure (Hanushek et al., 2004; Schachter, 2001).

Some subgroup differences were evident in the extent to which a desire to change schools was a motivator for residential mobility. White and Asian students, as well as high-SES students reporting lower than average rates of residential mobility, were motivated by access to a higher-quality school. Black and Hispanic students and low-SES students, on the other hand, were more likely than average to report that they made a residential move to gain access to a better school. Given the inequitable access to high-quality schools across race and class, this finding suggests that, for groups of students who disproportionally attend struggling schools (Darling-Hammond, 1998, 2004), attaining access to a better school is more of a motivation for residential mobility than for subgroups of students who are more likely to attend a high-quality school. Further, even when students from high-SES families are dissatisfied with a school, they may be better able to seek out alternate schooling options without having to make a residential move, particularly in the private sector, resulting in lower rates among this group of residential moves motivated by a desire to change schools.

School quality. Each of the three empirical chapters explores school-level motivators of student mobility, and each includes some exploration of school quality as a motivator of nonstructural mobility. In their study, which used the National Education Longitudinal Study (NELS), Rumberger and Thomas (2000) found that measures of school quality—in their case, teacher quality and average teacher salary—were negatively associated with student mobility; that is, students in higher-quality schools are less likely to experience mobility. Results from the empirical chapters were mixed, though findings support this prior research and the proposed relationship between school quality and mobility in the framework.

In the ECSI and Colorado analyses, many school quality measures were not significantly related to the likelihood of student mobility in regression models; however, these chapters did find some evidence of a relationship between school quality and nonstructural mobility. In the ECSI data, the lengths of the school day and school year were the only school quality measures associated with nonstructural mobility among students who won charter admissions lotteries. Students who were admitted to charter schools offering longer school days or school years had higher rates of mobility. In the Colorado sample, the length of the school year was also positively associated with nonstructural student mobility. With mobility rates found to be higher among students attending schools that offer additional instructional time, these results are contrary to what was expected.

Additional evidence in both the ECLS-K and Colorado chapters supports a relationship between school quality and nonstructural student mobility. Truancy rates were found to be associated with mobility rates among the aggregate student sample in the Colorado data. Schools in Colorado with higher truancy rates have significantly higher school-level mobility rates. And the Colorado analysis tested additional relationships between nonstructural mobility and school quality measures. The student-teacher ratio in a school was found to be significantly and positively associated with mobility rates among the full sample; schools with larger class sizes have higher rates of nonstructural mobility. Further, the percentage of students proficient in reading was significantly and negatively associated with mobility among the full sample. This suggests that students who attend higher-achieving schools are less likely to experience student mobility. The percentage of students proficient in math, however, did not have a significant relationship with mobility in the full sample.

In regression results estimating nonstructural mobility among students in the ECLS-K sample, however, measures related to the quality of students' sending schools were not significant predictors. Neither the percent of students performing on grade level nor measures related to negative school safety conditions in the sending school were significantly associated with the likelihood that a student would experience nonstructural mobility, after controlling for other student- and school-level covariates. These findings fail to provide additional evidence that attending a poor-quality school may motivate students and their families to seek alternate schooling options. However, descriptive results from this chapter suggest that a high-quality schooling alternative may motivate mobility. Rates of upward mobility—school switches resulting in enrollment in a higher-quality school—among students who experienced nonstructural mobility were high, relative to students who experienced structural mobility. In particular, in the third- and fifth-grade waves, 50 and 48 percent of students who were structurally mobile, respectively, had made an upward school switch. Students who had a nonstructural school change, on the other hand, made upward moves 63 and 60 percent of the time, respectively. This suggests that the quality of the receiving school may be a motivating factor in voluntary mobility decision-making.

Null findings contradictory to prior research and the proposed relationships in the framework were found. In the ECSI sample, none of the other school quality measures—student-teacher ratio, average daily attendance, expenditures per pupil, the age of the charter school, or the number of suspension incidents or suspended students per 100 students—were significant predictors of student mobility among lottery winners.

Together, the findings from the ECSI, Colorado, and ECLS-K chapters support both the proposed relationship between school quality and mobility in the framework and prior research that has affirmed this relationship. These results suggest that students in higher-quality schools are less likely to experience nonstructural mobility, and that further, the quality of the receiving school may motivate mobility.

Availability of services and programs. Prior research has demonstrated that offering particular programs or services, such as sports, arts, or childcare, attracts students and their families into particular schools (Harris & Larsen, 2015; Rumberger, 2003). In the ECLS-K and ECSI samples, however, no evidence was found to support this prior research or this aspect of the framework. In regression models predicting nonstructural mobility using these data, the availability of services and programs did not have a significant relationship with the likelihood of mobility.

In regression results using the ECLS-K, students' sending schools offering a gifted/talented program or being a special education school was not significantly related to the likelihood of nonstructural student mobility. Likewise, in the ECSI sample, sending schools offering a gifted/talented program or supports for ELL students did not have a significant impact on the likelihood of mobility among students who won admissions lotteries for charter middle schools. It may be that these offerings are not those that motivate students' and families' mobility choices; the data available on program offerings did not include those that prior research had found to be motivators of mobility, such as football or other sports. Further, the lack of significant findings may be because these programs and services impact relatively few students in the schools in which they are offered.

School choice. Chapters Three and Four both have particular focus on the relationship between one policy-level motivator, school choice, and mobility. These chapters, using the ECSI natural experiment data and administrative records for the state of Colorado, respectively, examine the relationship between one type of school choice—charter schools—and nonstructural school switches. The findings suggest different relationships between the two data sets. The opposing findings may result from differences in the type of data and the makeup of the samples. The ECSI sample is a student-level dataset that includes students who applied to a sample of oversubscribed charter middle schools nationwide whose administrators agreed to participate in the study. The Colorado data, on the other hand, is a school-level dataset that includes every brick-and-mortar charter school in the state of Colorado and includes charters of all grade levels, regardless of whether they are oversubscribed. These distinctions likely account for much of the divergence in findings regarding the relationship between school choice and student mobility.

In the school-level data from the entire state of Colorado, descriptive results demonstrate that mobility rates are higher in charter schools than in TPSs. For the full sample, as well as for every student subgroup, rates of mobility were between 17 and 55 percent higher in charter schools than they were in the TPS sector. These findings demonstrate that, across the state of Colorado, the student populations in charter schools are, on average, less stable than those in TPSs. These results are inconsistent, however, with the descriptive findings from the study conducted by Zimmer and Guarino (2013) in a large, unidentified urban school district. These authors found that mobility rates were lower in charter schools than TPSs—12 versus 15 percent, respectively.

In Colorado, the difference in mobility rates between charters and TPSs found in descriptive analyses remained present after controlling for school characteristics in regression analyses. After controlling for measures of school quality, school composition and market density, mobility rates in charter schools remained significantly higher than those in TPSs. This finding of significantly higher rates of mobility in the charter sector is inconsistent with the ECSI results, as well as results from past literature. Roy (2014), for example, found that in New York City, after controlling for student characteristics, charter school students were 23 percent less likely to leave their school than their peers in neighboring TPSs. Another study of nonstructural mobility in Los Angeles supports Roy's findings of lower mobility rates in charters compared to TPSs (Dauter & Fuller, 2011).

Contrary to what was found in regression results using the Colorado data, among the ECSI sample, winning admissions to or attending a charter school significantly reduced the likelihood of student mobility relative to peers who lost admissions or did not attend a study charter school. This significant relationship remains after controlling for student-level covariates, including whether a student changed school between baseline (prior to the lottery) and year one (the first school year after the lottery). This finding suggests study charter schools had an impact on student mobility rates and that students who gained admissions to them may have been more satisfied with their school, and therefore less likely to engage in nonstructural mobility, than their peers who lost charter admissions lotteries. While this finding is consistent with findings from observational studies (Dauter & Fuller, 2011; Roy, 2014), as mentioned above, it is inconsistent with what two studies using charter lottery data from Massachusetts have found. These studies found no difference in mobility rates between students who won charter admissions and those who lost admissions lotteries, in nearly all cases (Abdulkadiroglu et al., 2011; Angrist et al., 2012).

In the ECSI sample, measures related to students' prior engagement with schooling also significantly moderated the impact of charter admissions on student mobility. Students with a history of disciplinary issues or poor attendance who won admissions to a study charter school were more likely to leave than their lottery-winning peers. Looking at students' attendance histories, each additional day absent during the baseline school year was associated with a 1 percent increase in the likelihood of nonstructural mobility among lottery winners. On the other hand, no significant relationship was shown between absenteeism in the prior year and the likelihood of mobility among lottery losers. Further, having been suspended during the baseline school year is associated with a 21 percent increase in the likelihood of mobility, relative to their non-suspended peers, among lottery winners. Conversely, lottery losers who were suspended during the baseline school year were 31 percent less likely to experience mobility than lottery winners who had not been suspended.

If students' histories of absenteeism and prior disciplinary issues reflect a greater propensity for issues engaging with school in the future, these findings may indicate that disciplinary practices in study charter schools are, on average, stricter than in the schools attended by lottery losers. This would suggest that students with disciplinary issues or frequent absenteeism in study charter schools may engage in more voluntary mobility, perhaps as a result of the discord with the school culture, or that these students are expelled from these schools at a higher rate than their peers who did not gain admission. This is consistent with findings from Chicago that found higher rates of expulsions in charter schools than in TPSs (Ahmed-Ullah & Richards, 2014). Certain charter schools, in particular those that practice the "no excuses" model of schooling, include strict disciplinary expectations as part of their education methods (Angrist et al., 2012; Losen, Keith, Hodson, & Martinez, 2016). In addition to strict codes of conduct, no-excuses charter schools also often have longer school days or years (Angrist et al., 2012); the length of the school day and school year were also significantly, positively associated with rates of nonstructural mobility among lottery winners in the ECSI sample. The findings from this chapter suggest that charter schools may employ more stringent disciplinary standards than traditional public schools.

Among subgroups of students in the descriptive analyses, as among the full sample, this research found differences in mobility rates between the charter and TPS sectors. These differences persist for many subgroups in regression analyses. Black students had the lowest cross-sector differences in mobility rates, which only differed by 7.8 percentage points, on average—45 percent in charters and 37 percent in TPSs. Gifted and talented students had drastically different mobility rates across sectors, with, on average, 33 percent mobility in charter schools and only 15 percent mobility in TPSs—an 18-percentage point difference. FRL-eligible students also saw large cross-sector differences in mobility rates, with, on average, 46 percent mobility in the charter sector and

34 percent mobility in TPSs—a 12-percentage point difference. This finding is consistent with the findings from regression results using ECSI data, which found higher rates of mobility among FRL-eligible lottery winners relative to non-FRL-eligible lottery winners and lower rates of mobility among FRL-eligible lottery losers compared to non-FRL-eligible lottery winners. In regression results using the Colorado sample, the relationship between sector and mobility was consistently null for Black students, as well as for Hispanic students, Asian students, and English language learners. For remaining subgroups of students, including FRL-eligible students and gifted and talented students, significant cross-sector differences in mobility rates remained after controlling for school-level variables, with rates higher in charter schools than in TPSs. In moderator models that explore whether relationships between school quality measures and student mobility vary between charter schools and TPSs, the main effect of school sector is no longer significant for the aggregate sample or any subgroup of students. This suggests that the relationship between sector and mobility rates found in the Colorado sample may be explained by cross-sector differences in how school quality measures are related to student mobility.

In the Colorado sample, the number of choice schools serving the same grades within a five-mile radius of a given charter school or TPS was found to have a significant, negative relationship with school mobility. That is, schools with more schools of choice within five miles of their location had lower rates of mobility among these groups of students than schools in less choice-dense locations. Conversely, the number of newly opened choice schools—those that entered the market within five years of a given wave of data—was significantly and positively associated with rates of student mobility. This later finding is consistent with what Dauter and Fuller (2011) found in Los Angeles, where they demonstrated that as the number of charter schools in Los Angeles grew, rates of mobility in the district increased, a finding that suggests that when families are offered more schooling choices, they engage in more nonstructural mobility. Evidence in the Colorado data shows that the entrance of new schools to an education market introduces greater instability for a period of time, while in the long run, students with larger school choice sets may be more stable. This may be because they are able to select and attend a school with which they are more satisfied, reducing their motivation to engage in nonstructural mobility. Together these findings suggest that the enactment of school choice policies may initially serve to increase rates of student mobility as students change schools to take advantage of new opportunities, but after these schools have been present in the market for some time, school choice policies may ultimately reduce rates of student mobility.

Proximal consequences. The analyses in the three empirical chapters did not include an investigation of proximal consequences of nonstructural student mobility for schools, but the ECLS-K chapter included an investigation of nonstructural mobility's relationship with a change in school quality among mobile students, one of the proximal consequences for students. Chapter Two explored the relationship between nonstructural mobility and a change in school quality for students who experienced nonstructural mobility by examining rates of upward mobility among these students. As described earlier, upward mobility was defined for the analyses in this chapter as a school switch, where the receiving school has a higher proportion of students performing on grade level than the sending school. In the full ECLS-K sample, the majority of nonstructural mobility incidents across waves resulted in upward mobility, though rates of upward mobility among nonstructural movers decline over time. Seventy-four percent of nonstructural school switches that occurred between the first and third grade resulted in upward mobility. By the eighth-grade wave, 60 percent of nonstructural moves resulted in upward mobility.

Relative to the aggregate sample, some subgroups of students had high or low rates of upward mobility resulting from a nonstructural school switch. Among nonstructural school switchers, White and Asian students, across waves, and high-SES students in the fifth-grade wave all had relatively high rates of upward mobility. Conversely, rates of upward mobility among Black and Hispanic students, students with disabilities, and low-achieving students who experienced nonstructural mobility were consistently low relative to the aggregate sample. These subgroup differences may occur for several reasons. First, these differences may reflect differences in the quality of school choice sets available to students across subgroups. Alternatively, they could reflect differences in parents' ability or priorities regarding the identification of higher-quality schooling alternatives for their children. Further, these differences could reflect variances in rates of involuntary mobility that results from school closures, expulsions, etc.

Descriptive results suggest that nonstructural mobility is more likely to result in upward mobility than structural mobility among the full sample and for most subgroups of students. Results from the LPM predicting upward mobility, however, demonstrate no significant difference in the likelihood of an upward school switch based on a student making a structural on nonstructural school change, after controlling for student- and school-level covariates. These results suggest that differences in the occurrence of upward mobility between structural and nonstructural mobility are accounted for by differential rates of these two types of mobility based on the characteristics of students and schools that are controlled for in the regression models.

Distal consequences. In addition to the proximal consequences of nonstructural student mobility, Chapter Two also explores the relationship between nonstructural mobility and a distal outcome for students—change in achievement. Unlike findings for structural mobility, results from multilevel linear models found no evidence that nonstructural mobility had a significant relationship with either math or reading achievement among the ECLS-K sample. This finding is inconsistent with some prior literature that has established a link between nonstructural student mobility and subsequent student achievement in both math and reading (Mehana & Reynolds, 2004), but it is in line with other research finding that links between mobility and achievement disappear when controlling for background characteristics (Alexander, Entwisle, & Dauber, 1996).

Limitations resulting from of the ECLS-K data may explain, to some extent, these null findings. The ECLS-K does not include any measures that make it possible to determine the exact timing of nonstructural student mobility events over the period between waves of data collection. For some students, a nonstructural mobility event could have occurred during the same school year as the data collection, or this event may have occurred two or three years prior, depending on the length of time between data collections. Some studies have found the negative effects of mobility on student achievement to be short term (Engberg et al., 2012), so the inability to account for the timing of nonstructural mobility events may conceal potential relationships between nonstructural mobility and student achievement.

While the ECLS-K analysis showed no significant associations between nonstructural mobility and student achievement, regression results from this chapter did identify a relationship between the quality of student mobility—upward compared to lateral or downward—and later math achievement. Students making upward moves had math and reading achievement that was statistically indistinguishable from that of their non-mobile peers, while students who made a downward or lateral move had diminished math achievement in the following wave (with a *p*-value of 0.05, this relationship did not reach statistical significance but was just on the cusp of doing so). This result is consistent with what was found by Engberg et al. (2012) in their study of school closures. They found that students who made lateral moves had significantly diminished math and reading achievement in the first year after the closure, while students who made upward moves had achievement in math and reading that was statistically indistinguishable from students who did not have to make a school switch. These findings suggest that students who gain access to a higher-quality school through student mobility are insulated from the negative effects of a school change on their achievement.

To explore the relationship between mobility quality and later math achievement further, a regression model including interaction terms between student characteristics—race/ethnicity and SES, ELL, and IEP status—and mobility quality as predictors of math achievement was estimated. Regardless of the quality of a school switch, no relationship existed between mobility and math achievement for students based on race/ethnicity or ELL status. For students with IEPs, mobility was associated with lower math achievement, regardless of whether it was upward or lateral/downward in nature. Of particular note, school quality had a significant moderating effect on the relationship between students' SES and math achievement. For students who experienced a lateral or downward school switch, a significant, positive relationship was shown between SES and math achievement, above and beyond the relationship between these variables among non-mobile students. In other words, the SES-based differences in math achievement are larger among students who experienced a lateral or downward move than among non-mobile students. This suggests that higher-SES students are shielded from the negative impact of making a lateral/downward move or that these moves are especially damaging for lower-SES students. For students who made an upward school switch, no significant moderating relationship was present.

Conclusion

The work presented in this dissertation contributes to the literature on student mobility. First, this dissertation outlines a framework for understanding the motivators and consequences—

both proximal and distal—of both structural and nonstructural mobility. It is important to have a clearly organized framework to aid the development and interpretation of research studies focusing on student mobility. Chapter One attempts to provide such a guide by incorporating evidence from prior literature to develop a conceptual model of how different motivators contribute to differing types of mobility, which in turn, results in varying potential consequences.

The empirical chapters contribute to the body of research that has explored different aspects of student mobility. In particular, Chapter Two uses nationally representative data to explore differences in rates, predictors, and consequences of both residential and nonstructural mobility, finding evidence of student-, school-, and policy-level motivators of different types of mobility, as well as relationships between mobility and both proximal and distal outcomes, including later achievement, for mobile students. Chapters Three and Four contribute, in particular, to our understanding of how school choice as a policy mechanism, namely in the form of charter schools, is related to nonstructural mobility. These findings present mixed results on the relationship between charter schools and student mobility, suggesting that students in these schools may experience higher or lower rates of mobility, depending on the context.

Future research should continue to explore student mobility as a key topic in education research. We still do not know much about the many potential motivators and consequences of student mobility occurring under different conditions. Because this is a phenomenon that impacts so many students, directly and indirectly, we should continue to work for greater understanding of this topic. The framework presented in Chapter One can be used as a guide for this ongoing work, which can build on the findings from the empirical analyses in this dissertation and elsewhere in the literature on student mobility.

APPENDIX A

Table A.1

Student-Level Variables Used in Analyses

		1st grade	3rd grade	5th grade	8th grade
Variable	Description	Mean/(sd)	Mean/(sd)	Mean/(sd)	Mean/(sd)
Gender and age					
Male	Binary variable: 1 if a student is male	0.52 (0.50)	0.51 (0.50)	0.51 (0.50)	0.50 (0.50)
Age	Students' age in months	86.95 (4.50)	111.04 (4.54)	134.63 (4.53)	171.39 (4.50)
Race/ethnicity					
White	Binary variable: 1 if a student is White, non-Hispanic	0.53 (0.50)	0.53 (0.50)	0.53 (0.50)	0.59 (0.49)
Black	Binary variable: 1 if a student is Black, non-Hispanic	0.16 (0.37)	0.15 (0.35)	0.13 (0.33)	0.12 (0.32)
Hispanic	Binary variable: 1 if a student is Hispanic	0.19 (0.39)	0.20 (0.40)	0.20 (0.40)	0.18 (0.39)
Asian	Binary variable: 1 if a student is Asian	0.07 (0.25)	0.07 (0.26)	0.07 (0.26)	0.06 (0.23)
Other	Binary variable: 1 if a students' race is none of the above	0.06 (0.23)	0.06 (0.24)	0.06 (0.24)	0.06 (0.23)

Variable	Description	1st grade Mean/(sd)	3rd grade Mean/(sd)	5th grade Mean/(sd)	8th grade Mean/(sd)
Socioeconomic status					
SES	ECLS-K-computed var. including household education, occupation & income	0.13 (0.78)	-0.12 (0.79)	-0.13 (0.79)	-0.11 (0.78)
Low SES	Binary variable: 1 if a student is in bottom quintile of SES	0.22 (0.41)	0.22 (0.41)	0.22 (0.41)	0.21 (0.41)
High SES	Binary variable: 1 if a student is in top quintile of SES	0.19 (0.40)	0.20 (0.40)	0.20 (0.40)	0.21 (0.41)
Academic classifications					
English language learner (ELL)	Binary variable: 1 if a student is designated ELL	0.07 (0.26)	0.07 (0.26)	0.07 (0.25)	-- --
Special education	Binary variable: 1 if a student has an individualized education plan (IEP)	0.10 (0.30)	0.13 (0.34)	0.14 (0.34)	0.11 (0.31)
School engagement					
Days absent	Students' total number of absences during school year	8.26 (10.68)	6.72 (7.73)	6.70 (7.99)	2.12 (0.61)
Days tardy	Students' total number of days tardy during school year	3.74 (7.40)	3.01 (6.40)	2.94 (6.75)	1.50 (0.70)

Variable	Description	1st grade Mean/(sd)	3rd grade Mean/(sd)	5th grade Mean/(sd)	8th grade Mean/(sd)
Assessment performance					
Math IRT score	Item response theory scaled score on ECLS-K-administered math test	42.61 (9.35)	83.50 (18.24)	112.54 (21.97)	140.87 (22.61)
Reading IRT score	Item response theory scaled score on ECLS-K-administered reading test	54.53 (13.83)	105.62 (20.60)	137.08 (23.56)	168.59 (28.20)
Low-achieving	Binary variable: 1 if in bottom quintile of combined math and reading	0.20 (0.40)	0.20 (0.40)	0.20 (0.40)	0.20 (0.40)
High-achieving	Binary variable: 1 if in top quintile of combined math and reading	0.20 (0.40)	0.20 (0.40)	0.20 (0.40)	0.20 (0.40)
n students		13,530	11,960	9,330	7,810

Table A.2

School-Level Variables Used in Analyses

Variable	Description	1st grade Mean/(sd)	3rd grade Mean/(sd)	5th grade Mean/(sd)	8th grade Mean/(sd)
Total enrollment	Total school enrollment	3.59 (1.06)	3.62 (1.01)	3.64 (1.00)	4.12 (1.06)
Overcrowded	Binary variable:1 if principal reports school is overcrowded	0.35 (0.48)	0.21 (0.34)	0.24 (0.43)	0.19 (0.39)
Pct. free/ reduced lunch eligible	Percent of enrollment eligible for free or reduced lunch	43.39 (34.43)	46.06 (32.09)	49.17 (33.27)	45.73 (32.04)
Pct. Asian	Percent of students identified as Asian	4.98 (11.93)	5.32 (11.39)	5.67 (11.12)	4.67 (8.89)
Pct. Hispanic	Percent of students identified as Hispanic	15.18 (23.79)	17.68 (25.43)	3.29 (1.39)	3.24 (1.35)
Pct. Black	Percent of students identified as Black	18.72 (26.61)	18.22 (25.39)	3.18 (1.33)	3.19 (1.30)
Pct. White	Percent of students identified as White	57.67 (34.84)	56.58 (34.38)	50.54 (35.12)	54.44 (34.13)
Pct. on grade level in reading	Principal report of the percent of students on grade level in reading	59.45 (23.06)	62.32 (22.03)	62.24 (22.95)	67.95 (23.03)

Variable	Description	1st grade Mean/(sd)	3rd grade Mean/(sd)	5th grade Mean/(sd)	8th grade Mean/(sd)
Pct. on grade level in math	Principal report of the percent of students on grade level in math	60.47 (23.02)	63.02 (22.29)	62.68 (22.71)	62.03 (23.78)
School safety characteristics					
Students with weapons	Binary variable: 1 if principal reported child(ren) brought a weapon to school	0.20 (0.40)	0.17 (0.38)	0.18 (0.38)	-- --
Fights	Binary variable: 1 if principal reports child(ren) or teacher(s) have been attacked or involved in fights	0.40 (0.49)	0.39 (0.49)	0.38 (0.49)	-- --
School operational characteristics					
Special education school	Binary variable: 1 if school is a special education school	0.01 (0.11)	0.02 (0.13)	0.02 (0.15)	0.01 (0.07)
Gifted program offered	Binary variable: 1 if school offers a gifted program	0.75 (0.43)	0.75 (0.44)	0.76 (0.43)	0.21 (0.40)
Magnet school	Binary variable: 1 if school is a magnet school	0.09 (0.29)	0.07 (0.26)	0.08 (0.27)	0.06 (0.24)
School of choice	Binary variable: 1 if school is a school of choice	0.11 (0.31)	0.12 (0.32)	0.15 (0.35)	0.23 (0.42)
n		1,630	2,530	2,010	2,270

Sources: Early Childhood Longitudinal Study, Kindergarten Cohort of 1999-99 and the Common Core of Data

Note. Descriptive statistics and sample sizes presented in Tables II.4.a and II.4.b do not include imputed data and are unweighted (they do not account for sampling procedures).

APPENDIX B

The Evaluation of Charter School Impacts data include a sample of charter middle schools selected for the study using the following procedures. To begin, the study's researchers recruited a sample of eligible charter schools. To be eligible to become a part of the evaluation's sample of schools, a charter's entry grade had to be between four and seven, it had to have been operating for at least two years, and it had to serve a general population of students (as opposed to one that focused on a group of students with special educational needs). The researchers recruited eligible schools holding lotteries for admissions in both of two school years, 2005–06 and 2006–07. Based on entry grade and age of the charter school, the researchers compiled a list of 492 schools that would be potentially eligible for the study. From this list, 130 schools initially appeared to be sufficiently oversubscribed to be in the evaluation sample. Of these schools, 77 agreed to participate. This number was again reduced when some of the schools wound up not being sufficiently oversubscribed, even though it initially appeared they would be. The final evaluation sample consists of 36 charter schools, located across the country.[8] Of these schools, five were present in both the 2005–06 and 2006–07 cohorts, while 15 were present in just the first cohort and 16 were present in just the second.

After recruiting the 36 study charter schools, the researchers recruited students applying to each of these schools, prior to when the lotteries were held. Eligible students were those who applied to a study charter school's entry grade during the primary application period and

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[8] Breaking them down by sub-region, nine schools were located in the South Atlantic, seven in New England, six each in the Mountain and Pacific regions, three each in the Middle Atlantic and East/West South Central regions, and one each in the East North Central and West North Central regions.

participated in the admissions lottery. Students who were exempt from the lottery due to sibling policies or for other reasons were not eligible to be included in the study sample. Parental consent was obtained for eligible students prior to the time of the admissions lotteries, with the average consent rate for a school being 62 percent, and no statistically significant difference in consent rates for lottery winners and losers. The study began with a pool of 6,356 potential students, but after excluding those who were ineligible and those from whom the researchers did not receive parental consent, this number was reduced to an evaluation sample size of 2,904.

After the recruitment of schools and students, members of the research team observed each of the lotteries for admissions, to ensure that they were conducted in fitting with the study design. The process of each school's lottery was documented, including any sibling rules, stratification used to ensure set numbers of students with certain characteristics, and other procedures impacting the lottery results. The results of the lotteries, including randomly ordered waitlists, were also documented by the study staff and later checked against each school's records. All students who were admitted at the time of the lottery, or who were later offered admission in proper order from the waitlists were included in the treatment group, whether or not they ultimately chose to attend. The remaining students made up the control group. Of the 2,904 students making up the evaluation sample, 1,744 were in the treatment group and 1,160 were in the control group.

The full evaluation sample was further reduced to construct the analysis sample. Two reasons explain how a student or school would be excluded from the analysis sample. First, students without baseline student achievement data were not included in the analysis sample. Second, only students attending study charter schools with outcome data for a sufficiently high number and percentage of both lottery winners and losers were included in the sample. After these two types of exclusions, the analysis sample consisted of 2,330 students—1,400 treatment group students and 930 control group students—who applied to 29 charter schools.

For their analysis, the study's researchers collected data from six different sources: a baseline survey, administrative records, a parent survey, a student survey, a principal survey, and a charter school authorizer survey. A description of the data collected from each of these sources is found in Table B.1. In addition to these data, which the researchers themselves collected, their analyses were supplemented with data from the Common Core of Data, the Private School Survey, School Data Direct, and school-specific report cards found on state department of education websites. Together, these data provide a rich set of information on students and the schools attended by both lottery winners and losers.

Table B.1

Description of Data Sources in the Evaluation of Charter School Impacts Study

Data Source	Description
Baseline survey	Given to parents when they applied for admission to a study charter school. Collects demographic and socioeconomic information, reasons for applying to study charter school, and information on what other schools they are applying to.
Administrative records	Includes data on students' state test scores, attendance, and disciplinary incidents.
Parent survey	Data on parents' attitudes about their children's schools, assessments of their children's behavior, and a report of their involvement in their children's education and their school.
Student survey	Provides information on students' behavior both inside and outside of school as well as their attitudes about their schools.
Principal survey	This survey was administered to all principals of students in the study as well as every principal of a charter middle school in the U.S. Collects information on principals' level of autonomy and on their curriculum and instructional approach, as well as other aspects of their operations.
Charter school authorizer survey	Administered to the authorizing agencies of study charter schools. Provides information on authorizers' monitoring of study charter schools. This survey was also administered to state department of education officials in study states that were responsible for assessment and accountability and for charter schools.

APPENDIX C

Table C.1

Baseline Student Characteristics of Lottery Winners and Losers

	Description	Full Sample	Treatment Group	Control Group	Difference	p-value
Academic characteristics						
Baseline reading (z-score)	Students' score on their state reading assessment in the baseline year; normalized by year, state, grade, and subject.	0.42 (0.439)	0.43 (0.483)	0.42 (0.429)	0.00	0.975
Baseline math (z-score)	Students' score on their state mathematics assessment in the baseline year; normalized by year, state, grade, and subject.	0.45 (0.423)	0.44 (0.475)	0.46 (0.420)	-0.02	0.784
IEP status	Dichotomous indicator equal to 1 if a student has an individualized education plan, 0 otherwise	0.17 (0.205)	0.13 (0.109)	0.18 (0.232)	-0.06	0.555
LEP status	Dichotomous indicator equal to 1 if a student has limited English proficiency, 0 otherwise	0.09 (0.154)	0.07 (0.145)	0.10 (0.171)	-0.03	0.153
Old for grade	Dichotomous indicator equal to 1 if a student is old for their grade, 0 otherwise	0.09 (0.057)	0.10 (0.082)	0.09 (0.073)	0.01	0.819
Student engagement						
Suspended	Dichotomous indicator equal to 1 if a student was suspended during the baseline year, 0 otherwise	0.03 (0.042)	0.03 (0.061)	0.03 (0.044)	-0.00	0.866
Days absent baseline	Number of days a student was absent in the baseline year	5.76 (2.564)	5.53 (2.547)	6.00 (2.853)	-0.47	0.291

	Description	Full Sample	Treatment Group	Control Group	Difference	p-value
Family characteristics						
Two-parent family	Dichotomous indicator equal to 1 if a student is in a two-parent family, otherwise 0	0.79 (0.115)	0.80 (0.144)	0.78 (0.121)	0.02	0.536
Mother's education: high school or less	Dichotomous indicator equal to 1 if a student's mother has high school or less as highest level of education, otherwise 0	0.24 (0.194)	0.24 (0.230)	0.23 (0.179)	0.01	0.778
Mother's education: some college	Dichotomous indicator equal to 1 if a student's mother has some college as highest level of education, otherwise 0	0.35 (0.118)	0.35 (0.168)	0.35 (0.125)	-0.00	0.953
Mother's education: college	Dichotomous indicator equal to 1 if a student's mother has completed college, otherwise 0	0.42 (0.233)	0.41 (0.274)	0.42 (0.227)	-0.01	0.871
English main language spoken at home	Dichotomous indicator equal to 1 if English is the main language spoken in a student's home, otherwise 0	0.89 (0.180)	0.90 (0.192)	0.89 (0.178)	0.01	0.772
Born in US	Dichotomous indicator equal to 1 if the student was born in the United States, otherwise 0	0.92 (0.070)	0.92 (0.079)	0.93 (0.080)	-0.01	0.770
Mobility						
Student mobility	Dichotomous indicator equal to 1 if a student changed schools between the baseline school year and year 1 of the study, otherwise 0	0.84 (0.201)	0.72 (0.290)	0.92 (0.188)	-0.20	0.004
Number of students	Number of students with non-missing data on the nonstructural mobility indicator	2,000	1,240	760		
Number of schools		29	29	29		

Source: Evaluation of Charter School Impacts
Notes. Standard deviations in parenthesis.
Student characteristics were first averaged at the site level, and then averaged across sites so that each study charter school is given equal weight, regardless of student sample size.

Averages are weighted to account for differential probabilities of selection into the treatment group.
Sample sizes vary across cells due to variation in missing data across variables.
P-values calculated by regressing each student characteristic, separately, on treatment status including fixed effects for the charter applied to.

APPENDIX D

Table D.1

Linear Probability Model Results of Study Charter School Disciplinary Characteristics as a Moderator of Charter School Impacts on Student Mobility

	Model 1		Model 2	
	Coef.	p-value	Coef.	p-value
Prob. attend study charter	-0.14 (0.034)	**0.000**	-0.15 (0.036)	**0.000**
Prob. attend study charter * suspension incidents per 100 students	0.32 (0.183)	0.093	--	
Prob. attend study charter * suspended students per 100 students	--		0.28 (0.269)	0.308
Constant	-0.05 (0.077)	0.515	-0.02 (0.072)	0.792
R-square	0.096		0.105	
student *n*	1,676		1,738	
study charter school *n*	26		27	

Source: Evaluation of Charter School Impacts

Notes. Robust standard errors in parenthesis.

Standard errors adjusted for clustering at the 29 study charter schools.

All student characteristics from Table C.1 included as controls in the model.

All continuous variables grand-mean centered.

Table D.2

Linear Probability Model Results of Study Charter School Programs and Services as a Moderator of Charter School Impacts on Student Mobility

	Model 1		Model 2	
	Coef.	p-value	Coef.	p-value
Prob. attend study charter	-0.15 (0.045)	**0.003**	-0.10 (0.043)	**0.026**
Prob. attend study charter * gifted/talented program	0.02 (0.065)	0.706	--	
Prob. attend study charter * no LEP support	--		-0.06 (0.064)	0.383
Constant	-0.07 (0.083)	0.417	-0.06 (0.079)	0.471
R-square	0.091		0.092	
students n	1,853		1,853	
study charter school n	29		29	

Source: Evaluation of Charter School Impacts
Notes. Robust standard errors in parenthesis.

Standard errors adjusted for clustering at the 29 study charter schools.
All student characteristics from Table C.1 included as controls in the model.
All continuous variables grand-mean centered.

APPENDIX E

Table E.1

Description of Colorado Department of Education and Common Core of Data Measures

Variable	Description	Mean			t-test
		All Schools	Charter	TPS	difference (*p-value*)
School quality measures					
Attendance rate	Total number of days attended by students divided by total possible days attended by students	0.94 (0.04)	0.94 (0.07)	0.94 (0.03)	-0.00 (.538)
Truancy rate	Total number of unexcused absence days divided by total possible days attended by students	0.02 (0.03)	0.02 (0.05)	0.02 (0.02)	0.01 (.045)
Days in school year	Total number of days in the school year	169.86 (10.03)	173.52 (11.80)	169.53 (9.80)	4.00 (.005)
Student-teacher ratio	Average number of students to each teacher in the school	17.73 (18.90)	17.24 (6.38)	17.78 (19.84)	-0.54 (.428)
Proportion students proficient/ advanced in reading	Proportion of students taking the CSAP/TCAP* who scored at the “proficient” or “advanced” levels in reading (as opposed to “unsatisfactory” or “partially proficient”)	0.63 (0.22)	0.64 (0.27)	0.63 (0.22)	0.01 (.777)
Proportion students proficient/ advanced in math	Proportion of students taking the CSAP/TCAP* who scored at the “proficient” or “advanced” levels in math (as opposed to “unsatisfactory” or “partially proficient”)	0.54 (0.25)	0.52 (0.28)	0.54 (0.24)	-0.02 (.463)
Market density					
Choice schools in five miles	Count of the number of charter and magnet schools serving the same grade range—elementary, middle, or high school—within a five-mile radius of a school’s location	2.47 (3.45)	3.60 (3.66)	2.34 (3.41)	1.26 (.704)
New choice schools in five miles	Count of the number of charter and magnet schools opened within five years, serving the same grade range, within a five-mile radius of a school’s location	1.31 (2.27)	2.01 (2.40)	1.24 (2.25)	0.77 (.000)

Variable	Description	Mean			t-test
		All Schools	Charter	TPS	difference (*p-value)*
Enrollment characteristics					
Total enrollment	Total number of students enrolled during the fall	469.62 (380.39)	394.20 (306.98)	478.18 (387.00)	-83.98 (.001)
Male	Proportion of student enrollment that is male	0.51 (0.05)	0.50 (0.07)	0.52 (0.04)	-0.02 (.000)
Female	Proportion of student enrollment that is female	0.49 (0.05)	0.50 (0.07)	0.48 (0.04)	0.02 (.000)
Black	Proportion of student enrollment that is Black, non-Hispanic	0.05 (0.09)	0.09 (0.14)	0.04 (0.08)	0.04 (.000)
White	Proportion of student enrollment that is White, non-Hispanic	0.59 (0.27)	0.55 (0.31)	0.59 (0.27)	-0.04 (.024)
Hispanic	Proportion of student enrollment that is Hispanic, of any race	0.31 (0.25)	0.30 (0.27)	0.31 (0.25)	0.01 (.575)
Asian	Proportion of student enrollment that is Asian, non-Hispanic	0.03 (0.03)	0.03 (0.03)	0.03 (0.03)	0.01 (.016)
Free/reduced lunch	Proportion of student enrollment that is eligible for free or reduced-price lunch	0.44 (0.28)	0.36 (0.31)	0.45 (0.28)	-0.09 (.000)
English language learners	Proportion of student enrollment that are English language learners	0.16 (0.21)	0.16 (0.23)	0.16 (0.21)	0.01 (.641)
Disability	Proportion of student enrollment that has an Individualized Education Program (IEP) to address a disability that impacts their ability to learn	0.11 (0.08)	0.09 (0.08)	0.12 (0.08)	-0.03 (.000)
Gifted/ talented	Proportion of student enrollment identified by district procedures as having exceptional abilities	0.07 (0.08)	0.07 (0.10)	0.07 (0.08)	-0.00 (.666)

Variable	Description	Mean			t-test
		All Schools	Charter	TPS	difference (*p-value*)
School level					
Elementary school	Dichotomous variable equal to 1 if designated as elementary school in Colorado administrative data, otherwise 0	0.62 (0.49)	0.57 (0.50)	0.62 (0.49)	-0.05 (.181)
Middle school	Dichotomous variable equal to 1 if designated as a junior high or middle school in Colorado administrative data, otherwise 0	0.17 (0.38)	0.12 (0.33)	0.18 (0.38)	-0.05 (.038)
High school	Dichotomous variable equal to 1 if designated as a senior high school in Colorado administrative data, otherwise 0	0.21 (0.41)	0.31 (0.46)	0.20 (0.40)	0.11 (.003)
School location					
Located in city	Dichotomous variable equal to 1 if designated as being in either a large, midsize, or small city, otherwise 0 †	0.31 (0.46)	0.42 (0.49)	0.29 (0.46)	0.13 (.001)
Located in town or suburb	Dichotomous variable equal to 1 if designated as being in a large, midsize, or small suburb, or in a fringe, distant, or remote town, otherwise 0 †	0.39 (0.49)	0.33 (0.47)	0.39 (0.49)	-0.06 (.094)
Located in rural area	Dichotomous variable equal to 1 if designated as being in a fringe, distant, or remote rural area, otherwise 0 †	0.31 (0.46)	0.25 (0.43)	0.31 (0.46)	-0.06 (.056)
	n schools	1,816	187	1,631	

Sources: Colorado Department of Education; † Common Core of Data

Notes. Standard deviations in parenthesis. Each school in the sample was given equal weight regardless of how many years of data were available.

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