MOVING MATTERS: THE CAUSAL EFFECT OF MOVING SCHOOLS ON STUDENT PERFORMANCE

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Abstract

Policy makers and analysts often view the reduction of student mobility across schools as a way to improve academic performance. Prior work indicates that children do worse in the year of a school move, but has been largely unsuccessful in isolating the causal effects of mobility. We use longitudinal data on students in New York City public elementary and middle schools to isolate the causal effects of school moves on student performance. We account for observed and time-invariant differences between movers and non-movers using rich data on student sociodemographic and education program characteristics and student fixed effects. To address the potential endogeneity of school moves arising from unobserved, time-varying factors, we use three sets of plausibly exogenous instruments for mobility: first-grade school grade span, grade span of zoned middle school, and building sale. We find that in the medium term, students making structural moves perform significantly *worse* in both English language arts (ELA) and math, whereas those making nonstructural moves experience a significant *increase* in ELA performance. In the short term, there is an additional negative effect for structural moves in ELA. These effects are meaningful in magnitude and results are robust to a variety of alternative specifications, instruments, and samples.

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1. INTRODUCTION

Policy makers and analysts often view the reduction of student mobility across schools as a way to improve academic performance. Indeed, the preponderance of existing research indicates that children do worse in the year of a school move (Rumberger 2003, 2015; GAO 2010), although in many respects the empirical base for this conclusion is lacking. Much of the existing work is best viewed as correlational rather than causal, with the observed lower performance of movers confounding the impact of mobility with unobserved determinants of moves. Moreover, most current work tends to ignore many nuances of school moves, despite the likelihood that the impact will depend on the timing and context of the move. Perhaps most importantly, moves that are *structurally* mandated when a student reaches the terminal grade of his current school and that take place only in the summer, are likely to have different effects than *nonstructural* moves which are made because of residential relocations, family dissolution, acceptance into preferred programs, and so forth, and which can occur either in the summer or middle of a school year. With one notable exception, much of the prior research fails to separate structural from nonstructural moves, ignoring their very different genesis and potential difference in impacts. Conversely, research that examines them separately—focusing on one and ignoring the other—is also problematic because the two types of moves are likely related, as parents consider both prior and anticipated mobility when making decisions about whether to change schools. Thus, studying one type of move to the exclusion of the other will not fully illuminate the effects of either type of move and may yield biased impact estimates. Finally, existing mobility research focuses on short-term impacts—typically on performance in the year of the move—providing little insight into medium-term effects that may affect learning several years later. If the medium-term effects of mobility on student performance are negative (positive), changes in policy may well be warranted to reduce (increase) mobility and/or to ameliorate the effects. If, however, short-term effects do not persist, then policy efforts may be better focused on facilitating adjustment and acclimation.

In this paper, we use longitudinal data on students in New York City (NYC) public elementary and middle schools to isolate the causal effects of school moves on student academic performance. Using student-level regression models, we account for observed and time-invariant differences between movers and non-movers with rich demographic data on student sociodemographic and education program characteristics as well as student fixed effects. To address the potential endogeneity of school moves arising from unobserved, time-varying factors, we use three sets of plausibly exogenous instruments for mobility in order to provide sufficient sources of exogenous variation for our multiple endogenous school move variables.

First, we exploit the relationship between grade span and mobility. Drawing on Rockoff and Lockwood (2010) and Schwerdt and West (2013), we construct instruments for mobility (both structural and nonstructural) using the **grade span of a student's first-grade school**. The underlying intuition is as follows. School grade span implies a future transition point at which a student *must* move to another school. This ultimately shapes decisions about the timing of both structural *and* nonstructural moves because parents balance the costs and benefits of making a move at a non-mandated time versus allowing their child to remain in the school until the next mandated move. The implication

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is that the grade span of a student's first-grade school can serve as an instrument for later mobility, both structural and nonstructural.

Second, we use the **grade span of a student's zoned middle school** with the reasoning that parents may be more likely to have their child make a structural move if there is a seamless transition between elementary and zoned middle schools (i.e., a student in a K–5 elementary school zoned for a grades 6–8 middle school), whereas they may be more likely to have their child make a nonstructural move if there is overlap in the grades offered by a student's zoned middle school and his current school (i.e., a student in a K–6 elementary school is zoned for a grades 6–8 middle school).[1]

Third, we use indicators of **the sale of the building in which a student lives**, and focus our analysis on the roughly 80 percent of public school students who live in renter households. Because building sale reflects characteristics or decisions of a building's *owner*, the timing of sale is plausibly random for *renters* living in those buildings. Thus, the sale creates an exogenous, unanticipated shock to residential stability that may induce school mobility as families relocate to housing farther away from their child's current school. To be clear, students in rental housing are, on average, more likely to be disadvantaged and experience housing instability than students in owner-occupied housing, so that our empirical work will shed light on the impacts of mobility for a large population of urban students.[2]

Our paper adds to the growing literature on student mobility by (1) directly addressing the endogeneity of mobility using student fixed effects and three different sets of credible instrumental variables to derive causal estimates of mobility's effects; (2) estimating the differential impact of mobility across timing and context, distinguishing between summer and mid-year moves, and (within the category of summer moves) further distinguishing structural from nonstructural moves, and articulated moves (made into the new school's lowest grade served) from nonarticulated moves (made into the middle of the grade span); (3) examining the medium-term impacts of mobility on student performance at the end of middle school; and (4) estimating the effects of mobility on students in rental housing in a large urban school district. Drawing together the separate literatures on mobility (i.e., nonstructural moves) and grade span (i.e., structural moves), we explore and exploit the relationship between structural and nonstructural moves, past moves and anticipated moves, and housing and schools, in order to shed new, nuanced insight into the impact of mobility on academic performance.

To preview the results, we find that mobility has significant and heterogeneous effects in both the short and medium term. In the medium term, students making structural moves perform significantly *worse* in both English language arts (ELA) and math, whereas those making nonstructural moves experience a significant *increase* in ELA

1. There is a wide variety of grade spans in NYC, including many where an elementary school is not perfectly aligned with a zoned middle school. A little over 35 percent of students in our sample attended a first-grade school whose terminal grade was not aligned with the zoned middle school's lowest grade (see table A.3 in the online appendix, which is available on the *Education Finance and Policy* Web site at www.mitpressjournals.org/doi/suppl/10.1162/EDFP_a_00198).
2. A large share of renters is also found in other large U.S. cities. For example, in the Miami metropolitan area 63 percent of family households are renters; in Los Angeles, it's 55 percent. These numbers understate the share of public school students in renter households if children of owner-occupants disproportionately attend private schools.

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performance only. In the short term, there is an additional negative effect for structural moves in ELA but not math, whereas nonstructural moves have no additional short-term effect in either subject. Finally, our findings suggest that articulated moves, made to start a destination school in its lowest grade, are driving the positive effect of nonstructural moves for ELA. Thus, our estimates indicate that the type of mobility most commonly ignored in the literature (structural) has long-term negative consequences for both math and ELA performance, and articulated, nonstructural moves have significant positive consequences for ELA. These effects are meaningful in magnitude and the results are robust to a variety of alternative specifications, instruments, and samples. Importantly, they speak to the effects of mobility among some of the most vulnerable populations of students—those living in rental housing who are disproportionately poor and underperforming.

The rest of the paper is organized as follows. Section 2 provides a review of the literature, followed by a framework for understanding mobility in section 3. Section 4 describes the identification strategy and empirical models, and data are discussed in section 5. Results are presented in section 6. We conclude with a discussion and consideration of implications for policy and future research.

2. PREVIOUS LITERATURE

Early literature is practically unanimous in finding that school moves are associated with dips in academic performance. (See Mehana and Reynolds 2004 for a meta-analysis of quantitative studies from 1975 to 1994; Reynolds, Chen, and Herbers 2009 for a meta-analysis of quantitative studies from 1990 to 2008; and Rumberger 2015 for a more recent overview of the mobility literature.) These findings, however, are based primarily on cross-sectional data, lack refinement in their measurement of mobility, omit controls for important covariates, and are not based on an empirical approach that addresses unobserved student and family characteristics that lead to some school moves. Thus, the results are best viewed as correlational, establishing that students who move also tend to have lower performance.

The next generation of studies takes a more nuanced approach, using longitudinal data to more finely characterize moves, explore the number of moves made over a student's academic career, and control for a multitude of family and individual characteristics, including pre-move academic performance. These studies suggest there may be greater heterogeneity in the impact of mobility than described by previous work, finding that reductions in performance are cumulative with the number of moves. In a study of Baltimore's first through fifth graders, Alexander, Entwisle, and Dauber (1996) find that controlling for student background and first-grade test scores, there is a significant negative relationship between the number of school moves and fifth grade reading (but not math) performance. In their study of Chicago low-income, black seventh graders, however, Temple and Reynolds (2000) find that both math and reading scores decline with each additional move even when controlling for student characteristics and kindergarten performance.

A second set of longitudinal studies uses nationally representative data (NELS:88) collected by the National Center for Education Statistics to analyze the relationship between mobility and high school students' performance and graduation outcomes. These

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data include richly detailed characteristics of students and their families as well as information on school and residential moves. These studies find that moves involving both residential and school changes are associated with large reductions in math (but not reading) performance (Pribesh and Downey 1999) and also with a decreased probability of graduation (Rumberger and Larson 1998; Swanson and Schneider 1999). Swanson and Schneider (1999) find that the relationship varies with the timing of the move, with early moves (before tenth grade) having a positive association with math score gains between tenth and twelfth grades and late moves (between grades 10 and 12) having a negative association. Critically, this generation of longitudinal studies does not distinguish mid-year mobility, include student fixed effects to minimize the influence of unobserved characteristics associated with moving, or address possible endogeneity of moves. Further, because the data are drawn from high school students, these studies focus almost exclusively on nonstructural mobility.

In the most recent wave of longitudinal studies, researchers include student fixed effects to mitigate potential bias due to unobserved time invariant differences between movers and non-movers. Hanushek, Kain, and Rivkin (2004) model annual gains in math scores using three cohorts of Texas elementary school students to examine the relationship between various types of *nonstructural* moves made within and across districts and regions in Texas. Using a single aggregated measure of mobility, they find a negative and significant coefficient on gain scores, but estimates are sensitive to the specification of the model and to controls for school quality.[3] Most relevant to our study, they find that within-district moves decrease score gains on the order of 0.024 to 0.088 standard deviation (SD), but this study fails to consider the impacts of *structural* mobility, such that the comparison group is composed of both movers and non-movers.

In another study, Grigg (2012) uses longitudinal data on elementary and middle school students in Metropolitan Nashville Public Schools to examine the relationship between various kinds of moves (between-year compulsory, between-year noncompulsory, within-year compulsory, and within-year noncompulsory) and achievement growth. Exploiting a policy change that created an exogenous shock to the timing of structural moves, Grigg finds that all types of moves are associated with lower achievement growth in the year immediately following the move. Furthermore, the findings suggest that the move itself, net of other factors, may influence achievement. Although the Grigg study makes a substantial contribution to the literature by exploring whether impacts of school mobility vary by the timing and context of the move and includes student fixed effects to lessen bias from time-invariant differences between movers and non-movers, it does not directly address the endogeneity of school moves arising from unobserved, time-varying factors. This suggests that the findings, particularly those regarding the impacts of between-year noncompulsory moves, may be biased.

Most school mobility literature focuses exclusively on nonstructural moves, yet there is a separate body of work on the relationship between grade span and academic achievement that focuses almost exclusively on structural moves. In the grade span literature, authors consistently find that academic performance dips as students move

3. Specifically, they find that students who move within a district have lower gains in math achievement than students who change districts. Students who change districts, but stay within a geographic region, also have lower gains but the magnitude of the estimated effect is smaller.

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from lower schools (elementary schools) to upper-level schools (i.e., middle or junior high schools; see Rockoff and Lockwood 2010; Schwartz et al. 2011; and Schwerdt and West 2013, for recent examples). More generally, Schwartz et al. (2011) find a negative relationship between school transitions—whether structural or nonstructural—and academic performance.[4]

Taken together, these findings indicate that both nonstructural and structural moves may matter for student performance. Thus, although the grade span and mobility literatures have been remarkably separate in considering these different moves, fully understanding the effects of student mobility likely requires simultaneous consideration of structural and nonstructural moves, which we do here.

3. A FRAMEWORK FOR MOBILITY: WHY DO STUDENTS MAKE NONSTRUCTURAL MOVES AND HOW DOES MOBILITY AFFECT PERFORMANCE?

Why Do Students Make Nonstructural Moves?

Students make nonstructural moves for either voluntary reasons, where the timing and destination of the move are chosen by the family, or involuntary reasons, where the timing and destination are largely determined by shocks to the household (see Grigg 2012 and Rumberger 2015 for detailed discussion of typology of moves).

To understand why parents and families would *choose* to move, we draw on an economic approach to parent (family or student) decision making. In this approach, parents decide whether (and when) to move their student from one school to another by weighing the present value of the costs and benefits of available schooling options. Parents choose to move their child from school A to school B if the gain in the student's performance (or utility, human capital, etc.) is sufficient to offset the costs of moving.[5] In our discussion below, we focus on the mobility decision made at the family level, and therefore focus on costs to mobile students and their parents. There are also costs of mobility to schools (i.e., processing and acclimating new students) and to classmates (i.e., negative consequences of exposure to high levels of churn in their schools and classrooms), which we do not consider here.

Costs of moving arise from a variety of sources including the following: (1) *administrative* costs, which might include filling out new forms, providing documentation, and taking placement exams; (2) *logistical* costs, which might include making arrangements for transportation, after-school activities, and so on; and (3) *psychic* costs, which might arise from adjusting to new routines, adapting to a new physical space, and so forth. In addition, there may be a loss of *social capital* among both students and parents, which is likely to decrease student performance. For example, school mobility may disrupt a student's peer network, and at the same time reduce parents' information about school policies and culture. After the disruption of peer networks, mobile

4. There are, of course, many other forms of induced mobility: school closings, school reorganizations, student reclassifications into special education, student suspensions, program closings, and so forth, and many of these have a separate literature. These forms of induced mobility are far less common than the other forms of mobility that are the focus of this paper, however, thus we do not review them here.

5. The model we outline is primarily for expository purposes. There is extensive work in the school choice literature that examines the topic of how parents choose schools and whether they choose high-performing schools (see, e.g., Kleitz et al. 2000; Hastings and Weinstein 2008; Rich and Jennings 2015).

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students may be more likely to associate with lower-performing and/or more deviant peers (Phelan, Davidson, and Yu 1998; South and Haynie 2004; Haynie, South, and Bose 2006; Dupere et al. 2015) and suffer both socially and psychologically (Rumberger et al. 1999; Dupere et al. 2015). Finally, there may be a cost due to differences between the academic programs and curricula in the old and new schools (*curricular mismatch*), which could also affect performance. As an example, if two schools cover mathematical topics differently, students who move may find themselves either over or underprepared for the material being taught at the destination school.

Potential benefits are also myriad—the new school may offer a higher achieving peer group which in turn may increase a student's own performance (Hanushek et al. 2003) or a curriculum better matched to a student's learning (or just one that is more preferred). It may offer access to better transportation, after-school options, and so on. The disruption to peer groups and friendship networks may, indeed, be a good thing if, for example, the student had been bullied or fallen in with a bad crowd at the origin school. Thus, mobility may, in principle, yield net positive effects on student performance.[6]

Because the costs and benefits of mobility depend upon the length of time a student spends (or would spend) in each alternative school, this suggests that parents will consider both prior and anticipated future moves when making their decision. Put simply, the benefit of attending a better school is likely to be increasing in the number of years a student attends that school and the cost of remaining in a worse school will similarly increase with the number of years he stays in that school.[7] Thus, the probability that a student will move to a better school is increasing in the number of years until the next structural move at both the origin and destination schools. As an example, parents will be more likely to move their child from a mismatched or low-quality K–5 elementary school at the end of third grade than at the end of fourth grade because the fourth grader will enjoy the benefits of any new school for less time than the third grader will, other things constant. Similarly, parents will also consider the grade span of nearby middle schools. For example, parents will be more likely to move their children at the end of fifth grade than at the end of fourth grade if the closest middle school starts in grade six because moving their child in fourth grade would result in multiple moves over a short period of time.

Under this framework, students will make voluntary nonstructural moves if and only if parents decide that the benefits of the move ultimately outweigh the costs. That is, if they expect their child to be better off even after the disruption of a nonstructural move. Therefore, one would expect children making such voluntary, nonstructural moves to perform better or no differently than their peers, on average. Conversely, involuntary moves will tend to be precipitated by unforeseen events where parents are unable to weigh the costs and benefits of a mobility decision, such that these involuntary

6. It should be noted that mobility is also likely to affect not only the mobile student but also his peers. Examining the spillover effects of mobile students on their nonmobile peers is beyond the scope of this paper but has been investigated by others (see, e.g., Whitesell, Stiefel, and Schwartz 2016).

7. Similarly, the benefits and costs of moving to a new school will depend upon the number of years until the next mandated structural move out of that school—that is, the number of years a student will be able to attend the new school until the next structural move mandated at that school. The shorter the time until an anticipated structural move in the next school, the shorter the period to amortize the cost of the move to the new school.

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structural moves might well harm performance. The implication is that effects of mobility are likely to be heterogeneous, with some moves improving student outcomes and others proving harmful. Although the mobility literature does acknowledge this potential heterogeneity (Rumberger 2015), as noted previously, there is only one other study of which we are aware that attempts to empirically differentiate the impacts of mobility across timing and context (Grigg 2012).

How Might Mobility Affect Performance?

Given that every move is accompanied by a different set of costs and benefits, the effect of mobility on performance is likely to depend, at least in part, on the context of the move. Structural moves may be less costly than nonstructural moves if schools provide supports or processes to ease transitions (e.g., orientation programs, freshman social events) and/or design instruction to stem losses in student performances due to curricular mismatch. Similarly, articulated nonstructural moves (made to start in the destination school on time) may be less costly than nonarticulated moves (where students join a new school in the middle of its grade span). Following a similar logic, involuntary nonstructural moves made in response to a shock may be more harmful than voluntary nonstructural moves where parents are able to optimize the timing and context.

In the end, decisions about whether, and when, to move schools are clearly complicated, reflecting multiple motivations that are beyond the scope of this paper to specifically identify. Rather, we draw the following key insights from our conceptual framework, which informs our empirical efforts to estimate causal effects of moves: (1) the effects on performance are likely to vary with the timing and context of mobility; (2) structural and nonstructural moves are related to one another and should be considered simultaneously, rather than in isolation; (3) anticipated mobility shapes the likelihood of mobility in any year and, because both the terminal grade of a student's first-grade school and the entry grade of a student's middle school determine anticipated future mobility, they also predict mobility each year; and (4) unanticipated mobility is related to changes in life circumstances, such as changes in housing.[8] We use these insights in the empirical strategy below.

4. EMPIRICAL STRATEGY

The primary challenges to identifying the causal effects of school moves on student performance are that (1) movers are likely to be different from non-movers and (2) moves may be endogenous. We propose, in turn, solutions to each of these challenges.

First, movers are likely to be different from non-movers in many ways. For example, households/children who move may be more ambitious and forward-looking (potentially leading to upwardly biased estimates) or more irresponsible and transient (potentially leading to downwardly biased estimates). To address this, we use student fixed effects to capture time-invariant differences between students and families, such as

8. Although changes in housing are likely related to school moves, the focus of this particular analysis is on the impact of *school* mobility. We examine the impacts of residential mobility and concurrent residential and school moves in other work (see Cordes, Schwartz, and Stiefel 2017 and Cordes et al. 2016).

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general propensity to move schools, supplemented by a variety of time-varying student characteristics.

Second, mobility may reflect factors that change over time, including those that relate directly to schooling (e.g., fit or opportunity) and those that relate only indirectly (e.g., housing or employment). Without accounting for these factors, any observed relationship between mobility and student performance may be spurious, reflecting changes in life circumstances rather than the impact of mobility per se. We address this concern with instrumental variables. In particular, we use three alternative sets of instruments representing three different sources of variation: a set based upon the grade span of a student's first-grade school, a set based on the entry grade of a student's zoned middle school, and a set based on the sale of the building where a student lives, which are credibly exogenous for our sample of students living in rental housing.

As described earlier, the grade span variables will predict both structural and nonstructural moves—the terminal grade of a student's first-grade school will be highly correlated with the year in which that student makes a structural move. It will also capture, in some part, the potential net benefit (or net cost) of making a nonstructural move and, thus, the probability of making a nonstructural move in any given year. Similarly, the grade span of a student's middle school is correlated with the year in which a student will make a structural or nonstructural move. If the entry grade of a student's middle school is one grade higher than the terminal grade of his elementary school, this will increase the probability that a student makes a structural move. Conversely, if the entry grade of a student's zoned middle school is the same as the terminal grade of his first-grade school, he might be more likely to make a nonstructural move in order to begin middle school on time. Put differently, the likelihood of a nonstructural move increases when grade spans of elementary and middle schools overlap than if they align.

For these instruments to be valid, it is only required that shocks to student achievement are not anticipated by families, conditional on student controls and fixed effects, and are therefore not reflected in the choice of grade configuration of either a student's first-grade elementary school or the middle school of that student's first-grade ZIP code. Similar instruments have been used in other work examining the impacts of grade configuration and middle school entry grade (see Rockoff and Lockwood 2010; Schwerdt and West 2013).

The building sale variables will predict nonstructural moves, as they capture shocks to family housing that may precipitate more unanticipated, reactive moves made with little regard to schooling per se. Because our analysis focuses on a sample of students living in rental units, and building sale reflects the characteristics of *owners*, this should meet the exclusion restriction.[9]

Long-term Effects of Mobility on Academic Performance

We begin with a simple difference-in-difference analysis to compare the medium-term performance of summer and within-year movers to that of their stable peers. To do so,

9. To eliminate concerns that building foreclosure or sale is related to characteristics of tenants in *small* rental buildings, we also perform a robustness test, including the exclusion of students who live in buildings that house two to four families (2–4 family buildings).

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we estimate models that link the performance of student i in academic year t to a series of variables capturing his school mobility as well as a vector of individual characteristics and a series of fixed effects. Our baseline model can be written as:

$$Y_{it} = \gamma\, PostSummer_{\mathrm{it}} + \theta\, PostMidYr_{\mathrm{it}} + \beta X_{it} + \alpha_i + \alpha_t + \alpha_g + \epsilon_{it}, \quad (1)$$

where Y_{it} represents performance on standardized tests in ELA or math, given in grades 3 through 8, *PostSummer* takes a value of 1 if student i made a summer move in year t and remains 1 in all years after, *PostMidYr* takes a value of 1 if student i attends a different school in March or June of year t than in October of that same year and remains 1 in all years after, X_{it} represents a set of time-varying student characteristics, including English proficiency, poverty status, and so on, α_i are student fixed effects, α_t are year effects that capture common macro factors such as changes in New York City Department of Education (NYCDOE) personnel and policies that affect all public students, and α_g are grade effects that capture differences in policies, programs, and other idiosyncrasies specific to students in a particular grade.[10] As is usual, α, β, γ, and θ are vectors of parameters to be estimated and ε is an error term. In this model, γ captures the average yearly post-move impact on the academic performance of mobile students compared with their stable peers.[11] We first estimate these models using ordinary least squares (OLS) with robust standard errors and student fixed effects.[12] We then turn to instrumental variables (IV) models.

Instrumental Variables

We begin with a set of variables that captures the number of years until the student reaches the terminal grade of his first-grade school (*YearsPre)* or after (*YearsPost),* and a dummy variable that takes a value of 1 in the year a structural move is anticipated (*Terminal*).[13] In an alternative specification, we include the squares of *YearsPre* and *YearsPost* as instruments; in another, we use a nonparametric form, replacing *YearsPre* and *YearsPost* with a full set of terminal grade indicator variables interacted with student grade, $\varphi_{gT,}$ where g is student i's current grade and T is student i's first-grade school terminal grade. To summarize, our first set of instruments uses the grade span of a student's first-grade school to predict school mobility, exploring different functional forms. In the analysis below, we show results from both the quadratic and nonparametric terminal grade span specifications.

Our second set of instruments mirrors the first, using the entry grade of a student's zoned middle school (as of first grade) rather than the terminal grade of his first-grade school. To be specific, we identify a student's zoned middle school as the middle school located closest to the centroid of his first-grade residence ZIP code. We then construct a set of variables capturing the number of years until the student reaches the entry grade

10. We can include both grade and year effects because we have multiple cohorts of students, each of which is in different grades in different years.
11. This comparison group of stable students includes not only those who never move, but also those who will move in the future but have not yet made a move.
12. Notice that our models include student fixed effects rather than lagged test scores. Similar results are obtained in a value-added specification.
13. Note that *YearsPre, YearsPost,* and *Terminal* are perfectly collinear within-student and so in models containing student fixed effects, we omit *YearsPost*.

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of that middle school (*YearsPreMS*) or after (*YearsPostMS*), and a dummy variable that takes a value of 1 in the year that the student's current grade is equal to the entry grade of his zoned middle school (*Entry*).[14] In an alternative specification, we include the squares of *YearsPreMS* and *YearsPostMS* as instruments; in another, we replace *YearsPreMS* and *YearsPostMS* with a full set of entry grade indicator variables interacted with the student's current grade, η_{gE}, where g is student i's current grade and E is the entry grade of student i's zoned middle school. As with the first-grade terminal grade instruments, in the results below we show results using both the quadratic and nonparametric forms of middle school entry grade.

Our third set of instruments exploits building sale for students living in rental housing. We create indicators for whether a student's rental housing building in t was sold between $t-2$ and $t-1$, interacting this variable with a set of building type dummies (2–4 family, 5-plus family, and other building type) to allow for different effects across building types, as building sale is likely to be more immediately disruptive for families in buildings with fewer residential units. We use these indicators as instruments following the logic that building sale might induce residential, and hence school, mobility, but because the student's family is a renter and not an owner, the sale will be unrelated to student performance except through its effect on mobility.

Heterogeneity in Medium-term Impacts: Structural and Nonstructural Moves

We next turn to exploring the heterogeneity in impacts, separating moves into structural and nonstructural moves:

$$Y_{it} = \gamma_S PostStruct_{it} + \gamma_N PostNonStruct_{it} + \theta PostMidYr_{it} + \beta X_{it} + \alpha_i + \alpha_t + \alpha_g + \epsilon_{it}, \quad (2)$$

where *PostStruct* is an indicator equal to 1 if a student made a structural move in year t and equal to 1 in all subsequent years, *PostNonStruct* is an indicator equal to 1 if a student made a nonstructural move in year t and equal to 1 in all subsequent years, and all other variables are as previously defined.[15]

Parsing Short-term and Medium-term Effects

Thus far, we have estimated the medium-term impact on academic performance from moving schools, but what remains unclear from these models is whether the entire impact occurs in the year of the move or whether mobility has lasting effects on performance. We next turn to parsing the short-term and medium-term effects of mobility by estimating the following:

$$Y_{it} = \gamma_{PS} PostStruct_{it} + \gamma_{PN} PostNonstruct_{it} + \gamma_S Structural_{it} + \gamma_N NonStruct_{it} + \theta_{PM} PostMidyr_{it} + \theta_M Midyr_{it} + \beta X_{it} + \alpha_i + \alpha_t + \alpha_g + \epsilon_{it}, \quad (3)$$

14. Note that *YearsToMS*, *YearsPostMS*, and *Entry* are perfectly collinear within-student. Thus in models containing student fixed effects, we omit *YearsPostMS*.

15. For students making multiple structural or nonstructural moves, *PostStruct* and *PostNonstruct* take a value of 1 in the year of the first such move. This is a relatively small fraction of our sample, however, with only 4 percent of students making more than one structural move and 7 percent making more than one nonstructural move.

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where *Structural* is an indicator equal to 1 if a student makes a structural move in year *t* and equal to zero in all years after, *NonStruct* is an indicator equal to 1 if a student makes a nonstructural move in year *t* and equal to zero in all years after, and all other variables are as defined in equation 2.[16] In these models, the coefficients on the *Structural* and *NonStruct* reflect any *differential* impacts of mobility experienced in the year of the move itself. That is, the total effect of structural mobility in the year of the move is represented by $\gamma_{PS} + \gamma_S$ and the total effect of nonstructural mobility in the year of the move is $\gamma_{PN} + \gamma_N$. If the main effects of mobility are short-lived, then we would expect large and significant coefficients on *Structural* and *NonStruct* and small, possibly insignificant coefficients, on *PostStruct* and *PostNonstruct*. Other models further differentiate *Nonstructural* moves to include *Articulated* moves, which take a value of 1 when a student joins the destination school in the lowest grade served, and *NonArticulated* moves, which take a value of 1 when a student enters the destination school in the middle of a grade span.

5. DATA, MEASURES, AND DESCRIPTIVE STATISTICS

Data and Measures

We use richly detailed student-level administrative data from the NYCDOE for three cohorts of eighth grade students living in rental units (i.e., excluding students in single-family homes, condos, and cooperatives, who number slightly more than 23,000) and making standard academic progress (SAP) from first grade through middle school, allowing us to construct a complete school mobility history. These cohorts are defined as those students in eighth grade in academic years 2008–10 who progressed through grades annually (e.g., in first grade in 2002, second grade in 2003, third grade in 2004 ... and eighth grade in 2009). These SAP students represent over 80 percent of all students who are continuously enrolled since first grade.[17] We exclude those students who enter NYC public schools after first grade or exit before eighth grade because we are unable to observe mobility patterns or performance during years in which these students were not enrolled in NYC public schools. We focus our analysis on students in grades 5–8 in order to include information on building sale. Overall, the sample has more than 88,000 unique students (or about 29,000 students per cohort) attending roughly 1,044 different schools.

Student-level data include information on gender, race/ethnicity, nativity, poverty (measured as eligibility for free or reduced-price lunch or attendance in a universal free meal school), English proficiency, home language, receipt of special education services,

16. For students making multiple structural or nonstructural moves, *Structural* and *NonStruct* take a value of 1 in each of the years that the student makes such a move.
17. The SAP students are a particularly attractive group of students to study for at least three reasons. First, there is a long history of their mobility, with potential for heterogeneity in types of moves and for large numbers of moves, and consistent longitudinal data on their schools and performance. Second, SAP students remain in one school district (NYC), thus removing the possibility of confounding effects of policies, practices, and cultures that differ across districts. Third, SAP students exclude students who have experienced significant changes in their academic placements—such as classification into self-contained, full time ("ungraded") special education programs—which might obscure the impact of mobility and complicate the interpretation of conclusions. The result is that SAP students are slightly higher achieving at any point in time than the cross section of NYC students which may mean that any estimated effects sizes are lower than would be found for other students. See online Appendix table A.1 for characteristics of other NYC students who are not included in the sample.

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residence borough, and performance on standardized ELA and math exams administered statewide in grades 3–8. Test scores are measured in z-scores, which are standardized to have a mean of zero and a standard deviation of 1 across all students for each grade–year combination. Each student has a unique identifier enabling us to follow him over time during his tenure in NYC public schools. These data also include information on the school attended at three points of the academic year (October, March, and June), allowing us to identify students changing schools in the summer (June to October) and during the academic year (October to March or March to June). We use this information to construct mobility measures.

For academic years 2005–10, NYCDOE data also contain student address information, which we link to information on building characteristics and property transactions to identify students living in rental units and construct our sale instruments.[18] We focus on renters for four reasons. First, we expect renters as a group to be more mobile and therefore we are particularly interested in the effects of school mobility on this population. Second, compared with students in owner-occupied housing, renters are disproportionately more likely to be poor (82 versus 56 percent), less likely to be white (13 versus 36 percent), and tend to be lower performing. Therefore, this is the group of students for whom mobility is most likely deleterious. Third, while the building sale instruments meet the exclusion restriction for students living in rental housing, they are almost certainly endogenous for students in owner-occupied units. Focusing on students in rental housing allows us to examine the impacts of unanticipated school mobility, which is understudied in the current literature. Finally, because the majority of NYC public school students (79.6 percent) are renters, this group provides insight about most of the public school student population in NYC. Our main analysis includes students living in any rental unit in year *t*, but we also estimate with two alternative samples: students who are always renters and excluding students in small (2–4 family) rental buildings where sale could be endogenous.

Descriptive Statistics

Despite popular notions of "typical" elementary school configurations, the timing of mandated moves actually varies significantly in NYC; there is simply no single standard grade span for elementary schools. Although the majority of students in our sample (63.5 percent) attended a K–5 school in first grade, a substantial fraction (19.1 percent) attended a K–6 school, 7.9 percent attended a K–8 school, and the remaining 9.5 percent of students attended a school with some other grade configuration. Taken from another perspective, 58.0 percent of the schools attended by first graders in our sample are K–5, 22.2 percent are K–6, 8.8 percent are K–8, and the remaining 11 percent of schools serve other grade spans. Therefore, although the vast majority of students will make at least one structural move before grade 8, there is variation in the timing of when such moves occur. Similarly, there is quite a bit of variation in when students enter middle school. For example, whereas 76.5 percent of students are zoned for a middle school that begins in sixth grade, 14 percent are zoned for a middle school that begins in

18. We define "owner occupied units" as all single-family homes, condos, and cooperatives. This is a conservative definition of "owner occupied," as some families living in condos are renters. Without unit-level data, however, we are unable to separate owner-occupants from renter-occupants in condo buildings.

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Table 1. Eighth Grade Student Characteristics by Mobility History, Renters Only

	Summer Moves			Mid-year Moves	
	None (1)	One (2)	Two plus (3)	None (4)	Any (5)
Female	0.53	0.53	0.53	0.53	0.52
Asian	0.08	0.17	0.13	0.16	0.12
Black	0.40	0.27	0.34	0.29	0.38
Hispanic	0.39	0.42	0.45	0.42	0.42
White	0.12	0.14	0.08	0.13	0.08
Foreign born	0.08	0.10	0.11	0.10	0.11
Limited English proficient	0.02	0.02	0.02	0.02	0.02
Non-English at home	0.36	0.47	0.43	0.47	0.38
Poor	0.85	0.80	0.84	0.81	0.86
Graded special education	0.06	0.05	0.07	0.05	0.08
Test scores					
5th grade ELA	0.005	0.193	0.034	0.160	−0.031
8th grade ELA	0.146	0.240	0.095	0.218	0.025
5th grade math	0.020	0.262	0.073	0.224	−0.017
8th grade math	0.132	0.226	0.051	0.206	−0.073
Average # summer moves	0.00	1.00	2.24	1.22	1.65
Average # structural moves	0.00	0.87	1.05	0.87	0.83
Average # nonstructural moves	0.00	0.13	1.19	0.35	0.82
Average # mid-year moves	0.13	0.09	0.30	0.00	1.25
Grade span of 4th grade school					
K to 8+	0.59	0.05	0.06	0.09	0.09
K to 4	0.00	0.04	0.06	0.04	0.05
K to 5	0.17	0.73	0.62	0.67	0.63
K to 6	0.17	0.16	0.16	0.16	0.18
All others	0.07	0.02	0.10	0.04	0.05
Observations	5,829	57,403	23,533	76,134	10,631
Percent of total	6.7%	66.2%	17.1%	87.7%	12.3%

Notes: Mobility history includes all moves made between grades 1–8. Summer moves are made between June and October. Mid-year moves are made between October and June. Poverty is defined by eligibility for free or reduced-price lunch, or attendance in a universal free meal school. Foreign-born students have birthplaces outside the United States. Graded special education students include those receiving full- or part-time services. Test scores are measured as z-scores (mean zero and standard deviation one for all tested students by grade and year).

fifth grade and another 9 percent are zoned for middle schools with other entry grades (see table A.2 in the online appendix). This variation in grade span is consistent with significant variation in both the timing and number of moves made by NYC public school students over the course of their schooling career. Furthermore, this variation is important for our identification strategy, which leverages these differences in grade configuration to predict student mobility.

As expected, there are significant differences between movers and non-movers (table 1). Students who never make a summer move are overwhelmingly enrolled in K–8 schools in fourth grade, disproportionately black (40 percent), poor (85 percent), and relatively low scoring (0.005 ELA and 0.020 math, grade 5; and 0.146 ELA and 0.132 math, grade 8), and those making only one summer move are almost entirely enrolled in K–5 or K–6 schools in fourth grade, disproportionately Asian (17 percent), white (14

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percent), and high scoring (0.193 ELA and 0.262 math, grade 5; and 0.240 ELA and 0.226 math, grade 8).[19] Furthermore, of the 66.2 percent of students who make only one summer move, the overwhelming majority make a structural move (87 percent) rather than a nonstructural move (13 percent). That is, students with relatively low levels of mobility appear less likely to make voluntary moves. Students making more than one summer move have characteristics associated with traditionally at-risk students: higher shares of black (34 percent), Hispanic (45 percent), and poor (84 percent) students, and lower performance on ELA and math exams in both fifth and eighth grades. Moreover, students who make two or more summer moves also make more mid-year moves than their peers who make zero or one summer move (0.30 compared with 0.13 and 0.09, respectively) and make roughly equal numbers of structural and nonstructural moves. Students who make at least one mid-year move are the lowest scoring of all groups (–0.031 ELA and –0.017 math, grade 5; and 0.025 ELA and –0.073 math, grade 8) and are disproportionately black (38 percent) and poor (86 percent). The majority of mid-year movers also experience at least one summer move during their academic careers (for relationship between summer and mid-year mobility, see table A.3 in the online appendix). Thus, movers and non-movers differ in in a variety of ways.

6. RESULTS

Difference-in-Difference Results

We begin with a simple summary analysis of the medium-term relationship between mobility and academic performance, comparing movers with their stable peers. These models are most similar to what has been estimated in the previous literature and therefore serve as a good starting point for the discussion. As shown in the first two columns of table 2, students who make summer moves earn lower scores in both ELA (0.041) and math (0.072) in the years following a move, as do mid-year movers (0.031 and 0.045 in ELA and math, respectively), controlling for student characteristics and prior performance only.[20] Introducing student fixed effects and moving to the difference-in-difference results (columns 3 and 4) substantially increases the magnitude of the coefficients: Summer movers perform 0.079 lower in ELA and 0.118 lower in math, and mid-year movers perform 0.039 lower in ELA and 0.131 lower in math than their stable peers. The finding that the negative relationship between mobility and performance is *larger* with the inclusion of student fixed effects suggests that movers as a whole are slightly better performing that non-movers (which is consistent with the descriptive results in table 1).

Disentangling structural and nonstructural moves (columns 5 and 6) suggests that there are likely heterogeneous medium-term effects of mobility: Students who make structural moves perform almost twice as poorly as students who make nonstructural moves, and this result is statistically significant. Even so, these results indicate that

19. Note, all z-scores are above zero because the sample is restricted to those students who are continuously enrolled and making standard academic progress—a group that tends to be higher performing, on average. Therefore, we expect that any estimated effects sizes for this group are lower than would be found for other students.

20. Although direct comparisons with Hanushek, Kain, and Rivkin (2004) are difficult because the outcome in their models is gain scores whereas our outcome is in levels, our results are of the same sign and similar magnitude to theirs, where they find a decrease in gain scores of between 0.024 and 0.088 SDs among within-district movers.

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Table 2. OLS Results, Relationship Between Mobility and Performance, ELA and Math Exams, Renters Only

	ELA (1)	Math (2)	ELA (3)	Math (4)	ELA (5)	Math (6)
Post-summer move	−0.041***	−0.072***	−0.079***	−0.118***		
	(0.003)	(0.003)	(0.004)	(0.004)		
Structural					−0.100***	−0.159***
					(0.004)	(0.004)
Nonstructural					−0.053***	−0.076***
					(0.007)	(0.006)
Post mid-year move	−0.031***	−0.045***	−0.039***	−0.131***	−0.000	−0.078***
	(0.003)	(0.003)	(0.011)	(0.011)	(0.012)	(0.012)
Student characteristics	Y	Y	Y	Y	Y	Y
Student fixed effects	N	N	Y	Y	Y	Y
Observations	342,685	343,832	342,685	343,832	342,685	343,832
Unique students	88,241	88,254	88,241	88,254	88,241	88,254
R^2	0.480	0.590	0.743	0.801	0.743	0.802

Notes: Robust standard errors in parentheses. Post-summer move is equal to 1 in all years after a student moves schools between June and October. Post-summer move is equal to 1 in all years after a student moves schools between October and June. Summer moves made after the completion of a terminal grade are structural moves. Summer moves made after the completion of a non-terminal grade are nonstructural moves. All models include controls for poverty, English proficiency, home language, participation in special education services, grade, residence borough, and year. Models in columns (1) and (2) also control for gender, race, and prior test scores. Models in columns (3) through (6) include student fixed effects. Sample excludes students living in single family homes, condos, or coops in year *t*.

***$p < 0.01$.

all else equal, both types of mobility have a negative relationship with student performance. As previously noted, however, there are reasons to believe these results do not fully account for the endogeneity of school mobility. We therefore turn to IV estimates, which are our preferred specification. In the results that follow, although we control for mid-year mobility, we do not report the results because no instruments suitable for the identification of this variable are available and we cannot interpret the coefficient estimates as causal.[21]

What Predicts Mobility?

Before turning to the estimates from the IV models themselves, by examining results from the first stage model we first consider whether and to what extent our proposed instruments actually predict student mobility. If, as described in our conceptual framework, structural and nonstructural mobility are related, we should see evidence that grade span is a significant predictor of both types of moves.

As shown in table 3, columns 1 and 3, the probability of making a structural move is strongly predicted by both elementary and middle school grade span. The probability that a student makes a structural move decreases with *YearsPre* (but at a decreasing rate) and *YearsPost*, and increases by 12.3–12.5 percentage points at *Terminal*. That is, a student is significantly more likely to make a structural move in the year after completing the terminal grade of his first-grade elementary school and significantly less likely to have made a structural move in any other year. For middle school entry grade, the probability

21. Although building sale was predictive of mid-year mobility in the first stage, the point estimates and the F of the excluded instruments were quite small and deemed insufficient for identification.

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Table 3. First-stage Instrumental Variable Results, Summer Moves, ELA Exams

	ELA		Math	
	Post Structural (1)	Post Nonstructural (2)	Post Structural (3)	Post Nonstructural (4)
First-grade terminal grade				
YearsPre	−0.129***	0.002	−0.126***	0.001
	(0.022)	(0.014)	(0.022)	(0.014)
YearsPre^2	0.073***	−0.015***	0.073***	−0.014***
	(0.003)	(0.003)	(0.003)	(0.003)
Terminal (= 1 if current grade is terminal grade)	0.123***	−0.016***	0.125***	−0.017***
	(0.010)	(0.005)	(0.010)	(0.005)
YearsPost^2	−0.033***	0.003***	−0.033***	0.003***
	(0.002)	(0.001)	(0.002)	(0.001)
Middle school entry grade				
YearsPreMS	−0.177***	0.045***	−0.177***	0.046***
	(0.035)	(0.014)	(0.035)	(0.014)
YearsPreMS^2	0.072***	−0.027***	0.072***	−0.027***
	(0.013)	(0.009)	(0.013)	(0.009)
Entry (= 1 if current grade is entry grade)	0.006	0.006**	0.006	0.007**
	(0.012)	(0.003)	(0.012)	(0.003)
YearsPostMS^2	0.002	−0.001	0.002	−0.001
	(0.002)	(0.001)	(0.002)	(0.001)
Building Sale				
Sale of 2–4 family building	0.011***	0.016***	0.012***	0.015***
	(0.004)	(0.003)	(0.004)	(0.003)
Sale of 5+ family building	−0.003	−0.002	−0.004	−0.001
	(0.005)	(0.002)	(0.005)	(0.002)
Sale of other building type	−0.008	0.005	−0.008	0.004
	(0.010)	(0.007)	(0.011)	(0.006)
Observations	342,685	342,685	343,832	343,832
Unique students	88,241	88,241	88,254	88,254
F excluded (11, 8,150)	203.26	23.40	205.79	23.33
Prob > F	0.000	0.000	0.000	0.000
R^2	0.849	0.912	0.849	0.912

Notes: Robust standard errors, clustered by first-grade school by cohort, in parentheses. Coefficients displayed are for the excluded instruments. Model also includes controls for poverty, English proficiency, participation in special education services, whether a student made a mid-year move, grade, residence borough, year, and student fixed effects.

$^{**}p < 0.05$; $^{***}p < 0.01$.

of making a structural move decreases with *YearsPreMS* at a decreasing rate. Structural moves are weakly predicted by the sale of 2–4 family homes.

Nonstructural moves are predicted by all sets of instruments (columns 2 and 4). For example, the probability that a student makes a nonstructural move decreases 1.6–1.7 percentage points at *Terminal* and increases with *YearsPreMS*, at a decreasing rate. That is, a child is less likely to make a nonstructural move the closer he is to the terminal grade of his elementary school and is more likely to make a nonstructural move if he has a longer time until he is eligible to attend his zoned middle school. Again, this is consistent with our intuition that parents are less likely to make a nonstructural move to a school where their child would be nearing the terminal grade (and have to make another move soon) and are more likely to make a nonstructural move if their child will not be eligible to attend the nearby middle school for multiple years. Finally, the probability of a nonstructural move increases 1.5–1.6 percentage points with sale of a

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2–4 family building, which is consistent with renters experiencing unanticipated shocks when owners sell buildings.

Overall these estimates show that our three sets of instruments are significant predictors of both structural and nonstructural moves. Many coefficients are individually significant, and the *F* statistics are large (all greater than 20). We find similar results using other specifications of grade span and a more parsimonious set of instruments, excluding middle school entry grade.[22]

IV Results

As shown in table 4, once we account for the endogeneity of moves, a very different picture of mobility emerges. Structural moves continue to have a significant negative impact on performance in the years after the move, decreasing performance by 0.096–0.113 in ELA and 0.182–0.200 in math, depending on the parameterization of the grade span instruments. This is similar to but slightly larger than the results with student fixed effects alone. In contrast to the fixed effects results, however, IV results show nonstructural moves have no significant medium-term impact in either ELA or math. Thus, it seems that estimates of the impact of nonstructural mobility from the student fixed effects models may be biased due to the endogeneity of nonstructural mobility. In particular, the compliers who are contributing to the estimated effect in the IV model are likely to be making more "strategic" moves based on the cost–benefit logic described previously, such that OLS estimates did not accurately capture the impact of nonstructural mobility for this group.

These estimates conflate the short- and medium-term effects of mobility, however. Although it could be that all effects of mobility are due to the disruption in the year of the move itself, it is also possible that effects of mobility due to changes in curriculum or peers take longer to materialize and are therefore only observed in the medium term, or it could be that mobility had both short-term and medium-term effects. To gain a further understanding of *when* mobility matters relative to the year of the move itself, we parse the short-term and medium-term effects of mobility. As shown in table 5, we see that structural moves have significant negative impacts on student performance for both ELA and math in the medium term, and an additional negative impact on short-term ELA performance.[23] In ELA, students perform an additional 0.052–0.059 worse in the year of the move itself with small negative effects in the years following the move. In math, there is no differential impact in the year of the move itself but students perform significantly worse in all years following a structural move (0.176–0.186). By contrast, nonstructural moves appear to have lasting positive effects in ELA (0.156–0.275) with no additional impact experienced in the year of the move itself. Nonstructural moves have no significant impact on math performance, however. Thus, these estimates provide consistent evidence that structural moves harm student math and ELA performance in the medium-term, and nonstructural moves appear to have a positive effect in ELA in

22. First-stage results from alternative grade span specifications and a more parsimonious set of instruments are available from authors upon request. Note that because there are only two endogenous variables in this model (structural and nonstructural moves), only two sources of exogenous variation are needed, thus including the third set is not required for estimation.

23. First-stage IV estimations for the results in table 5 are shown in tables A.4 (ELA) and A.5 (math) in the online appendix.

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Table 4. Instrumental Variable Results, Effects of Structural and Nonstructural Moves, ELA and Math Exams

	ELA		Math	
	(1)	(2)	(3)	(4)
Post-summer move				
Structural	−0.113***	−0.096***	−0.200***	−0.182***
	(0.017)	(0.014)	(0.023)	(0.019)
Nonstructural	0.020	0.043	0.089	−0.025
	(0.091)	(0.069)	(0.125)	(0.089)
Instruments				
Building sale	Y	Y	Y	Y
Terminal and entry grade				
Quadratic	Y	N	Y	N
Nonparametric	N	Y	N	Y
Observations	342,685	342,685	343,832	343,832
Unique students	88,241	88,241	88,254	88,254

Notes: Robust standard errors, clustered by first-grade school and middle school by cohort, in parentheses. Post-summer move is equal to 1 in all years after a student moves schools between June and October. Summer moves made after the completion of a terminal grade are structural moves and summer moves made after the completion of a nonterminal grade are nonstructural moves. All models include controls for poverty, English proficiency, home language, participation in special education services, mid-year moves, building type, residence borough, grade, and year. Models in columns (1) and (3) use the number of years between a student's grade in t and the completion of the terminal grade of his first-grade school (*YearsPre*) and this number squared, the number of years between the beginning of a student's grade in year t and the completion of the grade after the terminal grade of a student's first-grade school (*YearsPost*), and an indicator equal to one in the summer following the completion of the terminal grade of a student's first-grade school (*Terminal)* as grade span instruments. These models also include the number of years between a student's grade in t and the entry grade of his closest ZIP code (*YearsPreMS*) and this number squared, the number of years between a student's current grade and when he would have entered the lowest grade of his middle school (*YearsPostMS*), and an indicator equal to one in the summer before a student would enter the closest middle school if he started on time (*Entry)*. Models in columns (2) and (4) use a vector of indicators that are the interaction between a student's current grade and the terminal grade of his first-grade school (φ_{gT}) and a vector of indicators that are the interaction between a student's current grade and the entry grade of his closest middle school (η_{gE}). All models use the interaction between an indicator of whether a student's current building of residence was sold between $t-2$ and $t-1$ and an indicator for the building type as instruments for school moves.

***$p < 0.01$.

the medium-term. Furthermore, these results highlight the importance of separating the short-term versus medium-term impacts of mobility, as table 4 masks the result that the impacts of nonstructural mobility may take longer to appear.

Articulated versus Nonarticulated Moves

As noted in our conceptual framework, nonstructural moves include a set that is voluntary and strategic (likely to improve performance) and another set that is involuntary and unplanned (likely to harm performance). Although we have no direct data on parental motivation, we further probe the hypothesis that strategic moves are likely to differ from unplanned moves by dividing nonstructural moves into (1) articulated moves, made to allow a student to begin his next school on time, which are arguably more likely to reflect strategic behavior, and (2) nonarticulated moves, where a student joins the new school mid–grade span, which are arguably more likely to be made in

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Table 5. Instrumental Variable Results, Short-Term and Medium-Term Effects of Structural and Nonstructural Moves, ELA and Math Exams

	ELA		Math	
	(1)	(2)	(3)	(4)
Post-summer move				
Structural	−0.033	−0.047***	−0.186***	−0.176***
	(0.024)	(0.018)	(0.034)	(0.024)
Nonstructural	0.275**	0.156*	0.115	−0.040
	(0.109)	(0.083)	(0.149)	(0.107)
Move in year *t*				
Structural	−0.059***	−0.052***	0.022	−0.001
	(0.019)	(0.015)	(0.022)	(0.015)
Nonstructural	−0.005	−0.024	0.242*	0.074
	(0.113)	(0.067)	(0.127)	(0.071)
Instruments				
Building sale	Y	Y	Y	Y
Terminal and entry grade				
Quadratic	Y	N	Y	N
Nonparametric	N	Y	N	Y
Observations	342,685	342,685	343,832	343,832
Unique students	88,241	88,241	88,254	88,254

Notes: Robust standard errors, clustered by first-grade school and middle school by cohort, in parentheses. Post-summer move is equal to 1 in all years after a student moves schools between June and October. Summer moves made after the completion of a terminal grade are structural moves and summer moves made after the completion of a nonterminal grade are nonstructural moves. Move in *t* is equal to 1 in the year that a student makes a particular type of move and 0 in all other years. All models include controls for poverty, English proficiency, home language, participation in special education services, mid-year moves, building type, residence borough, grade, and year. Models in columns (1) and (3) use the number of years between a student's grade in *t* and the completion of the terminal grade of his first-grade school (*YearsPre*) and this number squared, the number of years between the beginning of a student's grade in year *t* and the completion of the grade after the terminal grade of a student's first-grade school (*YearsPost*), and an indicator equal to one in the summer following the completion of the terminal grade of a student's first-grade school (*Terminal)* as grade span instruments. These models also include the number of years between a student's grade in *t* and the entry grade of his closest ZIP code (*YearsPreMS*) and this number squared, the number of years between a student's current grade and when he would have entered the lowest grade of his middle school (*YearsPostMS*), and an indicator equal to one in the summer before a student would enter the closest middle school if he started on time (*Entry)*. Models in columns (2) and (4) use a vector of indicators that are the interaction between a student's current grade and the terminal grade of his first-grade school (φ_{gT}) and a vector of indicators that are the interaction between a student's current grade and the entry grade of his closest middle school (η_{gE}). All models use the interaction between an indicator of whether a student's current building of residence was sold between $t-2$ and $t-1$ and an indicator for the building type as instruments for school moves.

*$p < 0.1$; ***$p < 0.01$.

reaction to some sudden change in circumstance. Using multiple specifications, we find results consistent with these predictions (see table 6). Articulated moves appear to have large, positive, medium-term effects in ELA (0.173–0.229) and no effects in math. Further, students experience no differential impact in the year of the articulated move itself. Nonarticulated moves, by contrast tend to have little significant effect on performance (and in fact many of the coefficients are large and negative, although insignificant). This suggests that there is a particular set of nonstructural moves (articulated moves) that is likely to be beneficial to student performance, and, importantly, this is the set of moves most likely to reflect strategic behavior on the part of parents.

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Table 6. Instrumental Variable Regression Results, Robustness, Articulated versus Nonarticulated Moves, ELA and Math Exams

	ELA		Math	
	(1)	(2)	(3)	(4)
Post-summer move				
Structural	−0.046*	−0.048***	−0.136***	−0.177***
	(0.027)	(0.018)	(0.048)	(0.024)
Non-structural				
Articulated	0.229**	0.173**	0.063	0.022
	(0.102)	(0.084)	(0.170)	(0.113)
Nonarticulated	−0.128	−0.236	2.590***	−0.564
	(0.611)	(0.386)	(0.998)	(0.466)
Summer move in year *t*				
Structural	−0.072***	−0.051***	0.062*	−0.000
	(0.023)	(0.015)	(0.034)	(0.015)
Nonstructural				
Articulated	−0.202	−0.036	0.888**	0.052
	(0.212)	(0.073)	(0.347)	(0.076)
Nonarticulated	0.281	0.145	−0.584**	0.226
	(0.202)	(0.162)	(0.284)	(0.168)
Instruments				
Building Sale	Y	Y	Y	Y
Terminal and entry grade				
Quadratic	Y	N	Y	N
Nonparametric	N	Y	N	Y
Observations	342,685	342,685	343,832	343,832
Unique students	88,241	88,241	88,254	88,254

Notes: Robust standard errors, clustered by first-grade school and middle school by cohort, in parentheses. Post-summer move is equal to 1 in all years after a student moves schools between June and October. Summer moves made after the completion of a terminal grade are structural moves and summer moves made after the completion of a nonterminal grade are nonstructural moves. Move in year *t* is equal to 1 in the year that a student makes a particular type of move and 0 in all other years. All models include controls for poverty, English proficiency, home language, participation in special education services, mid-year moves, building type, residence borough, grade, and year. Models in columns (1) and (3) use the number of years between a student's grade in *t* and the completion of the terminal grade of his first-grade school (*YearsPre*) and this number squared, the number of years between the beginning of a student's grade in year *t* and the completion of the grade after the terminal grade of a student's first-grade school (*YearsPost*), and an indicator equal to one in the summer following the completion of the terminal grade of a student's first-grade school (*Terminal)* as grade span instruments. These models also include the number of years between a student's grade in *t* and the entry grade of his closest ZIP code (*YearsPreMS*) and this number squared, the number of years between a student's current grade and when he would have entered the lowest grade of his middle school (*YearsPostMS*), and an indicator equal to one in the summer before a student would enter the closest middle school if he started on time (*Entry)*. Models in columns (2) and (4) use a vector of indicators that are the interaction between a student's current grade and the terminal grade of his first-grade school (φ_{gT}) and a vector of indicators that are the interaction between a student's current grade and the entry grade of his closest middle school (η_{gE}). All models use the interaction between an indicator of whether a student's current building of residence was sold between $t-2$ and $t-1$ and an indicator for the building type as instruments for school moves.

*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

Other Considerations and Robustness Tests

We explore the robustness of our results by controlling for school quality, trends in performance before moves, and alternatives to our renter sample. Results are qualitatively unchanged. The results from alternative specifications discussed below use the

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Table 7. Robustness Checks, Instrumental Variable Specifications, School Quality, and Move Pre-trends

	ELA			Math		
	Main results (1)	School Quality (2)	Pre-trends (3)	Main results (4)	School Quality (5)	Pre-trends (6)
Post-summer move						
Structural	−0.047***	−0.042**	−0.037*	−0.176***	−0.140***	−0.148***
	(0.018)	(0.017)	(0.021)	(0.024)	(0.023)	(0.029)
Nonstructural	0.156*	0.121	0.249	−0.040	−0.063	−0.257
	(0.083)	(0.082)	(0.167)	(0.107)	(0.102)	(0.196)
Summer move in year *t*						
Structural	−0.052***	−0.039**	−0.052***	−0.001	0.031**	0.016
	(0.015)	(0.015)	(0.016)	(0.015)	(0.014)	(0.015)
Nonstructural	−0.024	0.000	−0.054	0.074	0.077	0.126*
	(0.067)	(0.069)	(0.065)	(0.071)	(0.067)	(0.072)
1 Year Prior to						
Structural move			0.029			0.058***
			(0.017)			(0.020)
Nonstructural move			0.141*			−0.039
			(0.075)			(0.085)
Instruments						
Building sale	Y	Y	Y	Y	Y	Y
Terminal & entry grade						
Nonparametric	Y	Y	Y	Y	Y	Y
Observations	342,685	342,685	342,685	343,832	343,832	343,832
Unique students	88,241	88,241	88,241	88,254	88,254	88,254

Notes: Robust standard errors, clustered by first-grade school and middle school by cohort, in parentheses. Post-summer move is equal to 1 in all years after a student moves schools between June and October. Summer moves made after the completion of a terminal grade are structural moves and summer moves made after the completion of a nonterminal grade are nonstructural moves. Move in *t* is equal to 1 in the year that a student makes a particular type of move and 0 in all other years. All models include controls for poverty, English proficiency, home language, participation in special education services, mid-year moves, building type, residence borough, grade, and year. All models use a vector of indicators that are the interaction between a student's current grade and the terminal grade of his first-grade school and a vector of indicators that are the interaction between a student's current grade and the entry grade of his closest middle school. All models use a vector of indicators that are the interaction between a student's current grade and the terminal grade of his first-grade school (φ_{gT}) and a vector of indicators that are the interaction between a student's current grade and the entry grade of his closest middle school (η_{gE}). School quality is the regression adjusted average ELA performance in that school-grade the prior year. Pre-trends are captured through a series of indicators controlling for one year pre-move.

$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$.

nonparametric grade span specifications as instruments for mobility, although results using the quadratic grade-span specification are qualitatively similar (see table A.6 in the online appendix). Further, although the results discussed below focus on structural and nonstructural moves, results regarding articulated and nonarticulated moves are similarly robust (see tables A.7 and A.8 in the online appendix).

School Quality

It is possible that moves are disproportionately made to better (or worse) schools, in which case our estimate of the impact of mobility may, in part, reflect changes in school quality such that isolating the impact of mobility (as distinct from improvements in school quality) requires controlling for these changes. Thus, we add a measure of school quality to our regression models (see table 7, columns 2 and 5). Specifically, we use the average, regression-adjusted value added for each school/grade in the previous year

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as a measure of school quality.[24] Overall, results are robust. Signs and significance of coefficients generally remain, with the exceptions that the medium-term effects of nonstructural moves in ELA are no longer significant and the effect of structural moves on math performance is small, positive, and significant in the year of the move itself. This slight attenuation suggests that uncontrolled impacts may have been due, in part, to school quality improvements in the case of nonstructural moves and due to decreases in school equality in the case of structural moves. This finding is entirely consistent with the notion of parents making strategic, nonstructural moves in an effort to improve their child's outcomes.

Prior Performance

Another potential concern is that our estimates may capture trends in student performance in the years leading up to a move. If, for example, movers perform worse in the year before they move, then the negative relationship between structural moves and performance could be an artifact of this pre-existing trend in performance. Thus, we augment our models with a series of indicators for one year prior to structural move and one year prior to nonstructural move, which will capture students' performance in the year preceding a particular type of move. Our results (see table 7, columns 3 and 6) are generally unchanged and, importantly, we see that students actually perform *better* or no differently in the year before a structural move (which is the opposite of what we would expect if our findings regarding the negative impact of structural moves were instead capturing pre-existing dips in student performance). Further, this does not appear to reflect a regression to the mean because when student performance is regressed on three years before and three years after a move there is a very obvious structural break in performance in the year of the move (see figures A.1 and A.2 in the online appendix). While nonstructural moves no longer appear to have a significant effect on ELA performance, the coefficient remains large and positive but imprecisely estimated.[25]

Alternative Samples

Next, we explore sensitivity to alternative samples of students. First, we limit our sample to those SAP students who always live in rental units between grades 5 and 8, to explore the possibility that results are at least partly driven by students moving into and out of rental housing for reasons not accounted for in this model. Results are robust to this change in sample—structural moves result in a significant decline in both medium-term ELA and math performance, with a significantly larger negative effect on ELA in the year of the move (table 8, columns 1, 2, 5, and 6). Also similar to our main results, we find that among students who never live in owner-occupied housing, nonstructural moves have positive impacts in ELA performance in all years following the move, with no effects in math.

Second, we exclude students living in small (2–4 family) rental buildings from our sample. The concern with including students in small rental buildings is that sale may,

24. These are calculated as the school/grade fixed effect from a conventional education production function model estimated for the year prior. That is, for year t models we use the $t-1$ school fixed effect.

25. Because the sample focuses on students in grades 5–8, we do not have enough years of data to include "trends" in our model. The estimates in online appendix figures A.1 and A.2 represent coefficient estimates from student fixed effects models estimated on our sample beginning in third grade.

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Table 8. Robustness, Always-Renter and No 2–4 Family Home Occupant Samples

	ELA				Math			
	Always-Renter		No 2–4 Family Homes		Always-Renter		No 2–4 Family Homes	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Post-summer move								
Structural	−0.032	−0.043**	−0.055*	−0.048**	−0.189***	−0.174***	−0.163***	−0.167***
	(0.024)	(0.018)	(0.028)	(0.020)	(0.034)	(0.024)	(0.040)	(0.026)
Nonstructural	0.283***	0.165**	0.229	0.119	0.107	−0.035	0.199	−0.026
	(0.109)	(0.083)	(0.146)	(0.101)	(0.149)	(0.107)	(0.198)	(0.126)
Summer move in year *t*								
Structural	−0.059***	−0.054***	−0.102***	−0.067***	0.020	−0.002	0.051	0.003
	(0.019)	(0.015)	(0.031)	(0.016)	(0.021)	(0.015)	(0.039)	(0.017)
Nonstructural	−0.004	−0.039	−0.389	−0.092	0.197	0.050	0.588*	0.171*
	(0.114)	(0.068)	(0.267)	(0.089)	(0.127)	(0.071)	(0.348)	(0.095)
Instruments								
Building sale	Y	Y	Y	Y	Y	Y	Y	Y
Terminal and entry grade								
Quadratic	Y	N	Y	N	Y	N	Y	N
Nonparametric	N	Y	N	Y	N	Y	N	Y
Observations	328,496	328,496	214,290	214,290	329,619	329,619	215,238	215,238
Unique students	82,698	82,698	57,097	57,097	82,700	82,700	57,146	57,146

Notes: Robust standard errors, clustered by first-grade school and middle school by cohort, in parentheses. Post-summer move is equal to 1 in all years after a student moves schools between June and October. Summer moves made after the completion of a terminal grade are structural moves and summer moves made after the completion of a nonterminal grade are nonstructural moves. Move in *t* is equal to 1 in the year that a student makes a particular type of move and 0 in all other years. All models include controls for poverty, English proficiency, home language, participation in special education services, mid-year moves, building type, residence borough, grade, and year. Models in columns (1), (3), (5), and (7) use the number of years between a student's grade in *t* and the completion of the terminal grade of his first-grade school (*YearsPre*) and this number squared, the number of years between the beginning of a student's grade in year *t* and the completion of the grade after the terminal grade of a student's first-grade school (*YearsPost*), and an indicator equal to one in the summer following the completion of the terminal grade of a student's first-grade school (*Terminal)* as grade span instruments. These models also include the number of years between a student's grade in *t* and the entry grade of his closest ZIP code (*YearsPreMS*) and this number squared, the number of years between a student's current grade and when he would have entered the lowest grade of his middle school (*YearsPostMS*), and an indicator equal to one in the summer before a student would enter the closest middle school if he started on time (*Entry)*. Models in columns (2), (4), (6), and (8) use a vector of indicators that are the interaction between a student's current grade and the terminal grade of his first-grade school (φ_g), and a vector of indicators that are the interaction between a student's current grade and the entry grade of his closest middle school (η_{gE}). All models use the interaction between an indicator of whether a student's current building of residence was sold between $t-2$ and $t-1$ and an indicator for the building type, as instruments for school moves. The always renter sample excludes students who ever live in a single-family home, condo, or cooperative between grades 5 and 8. The no 2–4 family home sample exclude students living in 2–4 family homes in year *t*.

$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$.

in fact, reflect the characteristics of tenants (see table 8, columns 3, 4, 7, and 8). Again, sign and significance of most coefficients are largely unchanged—structural moves appear to have negative effects on both ELA and math performance in the medium term, with a significantly more negative impact on ELA in the year of the move, and nonstructural moves have no impact on performance in either subject. Consistent with other findings, however, coefficients are large and positive, but imprecisely estimated.

7. CONCLUSIONS

The vast majority of students in the United States change schools at least once before reaching ninth grade, and many move multiple times (GAO 2010). As policy makers and educators consider interventions addressing school mobility, it is critical to be aware of several factors: (1) the organization of schools induces student mobility;

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(2) there is a relationship between mandated articulation points and the timing of school moves; and (3) structural and nonstructural moves are related. Importantly, differences in the expected costs, benefits, and motivation of structural and nonstructural moves imply that the consequences for students are likely heterogeneous and disentangling these differences is essential in crafting effective policy.

In this paper, we use longitudinal data on NYC public elementary and middle school students to estimate the causal effects of heterogeneous school moves on student academic performance. Student fixed effects control for time-invariant differences between movers and non-movers, such as differences in ability and family circumstances. Following the logic that the grade span of a student's first-grade elementary and zoned middle schools shapes subsequent mobility, and changes in housing may induce school moves, we use instrumental variables based on the configuration of the first-grade school, zoned middle school, and building sales as instruments for school mobility among a sample of students in rental housing.

Our results are intuitively appealing. We find that the impact of school moves on academic performance is, indeed, heterogeneous. Structural moves have negative consequences in both the short and medium terms, while the impact of nonstructural moves is more ambiguous, producing no effects in the short term and either positive or no effects in the medium term. When we disaggregate nonstructural moves into articulated and nonarticulated moves, we find evidence to suggest that nonstructural moves made to start the destination school on time (and that are most likely to reflect strategic behavior) have positive effects. These results are robust to alternative specifications, instruments, and samples. Perhaps most importantly, we uncover what appear to be permanent effects of structural mobility that have gone unrecognized in previous literature.

These results raise questions about the efficacy of the policies followed by most U.S. districts that build structural moves into their school organizations. These structural moves have negative short-term and medium-term consequences, and systems that minimize them have the potential to increase performance. For example, moving to a system of all K–8 schools would eliminate structural mobility, which would increase performance. But a K–8 system also might have the unintended effect of increasing nonstructural mobility. In particular, if all schools were K–8 schools, then any student moving schools would make a nonarticulated, nonstructural move. Although our results regarding nonarticulated moves are not significant, many point estimates are large and negative (but imprecisely estimated). The net effect of shifting to a K–8 system is, then, unclear a priori and would depend on the increased numbers of nonstructural movers compared with the reduced numbers of structural movers. If students mostly remain in the K–8 school in which they first enroll, performance would likely improve. It should be noted, however, that the results presented here are based on a system where the majority of students do, in fact, make structural moves. Therefore, our ability to extrapolate results to a system of K–8 schools where the majority of students do not make structural moves is limited. It would be worth examining mobility in urban school districts with K–8 systems, such as Chicago, as well as the impacts of reforms, such as those in Philadelphia, that have attempted to change districts over to K–8 systems.

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In the current system where districts often have a variety of grade spans, our results indicate that articulated, nonstructural moves, improve performance. Our estimates likely reflect the dominance of the strategic Tiebout-type moves, especially because we control for mid-year moves when many of the reactive moves likely occur.[26] Thus districts may want to provide information that helps parents understand differences across schools and encourage such moves.

Although the mobility and grade span literatures have remained largely separate, our work argues that they should be better integrated, and understanding the impact of mobility on academic performance requires recognizing the relationship between structural and nonstructural moves and between past and anticipated moves. Important directions for future research include more deeply probing underlying mechanisms of school mobility, including contemporaneous residential mobility, and exploring the externalities of mobility on nonmobile students. We look forward to the results of this work.

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26. Further, parents who wait until the summer to move their child are likely more strategic than those who move mid-year.

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