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Moving Matters: The Causal Effect of Moving Schools on Student Performance

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Abstract

The majority of existing research on mobility indicates that students do worse in the year of a school move. This research, however, has been unsuccessful in isolating the causal effects of mobility and often fails to distinguish the heterogeneous impacts of moves, conflating structural moves (mandated by a school's terminal grade) and non-structural moves (induced by residential mobility or by access to a better school) for example. Moreover, there is little evidence on the effects beyond the first year of a move. In this paper, we obtain credibly causal estimates of the impact of mobility on performance in both the short and long run, addressing heterogeneity in the impacts of mobility and the endogeneity of moving. We do so using richly detailed longitudinal data for five cohorts of New York City public school students making standard academic progress from grades 1-8. We estimate the impact of moving to a new school in a model with student fixed effects and two alternative sets of instrumental variables -- the grade span of a student's first grade school and foreclosure/building sale -- to isolate the causal effect of mobility that is likely planned and mobility that is likely due to unanticipated shocks, respectively. We find negative short-term as well as long-term effects of the structural moves built into the school system. Non-structural moves, however, have a positive effect on academic performance if they are made to join a new school at the beginning of that school's grade span and, thus, more likely made for strategic reasons. Robustness checks indicate results are not sensitive to inclusion of school quality measures, pre-move trends in mobility, or alternative samples. In the conclusions, we discuss the importance of findings on the heterogeneous impact of school moves to the literature and to policy makers.

I. Introduction

Policy makers and analysts increasingly 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 (GAO, 2010; Rumberger, 2003), although the empirical base for this conclusion is lacking in many respects. First, there is little evidence on the causal effect of mobility; much of the existing work is best viewed as correlational, with the observed lower performance of movers capturing both the impact of the move and the unobserved determinants of the move. Second, despite the likelihood that the impact of moving will depend on the timing and context of the move and characteristics of movers, there is little investigation of heterogeneity in the effect of moves. For example, summer moves that are *structurally* mandated by the configuration of schools (i.e. graduating from a lower school in its terminal grade) are likely to have different effects than *non-structural* moves made due to residential changes, family dissolution, or in search of a preferred program, for example. Unfortunately, much of the prior research fails to disaggregate types of moves or focuses exclusively on either structural or non-structural moves, ignoring their very different genesis and potential difference in impacts. Even more, structural and non-structural moves are likely to be related -- as parents consider both prior and future anticipated mobility in making decisions about whether to change schools in the current year -- such that studying one type of move to the exclusion of the other will not fully illuminate the effects of either type of move. Finally, existing research on mobility focuses on short-term impacts, providing little evidence on the permanent or long-term effect of moving that persists beyond the year of the school move. Thus, we know little about whether student performance recovers after a move, or whether, instead, mobility harms student performance in the long run.

Our paper adds to the literature by (1) directly addressing the endogeneity of mobility using two different sets of credible instrumental variables to derive causal estimates of mobility's effects, (2) exploring the heterogeneity of the impact of mobility across timing and context, distinguishing between structural and non-structural moves, summer and mid-year moves, and articulated moves – made into the new school's lowest grade served – and non-articulated moves - made into the middle of the grade span, and (3) examining the long-term impacts of mobility on student performance. Drawing together the separate mobility and grade span literatures, we explore and exploit the relationship between structural and non-structural moves and between past moves and anticipated moves to shed new, nuanced insight into the impact of mobility on academic performance.

Specifically, in this paper, we use longitudinal data on New York City (NYC) public elementary and middle school students to isolate the causal effects of school moves on student academic performance. We account for observable and time-invariant differences between movers and non-movers using rich demographic data on student socio-demographic and education program variables and student fixed effects.

To address the potential endogeneity of school moves arising from unobserved, time-varying factors, we use two sets of plausibly exogenous instruments for mobility. 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 non-structural – 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, shaping decisions about the timing of both structural and non-structural moves, which will be interconnected as parents balance the costs and benefits of moves made at different times. The implication is that grade span in the early years can serve as an instrument for later mobility – both structural and non-structural. Second, we use indicators of building foreclosure and sale as instruments for school mobility for students living in rental buildings. Since the timing of foreclosure and sale reflect characteristics or decisions of the building's *owner*, the timing of such events is plausibly random for *renters* living in those buildings and reflects an exogenous, unanticipated shock that may induce school mobility as families may be forced to move to a different housing unit further away from their child's current school.

To preview the results, we find that mobility has significant effects in the short term and that these effects persist in the long term. In the short term, structural moves have negative effects, while the impact of non-structural moves depends upon the timing. Articulated moves are beneficial, whereas non-articulated moves have negative impacts. In the longer run, structural moves result in a permanent dip in student performance on the order of 0.1 sds, while non-structural moves yield a permanent gain in student performance, ranging from 0.1 to 0.2 sds. Thus, our estimates indicate that while mobility *per se* does not negatively affect performance, the type of mobility most commonly ignored in the literature (structural mobility) does have long-term negative consequences for performance. These effects are meaningful in magnitude and the results are robust to a variety of alternative specifications, instruments, and samples.

The rest of the paper is organized as follows. Section II provides a review of the literature, followed by a discussion of conceptual issues in section III. Section IV describes the identification strategy and empirical models and data is discussed in section V. Results are presented in section VI. We conclude with a discussion and consideration of implications for policy and future research.

II. 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 examining elementary school students.) 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 the unobserved student and family characteristics that lead to some school moves. Thus, the results are best viewed as correlational, establishing the lower performance of students who have moved.

The next generation of studies uses 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 that there may be greater heterogeneity in the impact of mobility than described by previous work. In a study of Baltimore 1st to 5th 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 5th grade reading (but not math) performance. In their study of Chicago low income, black 7th 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 (NELS88) collected by the National Center for Education Statistics to analyze the relationship between mobility and high school students' performance and graduation outcomes. This data set includes richly detailed characteristics of students and their families, following students when they change schools and residences. Pribesh and Downey (1999) find that moves involving both residential and school changes are associated with the largest reduction in 12th grade performance for math (but not reading). Rumberger and Larson (1998) find a negative relationship between changing schools and residences on graduation, and Swanson and Schneider (1999) find that early moves (before tenth grade) have a positive association with math score gains between 10th and 12th grades, while late moves (between grades 10 and 12) have a negative association.[1] Critically, this generation of longitudinal studies does not separate structural from non-structural moves, distinguish mid-year mobility, include student fixed effects to minimize the influence of unobserved characteristics associated with moving, or address possible endogeneity of moves.

We are aware of only one longitudinal study that includes student fixed effects to lessen the 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 *non-structural* 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.[2] Most relevant to our study, they find that within district moves decrease score gains on the order of 0.024 to 0.088 sds.

While many studies of school mobility focus on non-structural (voluntary) moves, there is a separate body of work on the relationship between grade span and academic achievement that focuses almost exclusively on structural moves and pays little attention to non-structural moves. In the grade span literature, authors consistently find that academic performance dips as students move from lower schools (elementary schools) to upper-level schools (i.e., middle or junior high schools). (See Rockoff and Lockwood, 2010; Schwartz, Stiefel, Rubenstein, and Zabel, 2011; Schwerdt and West, 2013, for recent examples.) More generally, Schwartz *et al.* (2011) find a negative relationship between school transitions – whether structural or non-structural - and academic performance. This finding suggests that, although the grade span and

[1] Swanson and Schneider also explore the relationship between these moves and dropout rates and find, consistent with Rumberger and Larson, that moves of almost any kind, including pre-8th grade, increase the odds of dropping out.

[2] 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. The authors find no significant effect for students who change regions or move mid-year. Students who move more than once during the year perform worst.

mobility literatures have been remarkably separate, fully understanding the effects of student mobility likely requires simultaneous consideration of structural and non-structural moves, which we do here.

III. Understanding non-structural mobility: Why do students move schools when they do not have to?

To understand non-structural mobility, 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, including the cost of moving *per se.* 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.

Costs arise from a variety of sources including the following: *administrative* costs, which might include filling out new forms, providing documentation, and taking placement exams; *logistical* costs, which might include making arrangements for transportation, after school activities, etc.; and *psychic* costs, which might arise from adjusting to new routines, adapting to a new physical space, etc. School moves may also result in 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. Finally, there may be a cost due to differences between the academic programs and curricula in the old and new schools (*curricular mismatch*). As an example, if two schools cover mathematical topics differently, students who move may find themselves repeating a previously learned topic or, alternatively, without the necessary foundation to tackle a new one.

Potential benefits are also myriad: the new school may offer a higher achieving peer group 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, etc. 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.

To be sure, some moves are not the result of a decision *per se*, but rather are driven by shocks such as job loss, eviction, foreclosure, etc. In these situations, parents may be unable to fully weigh the costs and benefits of all their options in order to make an optimal move.

Accordingly, 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 non-structural moves if schools provide supports or processes to ease transitions (orientation programs, freshman social events, etc.) and/or design instruction to stem losses in student performances due to curricular mismatch. Following a similar logic, articulated moves into the lowest grade served at the new school may be less detrimental to performance than non-articulated moves.[3]

Conversely, moves made in the middle of the school year are likely to have more deleterious effects than those made during the summer – that is, between school years – because such mid-year moves will be more disruptive to peer networks and the learning process, whereas summer moves allow a student to begin the school year with new classmates.

Additionally, the probability a student moves in any year will depend upon the time until the next anticipated structural move, since the costs and benefits of mobility depend upon the length of time a student spends (or would spend) in each school. 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 be increasing in magnitude (increasingly

[3] A move at the end of 5th grade from a K-6 school to enroll in 6th grade at a 6-8 school would be an articulated move; to enroll in the 6th grade at a 5-8 school would be a non-articulated move.

negative) with the number of years the student stays in that school.[4] Thus, the probability of moving to a better school will be increasing in the number of years until the next structural move. 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 3rd grade than at the end of 4th grade because the 4th grader will enjoy the benefits of any new school for less time than the 3rd grader will, other things constant.

In the end, decisions about whether, and when, to move schools are clearly complicated, reflecting multiple motivations, which are beyond the scope of this paper to identify specifically. Rather, we draw the following key insights from our conceptual framework, which informs our empirical efforts to estimate causal effects of heterogeneous moves: (1) the effects on performance are likely to vary with the timing and the context of mobility; (2) structural and non-structural 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, since school grade span determines anticipated future mobility, it also predicts mobility each year; and (4) school moves include a set that are strategic, predictable, and endogenous (and more likely to have a positive effect) as well as a set of reactive moves driven by unanticipated shocks that may be more likely to have a negative effect. We use these insights in the empirical strategy below.

[4] 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

IV. Empirical strategy

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

First, movers are likely to be different from non-movers in many ways. For example, households/children that 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, supplemented by a variety of time-varying student characteristics.

Second, mobility may reflect factors that change over time including those that related directly to schooling (i.e., fit, opportunity, etc.) and those only indirectly related (i.e., housing, employment, etc.). Thus, we turn to instrumental variables to address this potential endogeneity of student mobility. In particular, we use two alternative sets of instruments: a set based upon the grade span of the student's first grade school, which we can use for the full sample of students, and a set based upon the foreclosure/sale of the building the student lives in, which we can use for the set of students living in rental buildings only (since foreclosure/sale is credibly exogenous for renters but not owners.)

As described earlier, the grade span variables will capture, in some part, the potential net benefit (or net cost) of moving in a given year and as such are more likely to predict strategic moves made by families with the ability and desire to move schools to improve student performance. The foreclosure/sale variables, in contrast, capture shocks to family housing, etc., and are more likely to predict unanticipated or reactive moves made with little regard to schooling *per se*. Thus, the two sets of instruments are likely to have quite different sets of compliers and yield impact estimates that are substantively different. Estimates from the grade span IVs may be viewed as offering insight into strategic moves; estimates from the foreclosure

IV's as offering insight into reactive moves. We therefore estimate separate models for each set of instruments, rather than combining the two, which would average the effects of moves that are more likely to be strategic (predicted by grade span) and moves that are more likely to be reactive (predicted by building foreclosure/sale.)

A. *Short-term effects of mobility on academic performance*

We begin by examining the short-term relationship between student mobility and academic performance -- that is, the impact of student mobility on performance *in the academic year of the move.* To do so, we estimate models that link the performance of student i in academic year t to a series of variables capturing his school mobility in academic year t as well as a vector of individual characteristics and a series of fixed effects. Our baseline model can be written as:

$$(1)\quad \mathrm{Y}_{\mathrm{it}} = \gamma Summer_{\mathrm{it}} + \theta MidYr_{\mathrm{it}} + \beta \mathrm{X}_{\mathrm{it}} + \alpha_i + \alpha_t + \alpha_g + \epsilon_{it}$$

where Y_{it} represents performance on standardized tests in English language arts (ELA) or mathematics, given in grades 3 through 8, *Summer* takes a value of one if the student i attends a different school in October than the previous June, *MidYr* takes a value of one if student i attends a different school in March or June than the previous October, 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, and α_g are grade effects that capture differences in policies, programs, and other idiosyncrasies specific to students in a that grade.[5] 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 impact of moving schools on academic

[5] Notice that our models include student fixed effects rather than lagged test scores. Similar results are obtained in a value-added specification.

performance in the school year of the move.[6] We first estimate these models using OLS with robust standard errors. We then turn to IV models.

Instrumental variables: We begin with a set of variables that captures the number of years until an anticipated structural move (*YearsPre)* or after (*YearsPost),* and a dummy variable that takes a value of one in the year a structural move is anticipated (*Terminal*). We allow the coefficients on these variables to vary across grades, reflecting the possibility that costs and benefits of mobility vary across grades.[7] In an alternative specification, we include the squares of *YearsPre* and *YearsPost* as instruments; in another, we replace *YearsPre* and *YearsPost* with a full set of terminal grade indicator variables interacted with student grade. To summarize, our first set of instruments uses the grade span of a student's first grade school to predict school mobility, allowing the coefficients on these variables to vary across grades and exploring different functional forms.

Our second set of instruments exploits building foreclosure and sale for students living in rental housing. More specifically, we create indicators for whether a student's rental housing unit received a foreclosure notice or was sold between t-2 and t-1, interacting this variable with a set of building type dummies (2-4 family, 5 plus family, mixed use, etc.) to allow for different effects across building types. We use these indicators and their lagged values as instruments, following the logic that foreclosure or building sale might well induce residential and hence school mobility, but, because the student's family is a renter and not an owner, the foreclosure or sale will be unrelated to student performance.[8,9]

[6] With the inclusion of fixed effects, one can think of γ as the difference-in-differences estimate of the impact of mobility on student performance. That is, it captures the post-move difference in performance between students who "ever move" and students who "never move."
[7] We do so by including an interaction with each of these measures and a grade indicator.
[8] These models are estimated using only students living in rental units, and only in AY 2005-2009 due to data availability.
[9] For the instruments to be legitimate, they should also pass the exclusion restriction, which in the case of the grade span instruments would mean that grade span should be excluded from our models of academic performance. Because these instruments are constructed based upon the grade span of the school attended three or more years

Heterogeneity in impacts: structural, non-structural, articulated, and non-articulated moves: We next turn to exploring the heterogeneity in impacts, differentiating moves into structural and non-structural moves:

$$(2)\quad \mathrm{Y_{it}} = \gamma_{\mathrm{S}} Structural_{\mathrm{it}} + \gamma_{\mathrm{N}} NonStruct_{\mathrm{it}} + \theta MidYr_{\mathrm{it}} + \beta \mathrm{X_{it}} + \alpha_{\,i} + \alpha_{\,t} + \alpha_{\,g} + \epsilon_{it}$$

where *Structural* is an indicator equal to one if a student made a structural move, *NonStruct* is an indicator equal to one if a student made a non-structural move, and all other variables are as previously defined. Other models further differentiate *Structural* moves to include *Articulated* moves, which take a value of one when a student joins the destination school in the lowest grade served, and *NonArticulated* moves, which take a value of one when a student enters the destination school in the middle of a grade span.

B. Long-term effects

Thus far, we have estimated the impact of moving schools on academic performance *in the same academic year.* We next turn to examining the long-term effect of mobility by estimating the following:

$$(3)\quad \mathrm{Y_{it}} = \gamma_{\mathrm{S}} Structural_{\mathrm{it}} + \gamma_{\mathrm{N}} NonStruct_{\mathrm{it}} + \gamma_{\mathrm{PS}} PostStruct_{\mathrm{it}} + \gamma_{\mathrm{PN}} PostNonstruct_{\mathrm{it}} + \theta Midyr_{\mathrm{it}} + \beta \mathrm{X_{it}} + \alpha_{\,i} + \alpha_{\,t} + \alpha_{\,g} + \epsilon_{it}$$

where *PostStruct* is an indicator taking a value of one in all years after a student makes his first structural move, *PostNonstruct* is an indicator taking a value of one in all years after a student makes his first non-structural move, and all other variables are as defined in equation (2). In these models, the coefficients on the *post* variables reflect the average performance of a student in the years after his first move, yielding a measure of the persistent effects of mobility.

prior to the current year, the first grade terminal grade is plausibly exogenous to our academic performance model. Thus, our IV models should yield unbiased estimates of the causal effect of student mobility on academic performance. Foreclosure and building sale among renters should likewise pass the exclusion restriction as these events reflect changes in the circumstances of the building owner that are likely to be uncorrelated with any changes in the circumstances of the renter occupants.

If the impact of mobility is short-lived, affecting students in the year of the move only, the coefficients on these post-move variables should be zero.

V. Data, measures, and descriptive statistics

A. Data and measures

We use richly detailed student-level administrative data from the New York City Department of Education (NYCDOE) for five cohorts of 8th grade students making standard academic progress (SAP) from 1st grade through middle school. These cohorts are defined as those students in 8th grade in the period 2005-2009 who progressed through grades annually (e.g., in 1st grade in 2002, 2nd grade in 2003, 3rd grade in 2004…and 8th grade in 2009.) Overall, the sample has more than 185,000 unique students in five cohort years (or about 37,000 students per cohort) attending roughly 1,100 different schools.[10]

These 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, residence borough, and performance on standardized English Language Arts (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 one 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. Further, these include data on school attended at three points of the academic year, October, March, and June, allowing us to identify

[10] 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.

students changing schools in the summer (June to October) and during the academic year (October to March or March to June). For AYs 2005-2009, NYCDOE data also contain student address information, which we link to information on foreclosure notices and property transactions to construct our foreclosure and sale instruments.

Table 1 defines the mobility measures, described above. There are six measures of short-term and two measures of long-term mobility.

B. Descriptive statistics

Despite popular conceptions 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. While the majority of students in our sample (62.5 percent) attended a K-5 school in first grade, a substantial fraction (22.3 percent) attended a K-6 school, 7 percent attended a K-8 school, and the remaining 11.8 percent of students attended a school with some other grade configuration. Taken from another perspective, 57.9 percent of the schools attended by first graders in our sample are K-5, 24.8 percent are K-6, 7.9 percent are K-8, and the remaining 9.4 percent of schools serve other grade spans. 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.

As shown in Table 2, there are, as expected, significant differences between movers and non-movers. Students who never make a summer move are disproportionately black (41%), poor (81%), relatively low scoring (0.120 ELA, 0.134 math), and overwhelmingly enrolled in K-8 schools in 4th grade, while those making only one summer move are disproportionately Asian (17%), white (20%), high scoring (0.322 ELA, 0.345 math), and almost entirely enrolled in K-5 or K-6 schools in 4th grade.[11] Students making more than one summer move have characteristics associated with traditionally at-risk students: higher shares of black (36%), Hispanic (40%), and

[11] 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.

poor (79%) students, and lower performance on ELA and math exams in both 3rd and 8th grade. Moreover, students who make two or more summer moves also make more mid-year moves than their peers who make zero or one summer moves (0.35 compared to 0.10 and 0.08, respectively). Students who make at least one mid-year move are the lowest scoring of all groups (0.113 ELA and 0.091 math, Grade 3, and 0.067 ELA and 0.010 math, Grade 8) and are disproportionately black (39%), foreign born (11%), poor (81%), and attend either a K-5 or K-6 school in 4th grade (83%). Thus, movers and non-movers differ in in a variety of ways.

Table 3 illustrates the empirical dimensions of the relationship between structural and non-structural moves for all cohorts of SAP students, revealing the inverse relationship between these moves: students making fewer (more) structural moves make more (fewer) non-structural moves.[12] For example, nearly half of the 29,381 students who never make a structural move, make one non-structural move and nearly two thirds make one or more non-structural moves. Conversely, almost three quarters (72.5%) of the 149,154 students who make one structural move make no non-structural moves whatsoever and the same pattern is seen for those who make two structural moves. This apparent trade-off between structural and non-structural moves is consistent with the intuition that decisions about non-structural mobility are shaped by structural mobility.

VI. Results

A. Short-term effects

We begin with analyses for the full sample of students. As shown in the first two columns of Table 4, students who make summer moves earn lower scores in both ELA (0.079) and Math (0.109), as do mid-year movers (0.069 and 0.099, respectively) controlling for student

[12] The correlation between these two types of moves is -0.27. A chi-square test indicates the entries are non-random.

characteristics only.[13] Introducing student fixed effects (Columns 3 and 4), substantially dampens the coefficients: summer movers perform 0.040 lower in ELA and 0.054 lower in math, and mid-year movers perform 0.028 lower in ELA and 0.054 lower in math than their stable peers. Disentangling structural and non-structural moves (Columns 5 and 6), indicates that students who make structural moves perform slightly worse than students who make non-structural moves (statistically significant). All else equal, however, mobility has a negative relationship with student performance.

Before turning to the IV models, it is worth considering the first stage model. As shown in Table 5, Column 1, the first stage model for structural moves works well. With few exceptions, coefficients are statistically significant, and the F statistic is large (F excluded = 369.69.) Further, the signs and magnitudes of the coefficients are consistent with the behavior of parents who strategically time school moves. For example, the coefficients suggest the probability of moving is highest in the terminal grade: coefficients on *Terminal* for grade 3 (grade 4, grade 5) is 0.742 (0.383, 0.773) etc. As shown in Column 2, the pattern for non-structural moves is reversed -- coefficients indicating the probability of making a non-structural move are negative and significant for *Terminal* for grades 3 (-0.077), 4 (-0.045), 5 (-0.044), etc. All of our first stage estimates, both those based upon alternative specifications of grade span of the first grade school (quadratic and non-parametric specifications) and those based on foreclosure and sale for the renter sample, yield coefficients with the expected signs.[14] For example, the first stage for building sale and foreclosure indicate that experiencing either of these events leads to a lower probability of making a structural move and a higher probability of making a non-structural move. All models also have excluded F's above 14, and usually higher, indicating that the instruments are jointly significant predictors of mobility.

[13] While direct comparisons with Hanushek *et al.* (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.
[14] Results for all first stage models are available from the authors.

As shown in Table 6, when we instrument for mobility, structural moves have a negative impact on student performance, now between -0.025 and -0.032 in ELA and between -0.029 and -0.040 in math, which is about half the size of the estimates when student fixed effects alone are included. In contrast to the fixed effects results, however, the IV results show non-structural moves have a notably large *positive* effect on student performance ranging from 0.195 to 0.251 in ELA and 0.278 to 0.343 in math, a finding that is robust across all specifications of the instruments. Thus, it seems that estimates of the impact of non-structural mobility from the student fixed effects models may be biased due to the endogeneity of non-structural mobility.

B. Long-term effects

Turning to the longer-term analyses, we find that the negative effects of structural mobility persist over time - ranging from -0.067 to -0.141 in both ELA and math in the years after the move (see Table 7.) Further, the short-term impact of structural moves is larger (in magnitude) than in previous specifications, between -0.081 and -0.141, while the short-term impacts of non-structural moves are statistically insignificant (IV results). The evidence on the long-term effect of non-structural moves is interesting. The fixed effects models suggest a negative effect of non-structural moves, which dissipates slightly in the long-term, while IV results suggest a persistent positive effect of between 0.119 and 0.269 in the years after the move.[15] Again, estimates of the impact of non-structural moves based on student fixed effects models, now in the long-term, may be biased due to endogeneity.

C. Foreclosure and sales IV: renter sample

We now turn to the renter sample, where foreclosure and sale of multi-family homes can be used as IVs. As in models with the full sample of students, fixed effects models estimated with the renter sample predict that all moves have negative impacts (see Table 8, columns 1, 2,

[15] We also examine long-term outcomes using a long-term value-added model where we capture changes in student performance over the five years between grades 3 and 8 and include indicators for whether students ever made a structural or non-structural move during this time. In these models we also find that there are long-term negative consequences of structural moves.

and 3); thus results for this particular group of students do not differ from those for the full sample in our baseline student fixed effects models. IV models using foreclosure and sale instruments, however, show different results than those using grade span instruments. While the models with grade span instruments predict positive effects for non-structural moves (both short-term and long-term), when we account for the endogeneity of mobility with foreclosure and sale (Table 8, columns 4 and 8), the coefficient on structural moves continues to be negative, but non-structural moves lead to a 0.215 decrease in math scores in the year of the move, and the effect persists such that the long-term impact of a non-structural move is a 0.565 decrease in math scores in the years after the move. Point estimates for effects in ELA are all in the same direction as math, but they are insignificant in both the short and long term.[16] This suggests that the long-term effects of mobility induced by housing insecurity are particularly pernicious.

While our results provide clear evidence that impacts of structural mobility are negative and significant - consistent with previous research on grade span -- our estimates of the impact of non-structural moves are more heterogeneous. Our grade span instruments yield positive or null short-term effects of non-structural moves, while housing instruments suggest negative or null effects. This difference may reflect the different timing and context of moves that are predicted by the different instruments. That is, grade span instruments may disproportionately predict *planned* or *strategic* moves – likely having positive effects -- while housing instruments disproportionately predict *unplanned* or *reactive* moves- which have negative effects. Although we have no direct data on parental motivation, we probe this further by dividing non-structural moves into (1) articulated moves, made to allow a student to begin his next school on time, and, arguably more likely to reflect strategic behavior, and (2) non-articulated moves, in which the student joins the new school mid-grade span, and, arguably more likely to be made in reaction

[16] A finding of stronger results in math than ELA is consistent with much of the education literature that tends to find larger effects of schools on math performance.

to some more sudden change in circumstance. We explore this below, estimating the impact of articulated and non-articulated moves separately (Table 9).

As in all previous models, student fixed effects results (columns 1 and 2) suggest that *all* kinds of moves are harmful for student performance. IV estimates (columns 3 and 4) suggest, however, that some moves may actually benefit performance. While students who make non-articulated moves score 0.920 lower in ELA, students making articulated moves score marginally better in ELA and significantly better (0.235) in math. Thus, these results indicate that mobility *per se* is not necessarily bad and, in fact, some moves are beneficial.

D. 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 SAP sample. Results are qualitatively unchanged.

School quality. It is possible that moves are disproportionately made to better 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 Appendix Table 1, columns 2 and 5.) Specifically, we use the average, regression-adjusted value-added for each school/grade in the previous year as a measure of school quality.[17] Overall, results are robust. All signs and significance of coefficients remain, with the size of the effect of structural moves essentially identical to that of the main model in Table 9. The effects of articulated moves are somewhat attenuated, suggesting the uncontrolled impacts may have been due, in part, to school quality improvements. Similarly, the negative effect of non-articulated moves is magnified in these models, suggesting that non-articulated moves also tend to be made from lower to higher quality schools.

[17] 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.

Pre-trends in performance: Another potential concern is that our estimates are capturing unaccounted for differences in trends in student performance in the years leading up to a move. If, for example, movers are on a downward trajectory before they move, then the negative relationship between moving and performance could be an artifact of this pre-existing trend. Thus, we augment our models with a series of indicators: one year prior to move, two years prior to move, three years prior to move, one year post move, two years post move, and three years post move.[18] Our results (see Appendix Table 1, columns 3 and 6) are unchanged, and we see no discernable pattern in the coefficients on indicators for years prior to move or post move, providing no evidence that mobile students are on a different trajectory immediately prior to their moves.

Alternative samples: Finally, we explore sensitivity to alternative samples of students. First, we limit our sample to those SAP students with standardized test scores in all grades 3 to 8, to explore the possibility that results are driven by differential test taking, say, by students moving mid-year. (See Appendix Table 2, columns 2 and 5.) Results are robust to this change in sample.

Second, we expand our sample to include continuously enrolled students who make non-standard progress, repeat or skip a grade. (See Appendix Table 2, columns 3 and 6.) Again, sign and significance of most coefficients are largely unchanged; the coefficient on non-articulated moves becomes more negative, remaining significant, indicating these non-articulated moves are more pernicious than SAP sample results suggested.

[18] Note, these "post move" variables differ from those used in our long-term effects analysis. Specifically, while the indicators in our long-term effects analyses are equal to one in all years after the first structural or non-structural move, the post indicators in this model are equal one only in years 1, 2, and 3 after a particular move and then become zero.

VIII. Conclusions

The vast majority of students in the United States change schools at least once before reaching 9th grade, and many move multiple times. As policy makers and educators consider interventions addressing school mobility, it is critical to consider several factors: first, that the organization of schools induces student mobility; second, that there is a relationship between mandated articulation points and the timing of school moves; and third, that structural and non-structural moves are related. Importantly, differences in the expected costs, benefits, and motivation of structural and non-structural moves imply that the consequences for students are likely heterogeneous and that 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 school shapes subsequent mobility, we use instrumental variables based upon the configuration of the first grade school to address potential endogeneity of school moves that are more likely to be strategic. We also use building foreclosures and sales on a sample of students living in rental housing to identify the effects of unanticipated school moves brought on by external shocks to the household.

Our results are intuitively appealing. We find that the impact of school moves on academic performance is, indeed, heterogeneous. Structural moves have negative consequences, while the impact of non-structural moves is more ambiguous: articulated moves have a positive effect, but non-articulated moves have negative, and sometimes insignificant effects. These results are robust to alternative specifications, instruments, and samples. Further, we find that rather than resulting in a transitory dip in performance as students acclimate to their new schools, structural moves result in a permanent and substantial decrease in student performance across both ELA and math. The results for non-structural moves are more mixed—there appears to be a permanent increase in performance among students making non-structural moves induced by grade span and a permanent decrease in performance among students making non-structural moves induced by a foreclosure or building sale. Most importantly, however, there appear to be permanent effects of 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 and long-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 non-structural mobility. In particular, if all schools were K-8's, then any student moving schools would make a non- articulated, non-structural move, which we have found is most detrimental to performance. The net effect of shifting to a K-8 system is, then, unclear *a priori* and would depend on the increased numbers of non-structural movers compared to the reduced numbers of structural movers. If students mostly remain in the K-8 school in which they first enroll, performance would improve.

In systems with a variety of grade spans, our results indicate that articulated, non-structural moves, which likely reflect voluntary moves by families seeking better outcomes, improve performance. Our estimates likely reflect the dominance of the strategic, Tiebout-type moves, especially since we control for mid-year moves when many of the reactive moves likely occur.[19] Thus districts may want to provide information that helps parents understand differences across schools and encourage such moves.

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

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

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Table 1: Definition of mobility variables

Variable name	Definition
Short-term mobility	
Summer move	Change schools between June and October
Structural	Change schools between June and October after completing the terminal grade of the origin school
Non-structural	Change schools between June and October before completing the terminal grade of the origin school
Articulated	Change schools between June and October and enter the lowest grade of the destination school
Non-articulated	Change schools between June and October and enter the destination school mid-grade span
Mid-year move	Change schools between October and June
Long-term mobility	
Post summer move	
Post-structural	In periods after student made first structural move
Post non-structural	In periods after student made first non-structural move

Table 2: 8th grade student characteristics by mobility history

	Summer moves			Mid-year moves	
	None	One	Two plus	None	Any
	(1)	(2)	(3)	(4)	(5)
Female	0.54	0.53	0.54	0.53	0.53
Asian	0.08	0.17	0.13	0.16	0.12
Black	0.41	0.27	0.36	0.29	0.39
Hispanic	0.35	0.36	0.40	0.37	0.38
White	0.15	0.20	0.12	0.19	0.10
Foreign born	0.07	0.09	0.10	0.09	0.11
Limited English proficient	0.01	0.01	0.02	0.01	0.01
Non-English at home	0.36	0.43	0.41	0.42	0.37
Poor	0.81	0.73	0.79	0.74	0.81
Graded special ed	0.06	0.04	0.05	0.05	0.06
Test scores					
3rd grade ELA	0.120	0.322	0.178	0.294	0.113
8th grade ELA	0.224	0.312	0.162	0.295	0.067
3rd grade math	0.134	0.345	0.167	0.313	0.091
8th grade math	0.220	0.302	0.122	0.282	0.010
Average # summer moves	0.00	1.00	2.32	1.24	1.95
Average # mid-year moves	0.10	0.08	0.35	0.00	1.21
Grade span of 4th grade school					
K to 8+	0.66	0.05	0.05	0.08	0.07
K to 4	0.00	0.04	0.06	0.04	0.05
K to 5	0.15	0.71	0.62	0.66	0.62
K to 6	0.16	0.19	0.19	0.19	0.21
all others	0.03	0.01	0.08	0.03	0.04
Observations	9,114	122,312	53,774	160,601	24,599
Percent of total	4.9%	66.0%	29.0%	86.7%	13.3%

Notes: Mobility history includes all moves made between grades 1-8. Summer moves are made between June and October. Mid-year moves made between October and June. Poverty is defined by eligibility for free\reduced price lunch or attendance in a universal free meal school. Foreign born students have birthplaces outside the U.S. 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 in a grade each year).

Table 3: Distribution of structural and non-structural moves, five SAP cohorts

Total # structural moves		Total # non-structural moves: 0	1	2	3	Total
	0	9,114	14,120	4,619	1,528	29,381
		31.0	*48.1*	*15.7*	*5.2*	*100.0*
	1	108,192	30,617	8,335	2,010	149,154
		72.5	*20.5*	*5.6*	*1.4*	*100.0*
	2	4,738	1,514	338	75	6,665
		71.1	*22.7*	*5.1*	*1.1*	*100.0*
	Total	122,044	46,251	13,292	3,613	185,200
		65.9	*25.0*	*7.2*	*2.0*	*100.0*

Notes: The total number of structural and non-structural moves includes summer moves (between June and October) made between grades 1-8. Each cell presents the frequency and the row percentages. The correlation between structural and non-structural moves is -0.27.

Table 4: Baseline regression results, short-term effects of moving schools, ELA and math exams

	ELA	Math	ELA	Math	ELA	Math
	(1)	(2)	(3)	(4)	(5)	(6)
Summer move	-0.079***	-0.109***	-0.040***	-0.054***		
	(0.002)	(0.002)	(0.002)	(0.001)		
Structural					-0.044***	-0.060***
					(0.002)	(0.002)
Non-structural					-0.033***	-0.045***
					(0.002)	(0.002)
Mid-year move	-0.069***	-0.099***	-0.028***	-0.054***	-0.029***	-0.055***
	(0.005)	(0.005)	(0.004)	(0.004)	(0.004)	(0.004)
Student characteristics	Y	Y	Y	Y	Y	Y
Student FX	N	N	Y	Y	Y	Y
Observations	1,092,488	1,102,440	1,092,488	1,102,440	1,092,491	1,102,440
Unique students	185,196	185,200	185,196	185,200	185,196	185,200
R-squared	0.472	0.530	0.744	0.771	0.744	0.771

Robust standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1). Standard errors in column (3) are clustered by first grade school by cohort. Summer moves occur between June and October. Mid-year moves occur between October and June. Moves after the completion of a terminal grade are structural moves. Moves after the completion of a non-terminal grade are non-structural moves. All models include controls for poverty, English proficiency (LEP), home language, participation in special education services, grade, residence borough, year, and student fixed effects.

Table 5: First-stage instrumental variable results, summer moves, ELA exams

	Structural	Non-structural
	(1)	(2)
G3 Yearspre	-0.008***	-0.007**
	(0.002)	(0.003)
G3 Yearspost	-0.038	-0.019
	(0.035)	(0.019)
G3*Terminal	0.742***	-0.077***
	(0.026)	(0.015)
G4 Yearspre	-0.010***	-0.005*
	(0.002)	(0.003)
G4 Yearspost	-0.042***	0.005
	(0.010)	(0.010)
G4* Terminal	0.383***	-0.045*
	(0.084)	(0.026)
G5 Yearspre	-0.007**	-0.003
	(0.003)	(0.003)
G5 Yearspost	0.021	-0.003
	(0.017)	(0.005)
G5*Terminal	0.773***	-0.044***
	(0.023)	(0.008)
G6 Yearspre	-0.066***	0.049***
	(0.009)	(0.011)
G6 Yearspost	0.012	-0.003
	(0.015)	(0.007)
G6*Terminal	0.492***	-0.049***
	(0.020)	(0.014)
G7 Yearspre	0.022***	-0.007
	(0.007)	(0.006)
G7 Yearspost	0.046***	-0.001
	(0.010)	(0.003)
G7*Terminal	0.415***	-0.022***
	(0.019)	(0.005)
G8 Yearspre	-0.012**	-0.014
	(0.006)	(0.009)
G8* Terminal	-0.015	-0.042**
	(0.015)	(0.017)
Observations	1,092,488	1,092,488
Unique students	185,196	185,196
F excluded (17, 3358)	396.41	25.21
Prob > F	0.000	0.000
R-squared	0.633	0.079

Robust standard errors, clustered by first grade school by cohort, in parentheses (*** p<0.01, ** p<0.05, * p<0.1). Coefficients displayed are for the excluded instruments. Model also includes controls for poverty, English proficiency (LEP), participation in special education services, whether a student made a mid-year move, grade, residence borough, year, and student fixed effects.

Table 6: IV Regression results, alternative grade span IVs, short-term effects of moving schools, ELA and math exams

	ELA			Math		
	Linear	Quad	Non-parametric	Linear	Quad	Non-parametric
	(1)	(2)	(3)	(4)	(5)	(6)
Summer moves						
Structural	-0.032***	-0.025***	-0.025***	-0.040***	-0.029***	-0.029***
	(0.009)	(0.009)	(0.008)	(0.010)	(0.010)	(0.010)
Non-structural	0.195***	0.251***	0.245***	0.278***	0.343***	0.334***
	(0.064)	(0.066)	(0.065)	(0.076)	(0.078)	(0.077)
Observations	1,092,488	1,092,488	1,092,488	1,102,440	1,092,488	1,102,440
Unique students	185,196	185,196	185,196	185,200	185,196	185,200

Robust standard errors, clustered by first grade school by cohort, in parentheses (*** p<0.01, ** p<0.05, * p<0.1). Summer moves occur between June and October. Mid-year moves occur between October and June. Moves after the completion of a terminal grade are structural moves. Moves after the completion of a non-terminal grade are non-structural moves. All models include controls for poverty, English proficiency (LEP), home language, participation in special education services, mid-year moves, residence borough, grade, and year. Columns (1) and (4) use the interaction between an indicator for current grade and the number of years between a student's grade in t and the completion of the terminal grade of his first grade school (years pre), 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 (years post), and an indicator equal to one in the summer following the completion of the terminal grade of a student's first grade school as instruments for structural and nonstructural moves. The instruments for columns (2) and (5) are the same as in columns (1) and (4), but also include the quadratic terms of years pre and years post. Columns (3) and (6) use the interaction between and indicator for the student's current grade and the terminal grade of his\her first grade school as instruments.

Table 7: Regression results, fixed effects and grade span IVs, long-term effects of moving schools, ELA and Math exams

	ELA				Math			
	Student FX	Linear	Quad	Non-Para	Student FX	Linear	Quad	Non-Para
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Summer moves								
Structural	-0.081***	-0.092***	-0.093***	-0.095***	-0.108***	-0.123***	-0.141***	-0.140***
	(0.002)	(0.078)	(0.011)	(0.011)	(0.002)	(0.016)	(0.014)	(0.014)
Non-structural	-0.046***	0.078	0.089	0.079	-0.061***	0.123	0.046	0.043
	(0.002)	(0.067)	(0.064)	(0.063)	(0.002)	(0.081)	(0.074)	(0.073)
Post summer move								
Structural	-0.079***	-0.067***	-0.076***	-0.081***	-0.103***	-0.093***	-0.139***	-0.141***
	(0.003)	(0.014)	(0.012)	(0.012)	(0.002)	(0.018)	(0.015)	(0.016)
Non-structural	-0.036***	0.173**	0.138**	0.119**	-0.048***	0.269***	0.047	0.040
	(0.003)	(0.071)	(0.058)	(0.057)	(0.002)	(0.089)	(0.071)	(0.071)
Observations	1,092,491	1,092,488	1,092,488	1,092,488	1,102,440	1,102,440	1,102,440	1,102,440
Unique students	185,196	185,196	185,196	185,196	185,200	185,200	185,200	185,200

Robust standard errors, clustered by first grade school by cohort, in parentheses (*** p<0.01, ** p<0.05, * p<0.1). Summer moves occur between June and October. Mid-year moves occur between October and June. Moves after the completion of a terminal grade are structural moves. Moves after the completion of a non-terminal grade are non-structural moves. Post structural move is an indicator equal to 1 in all years following a student's first structural move. Post non-structural move is an indicator equal to 1 in all years following a student's first non-structural move. All models include controls for poverty, English proficiency (LEP), home language, participation in special education services, mid-year moves, residence borough, grade, and year. Columns (2) and (6) use the interaction between an indicator for current grade and the number of years between a student's grade in t and the completion of the terminal grade of his first grade school (years pre), 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 (years post), and an indicator equal to one in the summer following the completion of the terminal grade of a student's first grade school as instruments for structural and nonstructural moves. The instruments for columns (3) and (7) are the same as in columns (2) and (6), but also include the quadratic terms of years pre and years post. Columns (4) and (8) use the interaction between the student's current grade and the terminal grade of his\her first grade school as instruments.

Table 8: Regression Results, renter sample

	ELA				Math			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Summer move	-0.020***				-0.038***			
	(0.007)				(0.003)			
Structural		-0.037***	-0.074***	-0.023		-0.067***	-0.132***	-0.181
		(0.003)	(0.004)	(0.311)		(0.003)	(0.004)	(0.268)
Non-structural		-0.040***	-0.044***	-0.006		-0.059***	-0.073***	-0.215*
		(0.004)	(0.005)	(0.141)		(0.004)	(0.005)	(0.125)
Post summer move								
Structural			-0.067***	-0.378			-0.119***	-0.021
			(0.005)	(0.366)			(0.004)	(0.334)
Non-structural			-0.023***	-0.091			-0.057***	-0.565**
			(0.006)	(0.259)			(0.005)	(0.244)
Student characteristics	Y	Y	Y	Y	Y	Y	Y	Y
Student FX	Y	Y	Y	Y	Y	Y	Y	Y
IV for summer move	N	N	N	Y	N	N	N	Y
Observations	507,061	507,061	507,061	470,864	509,742	509,742	509,742	473,842
Unique students	136,498	136,498	136,498	136,498	172,352	172,352	172,352	136,452

Robust standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1). Standard errors in column (3) are clustered by first grade school by cohort. Summer moves occur between June and October. Mid-year moves occur between October and June. Moves after the completion of a terminal grade are structural moves. Moves after the completion of a non-terminal grade are non-structural moves. Post structural move is an indicator equal to 1 in all years following a student's first structural move. Post non-structural move is an indicator equal to 1 in all years following a student's first non-structural move. All models include controls for poverty, English proficiency (LEP), home language, participation in special education services, mid-year moves, grade, residence borough, year, and student fixed effects. All models use the interaction between building type and indicators for whether the building was sold in the prior year for both current residence and prior year's residence as instruments for the number of summer moves made.

Table 9: Regression results, articulated and non-articulated moves separated, ELA and math exams

	Student FX Only		Student FX, with IV	
	ELA	Math	ELA	Math
	(1)	(2)	(3)	(4)
Summer move				
Structural	-0.047***	-0.064***	-0.083***	-0.071***
	(0.002)	(0.002)	(0.019)	(0.021)
Non-structural				
Articulated	-0.075***	-0.102***	0.128*	0.235***
	(0.005)	(0.004)	(0.072)	(0.077)
Non-articulated	-0.021***	-0.028***	-0.920**	-0.430
	(0.003)	(0.002)	(0.368)	(0.391)
Student characteristics	Y	Y	Y	Y
Student FX	Y	Y	Y	Y
IV for Summer Move	N	N	Y	Y
Observations	1,092,488	1,102,440	1,092,491	1,102,440
Unique students	185,196	185,200	185,196	185,200
R-squared	0.744	0.771		

Robust standard errors, clustered by first grade school by cohort, in parentheses (*** p<0.01, ** p<0.05, * p<0.1). Summer moves occur between June and October. Mid-year moves occur between October and June. Moves after the completion of a terminal grade are structural moves. Moves after the completion of a non-terminal grade are non-structural moves. Entering a destination school in the lowest grade is an articulated move. Entering a destination school mid-grade span is a non-articulated move. All models include controls for poverty, English proficiency (LEP), home language, participation in special education services, mid-year moves, residence borough, grade, and year. Columns (2) and (4) the interaction between an indicator for current grade and the number of years between a student's grade in t and the completion of the terminal grade of his first grade school (years pre), 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 (years post), and an indicator equal to one in the summer following the completion of the terminal grade of a student's first grade school as instruments for structural, articulated, and non-articulated moves.

Appendix Table 1: Robustness checks, IV specifications, school quality and move pre-trends

	Main result, ELA	Alternate specifications, ELA		Main result, Math	Alternate specifications, Math	
		School Quality	Pre-trends		School Quality	Pre-trends
	(1)	(2)	(3)	(4)	(5)	(6)
Summer move						
Structural	-0.083***	-0.083***	-0.076***	-0.071***	-0.036*	-0.067***
	(0.019)	(0.022)	(0.018)	(0.021)	(0.021)	(0.021)
Non-structural						
Articulated	0.128*	0.057	0.227***	0.235***	0.169**	0.350***
	(0.072)	(0.077)	(0.082)	(0.077)	(0.069)	(0.092)
Non-articulated	-0.920**	-1.064***	-0.877**	-0.430	-0.458	-0.345
	(0.368)	(0.388)	(0.417)	(0.391)	(0.361)	(0.464)
Observations	1,092,488	1,092,488	1,092,488	1,102,440	1,102,440	1,102,440
Unique students	185,196	185,196	185,196	185,200	185,200	185,200

Robust standard errors, clustered by first grade school by cohort, in parentheses (*** p<0.01, ** p<0.05, * p<0.1). Summer moves occur between June and October. Mid-year moves occur between October and June. Moves after the completion of a terminal grade are structural moves. Moves after the completion of a non-terminal grade are non-structural moves. Entering a destination school in the lowest grade is an articulated move. Entering a destination school mid-grade span is a non-articulated move. All models include controls for poverty, English proficiency (LEP), home language, participation in special education services, mid-year moves, residence borough, grade, and year. All models use the interaction between an indicator for current grade and the number of years between a student's grade in t and the completion of the terminal grade of his first grade school (years pre), 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 (years post), and an indicator equal to one in the summer following the completion of the terminal grade of a student's first grade school as instruments for structural, articulated, and non-articulated moves. 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, two, or three years pre and post move.

Appendix Table 2: Robustness checks, Alternative Samples

	Main result, ELA	Alternate samples, ELA		Main result, Math	Alternate samples	
		Always tested	Cont. enroll		Always tested	Cont. enroll
	(1)	(2)	(3)	(4)	(5)	(6)
Summer move						
Structural	-0.083***	-0.082***	-0.084***	-0.071***	-0.071***	-0.062***
	(0.019)	(0.018)	(0.018)	(0.021)	(0.021)	(0.021)
Non-structural						
Articulated	0.128*	0.121*	0.124*	0.235***	0.228***	0.266***
	(0.072)	(0.072)	(0.068)	(0.077)	(0.076)	(0.077)
Non-articulated	-0.920**	-0.954**	-0.831**	-0.430	-0.388	-0.241
	(0.368)	(0.373)	(0.366)	(0.391)	(0.393)	(0.422)
Observations	1,092,488	1,031,916	1,352,830	1,102,440	1,062,786	1,367,802
Unique students	185,196	171,986	228,267	185,200	177,131	228,277

Robust standard errors, clustered by first grade school by cohort, in parentheses (*** p<0.01, ** p<0.05, * p<0.1). Summer moves occur between June and October. Mid-year moves occur between October and June. Moves after the completion of a terminal grade are structural moves. Moves after the completion of a non-terminal grade are non-structural moves. Entering a destination school in the lowest grade is an articulated move. Entering a destination school mid-grade span is a non-articulated move. All models include controls for poverty, English proficiency (LEP), home language, participation in special education services, mid-year moves, residence borough, grade, and year. All models use the interaction between an indicator for current grade and the number of years between a student's grade in t and the completion of the terminal grade of his first grade school (years pre), 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 (years post), and an indicator equal to one in the summer following the completion of the terminal grade of a student's first grade school as instruments for structural, articulated, and non-articulated moves. The continuously enrolled sample includes students who are retained or skip grades.

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