Title: Lost in Transition: The Impact of Middle School Transitions on Student Learning Trajectories

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Background / Context:

The effect of student mobility on student outcomes has garnered much attention by researchers and policy-makers over the past few decades (e.g., Hanushek, Kain, & Rivkin, 2004). Out of this work, researchers have found that a specific type of mobility, structural moves when students age out of a given school (e.g., k-5 to 6-8), is associated with negative shocks to students short- and long-term achievement (Dhuey, 2013; Schwartz, Stiefal, Rubenstein, & Zabel, 2011; Schwerdt, & West, 2013; Rockoff, & Lockwood, 2010). However, the extant research relies on annual tests, typically measured each spring, to estimate the effect of structural moves on student achievement. The current literature does not allow researchers to evaluate whether the negative shock occurs at the start of the school year, or develops over time as students adjust to their new setting. Using a unique data set that includes both fall and spring test scores, we set out to evaluate whether students fall achievement, presumably before instruction occurs, is affected by the structural move, and whether students' school-year achievement growth is affected as well. Our preliminary results suggest that students experience a negative shock to achievement at the start of the year. Our results have the potential to shed new light on the impact of structural transitions, and have important implications for policy and practice.

Purpose / Objective / Research Question / Focus of Study:

We estimate the overall impact of middle school transitions on students' achievement, both in terms of test score performance in the fall as students first arrive in their new school, as well as their learning rate throughout the subsequent school year(s). We build off summer learning loss research which suggests that minority students may be more likely to lose ground during the summer and therefore start each school year off behind. We therefore also explore whether minority students' growth trajectories are more severely affected by middle school transitions. The current project fits nicely with the conference theme, which specifically focuses on "educational trajectories and transitions, from: (a) preschool to kindergarten, (b) elementary to middle school, (c) middle to high school, (d) high school to college, and (e) into adulthood."

Setting:

The data for the current study comes from a partnership with the Northwest Evaluation Association (NWEA), which administers the Measures of Academic Progress (MAP) assessment to school age students across the U.S. The MAP is a computer adaptive test that assesses student performance in math and reading. The MAP assessment is not used in accountability policies, but rather serves as a formative tool delivered to teachers and schools multiple times per year. NWEA reports test scores in an IRT-based metric, which is vertically equated and equal-interval scaled.

Population / Participants / Subjects:

The dataset includes students enrolled in public schools who take the MAP assessment. The Southern State uses the MAP assessment in all public school districts for the past six years. In theory, all students in public schools should take the MAP assessment twice per year (fall and spring) in grades two through nine, however for idiosyncratic reasons, many students may not have test scores at every testing occasion. Table 1 presents sample sizes by grade and year of data (see appendix for tables, figures, and equations). We are particularly focused on the subset of students who make a middle-school transition after fourth, fifth, or sixth grade, as well as students who attend K-8 schools and therefore make no middle-school transition.

Intervention / Program / Practice:

We examine the impact of structural mobility on student performance. Extant research documents that structural transitions are difficult for students, and that student achievement is disrupted—either temporarily or permanently— as a result of these moves. The study of structural mobility requires robust data that differentiates between a structural move and a student who leaves the district. Furthermore, because large-scale testing typically occurs once per year in the spring, it is often impossible to detect if the start of the new school year might be particularly difficult.

For a subset of the students in our Southern State whom we follow across our five-year longitudinal panel, we observe their MAP test score trajectory as they move from 4th through 8th h grade. A structural transition occurs as students complete the final grade level offered at their elementary school and are re-assigned to a new middle school. Although the modal transition in the state is between 5th and 6th grade, a non-trivial share of elementary schools end in 4th or 6th grade. We will use this variation to estimate the effect of structural moves on students' middle school achievement using either students' own histories as a counter-factual (e.g., student fixed-effects) or students who do not make structural moves (e.g., students in K-8 schools) as a counter-factual. These different approaches to timing of structural transitions allows us some variability in the treatment of interest—structural transitions—that we can use to explore the impact on student achievement both in terms of immediate performance (fall scores), as well as future performance (following students through the end of middle school). Of course, the variation in when students experience their middle school may not be exogenous—a complication we seek to address through various quasi-experimental approaches described in the next section in more detail.

Research Design:

The treatment of interest is the impact of middle school transitions on immediate (fall) and longer term (throughout middle school) student achievement. We start by modeling students' math or reading test scores as a function of time in a multi-level modeling framework. We use a two-level random effects (hierarchical) model, where the outcome of interest is a test score, Y_{ijk}, assigned to student i at grade-semester j, in school k. Each student's vector of test scores (fall and spring, across years) are modeled at level one as repeated observations nested within students. At level one, students' growth trajectories are modeled using a set of dummy variables for each grade-semester—Gr4_Fall, Gr4_Spr, Gr5_Fall, Gr5_Spr, etc.— that are coded as 1 if the observation occurred *after* the given grade-semester. This coding scheme structures the level-one coefficients so that they represent individual students' grade-specific school-year and summer learning rates. One of the main advantages of this approach is the ability to estimate both the mean and variance across students in school-year and summer learning rates. (See Equation (1) in the appendix). We first use Equation (1) to examine overall mean growth trajectories, as well as to estimate the variance across schools. These preliminary descriptive explorations will provide us with a basis for thinking about how to best approach modeling student growth trajectories over time (e.g., linear, quadratic, logarithmic, etc).

In order to explore whether variability in middle school transitions are associated with decrements to student learning, we change the temporal structure of Equation (1) to best represent the overall pattern of student learning based on our initial descriptive exploration (for the sake of simplicity, we assume in this proposal that a simple linear model is most appropriate). We then introduce a new time-varying indicator that identifies when a structural move at the start of the school year occurs, whenever that might be (e.g., start of 5th, 6th, or 7th grade). The inclusion of the indicator allows us to test whether an immediate decrement in test scores is detectable in the fall. Furthermore, we interact the transition indicator variable with the linear time variable in order to explore whether the rate of learning subsequent to the structural transition differs from each

student's pre-transition growth rate. We have also estimated school value-added measures so that we can control for the quality of both the school left, as well as the school attended after the structural transition. Students who transition to schools of lower relative quality may experience a decrement to learning that is not due to the experience of being at a new school, but rather to the change in the quality of instruction, and so in some models we account for the relative difference in school quality (as measured imperfectly through school value-added measures). While on the one hand, it seems straightforward that one would want to control for post-transition school quality, there is some possibility that school quality is endogenous to transition timing.

Because students make structural transitions at different points in time, we can disentangle any grade-specific learning patterns from the timing of the structural transition itself. Furthermore, we can control for some time-invariant or pre-fourth grade characteristics of students including their fourth grade test scores, gender, and race/ethnicity. At the within-student level, we can also control for non-structural moves across schools, as well as student grade repetition or skipping. To some extent, these time-varying and time-invariant controls ensure that any comparisons in test scores when students are making structural moves or not are among more "similar" conditions, however we will discuss other approaches to isolate the variation in treatment status, below.

Our random effect strategy is vulnerable to omitted variable bias due to systematic differences between students who do and do not make structural moves. We will also pursue a random effects model that removes fixed differences among students while maintaining our ability to estimate the variation in the effect of structural moves across students. This approach is akin to a "within-student" approach, because we compare each student's achievement before and after the structural move and estimate the coefficient on transitioning only using within-student variation.

It is important to think about the systemic ways in which students may be sorted into structural transitions at different timings and address any non-random sorting in the analytic approach. On the one hand, we believe that families are probably unlikely to select which school their child attends at the start of formal schooling based on whether they prefer transitions to occur after a particular grade level. In addition, for some families, geographic constraints may determine whether and when their children experience the middle school transition: For instance, perhaps only one particular structural transition timing is available to them because, for example, all schools in the given districts transition after fifth grade. In this sense, families are less likely to self-select into a given treatment timing. That said, it seems possible that some families could have some preferences about middle school transitions, perhaps preferring to send their children to K-8 schools in which no middle school structural move occurs.

Ultimately, our most powerful source of evidence on whether middle school transitions negatively affect student achievement and learning rates will come from the variability in transition timing. If, for instance, we see a decrement to student learning appears at the start of 6th grade for those who transition summer after 5th grade but no such decrement exists for students who transition at a later time, then this suggests the structural transition itself could be the cause. We would be further convinced if we also see that students who transition in 7th grade (who did not exhibit a drop in test scores at the start of 6th grade when they did not transition) in fact *do* exhibit a drop in fall test scores at the start of 7th grade, while the earlier transitions do not.

In order to attend to the fact that students may not be randomly assigned to whether they experience a structural transition or not (and if so, after what grade), we explore several quasi-experimental approaches to identifying some random variation in the treatment of interest. For instance, we explore the feasibility of using district fixed effects so that we can hold constant the public school settings. We also explore the feasibility of using an instrumental variables approach, in which the instrument is the terminal grade of the school the students first attends in kindergarten.

Finally, one avenue which we have not yet explored is whether the given state has schools that have changed their grade-level structure since 2007-08. For instance, a given elementary school might change from serving grades K-4 to serving grade K-5. We could compare the outcomes of students in one cohort who made the structural transition after 4th grade, to students in the subsequent cohort who made the transition after 5th grade. Such an approach could improve our ability to identify exogenous variation in transition timing, however the subset of schools that make such changes may not be representative of the larger population.

Data Collection and Analysis:

We currently have the data and have cleaned and used it for other analyses. Our previous work with this data increases the feasibility of the current proposed work. Of the approximately 170,000 students for whom we observe achievement throughout 4th through 8th grade, approximately 20 percent do not make a structural transition before the start of sixth grade. This suggests that there is variation in exposure to and timing of middle school transitions in our sample.

Findings / Results:

We have conducted preliminary analyses following one cohort of students as they move through grades 3 through 7. In Figure 1, we present predicted model-based growth trajectories estimated using Equation (1) above. We ran the model on two separate samples: students who attended elementary schools that ended after 5th grade, and students who attended elementary schools that ended after 6th grade (see Figure 1).

These preliminary results are compelling: Students who experience a structural shift between 5th and 6th grade (blue) exhibit an especially low 6th grade fall score, which results in what looks like an especially large learning loss during the summer. On the other hand, students who do not transition between 5th and 6th grade do not show any major decrement. At the same time, students who transition between 6th and 7th grade (orange) experience an unusually large summer learning loss in the fall, while the students who transitioned at an earlier grade do not. This preliminary work is suggestive that middle school transitions are hard on students—regardless of which grade level they experience them in. More nuanced modeling approaches will more formally compare the subsequent learning trajectories of pre-treatment similar students in relation to if and when they experience middle school transitions.

Conclusions:

The phenomenon of middle school transitions is difficult to study in a causal framework, either because students in the same schools all make the structural move at the same time (i.e., no variation in treatment status), or because the reasons students attend K-4, K-5, K-6, or K-8 elementary schools may be non-random. Furthermore, it is uncommon for schools to change their structure over time, and if they do so, there is probably a reason for doing so that may have its own correlated relationship with student achievement. Though we take several approaches to addressing these challenges, no one single quasi-experimental approach ensures perfect internal validity. Our hope is that, by triangulating several different analytic approaches, we will see a preponderance of evidence about whether middle school transitions negatively affect students (and perhaps some students more than others). If we do find evidence that middle school transitions have lasting, negative effects   researchers may wish to explore interventions designed to ease these transitions, and policy makers may consider whether certain school grade groupings—like K-8 schools, which eliminate one such transition—are more beneficial to students than others.

Appendices
Not included in page count.

Appendix A. References

Dhuey, E. (2013). Middle school or junior high? How grade-level configurations affect academic achievement. *Candian Journal of Economics, 46*(2), 469-496

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Schwartz, A.E., Stiefal, L., Rubenstein, R., & Zabel, J. (2011). The path not taken: How does school organization affect eighth-grade achievement? *Educational Evaluation and Policy Analysis, 33*, 293-317.

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Appendix B. Tables and Figures
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Table 1. Number of Unique Students in NWEA Dataset for South Carolina, by Grade and School Year

	2007-08	2008-09	2009-10	2010-11	2011-12	
2	49,230	49,943	50,024	47,669	44,905	**241,771**
3	49,671	52,684	52,118	49,390	45,452	**249,315**
4	49,206	50,736	52,039	50,231	45,582	**247,794**
5	48,086	49,978	50,739	50,308	46,604	**245,715**
6	48,515	48,801	48,949	47,358	43,405	**237,028**
7	49,760	49,496	48,746	47,288	43,064	**238,354**
8	49,885	49,827	48,098	45,779	43,154	**236,743**

Equation 1. Basic Structure of Two-Level Random Coefficients (Hierarchical) Model

Level-1 Model (Repeated Observations of Students (i) over Grade-Sems (j)

$$Score_{ki} = \pi_{0i} + \sum_{g=4}^{8} \left[\pi_{(2g-3)i}(Gr`g'\_Fall_{ik}) + \pi_{(2g-2)i}(Gr`g'\_Spr_{ik}) \right] + e_{ki}$$

Level-2 Model (Students)

$\pi_{0i} = \beta_{00} + r_{0i}$ ← where β_{00} = *average Gr 4 Fall score*
$\pi_{1i} = \beta_{10} + r_{1i}$ ← where β_{10} = *Grade 4 learning rate*
$\pi_{2i} = \beta_{20} + r_{2i}$ ← where β_{20} = *Summer after Grade 4 learning rate*
$\pi_{3i} = \beta_{30} + r_{3i}$ ← where β_{30} = *Grade 5 learning rate*
$\pi_{4i} = \beta_{40} + r_{4i}$ ← where β_{40} = *Summer after Grade 5 learning rate*
$\pi_{5i} = \beta_{50} + r_{5i}$ ← where β_{50} = *Grade 6 learning rate*
$\pi_{6i} = \beta_{60} + r_{6i}$ ← where β_{60} = *Summer after Grade 6 learning rate*
$\pi_{7i} = \beta_{70} + r_{7i}$ ← where β_{70} = *Grade 7 learning rate*
$\pi_{8i} = \beta_{80} + r_{8i}$ ← where β_{80} = *Summer after Grade 7 learning rate*
$\pi_{9i} = \beta_{90} + r_{9i}$ ← where β_{90} = *Grade 8 learning rate*
$\pi_{10i} = \beta_{100} + r_{10i}$ ← where $\beta_{10,0}$ = *Summer after Grade 8 learning rate*

Figure 1. Estimate Math Achievement From Third Through Seventh Grade for One Cohort of South Carolina Students, by Structural Elementary School Type