Introduction

We use administrative data panels in three states—Massachusetts, Missouri, and Washington—to document the link between educational outcomes and longitudinal measures of student mobility across schools. We define two types of student mobility. The first, “structural mobility,” is when a student’s natural progression through the schooling system is such that a school move occurs due to district structure (e.g., at the transition point from elementary to middle school). The second, “nonstructural mobility,” is when a student moves for another reason (e.g., a residential move due to economic instability; see, e.g., Been et al., 2011; Desmond & Gershenson, 2016). Our goal is to examine the extent to which repeated nonstructural mobility during primary and secondary education is useful for identifying at-risk students.

We show that nonstructural mobility is strongly associated with student risk status, as measured by low academic performance and graduation rates. For example, students in all three states who switch schools (nonstructurally) three times during Grades 3 to 12 score about 20 percentile points lower in the distribution of test performance in high school and are 9 to 27 percentage points less likely to graduate from high school, on average, compared with students without any nonstructural moves.

Our findings are in line with existing evidence showing that mobile students are more likely to be at-risk than other students (Anderson & Leventhal, 2017; Barrat & Berliner, 2013; Courtney et al., 2004; Cowen, 2017; Cutuli et al., 2013; Ingersoll et al., 1989; Mehana & Reynolds, 2004; Rumberger & Larson, 1998). Our unique contribution is to establish that the relationships between student mobility and outcomes are much stronger when the cumulative history of mobility is considered. In this way, our work mirrors findings by Michelmore and Dynarski (2017), who perform a conceptually similar analysis of the information conveyed by a student’s history of free and reduced-price lunch (FRL) eligibility to identify persistent poverty. Like their work, our findings point to the value of using longitudinal data to provide a more complete picture of student risk than is available from cross-sectional data. Moreover, we show that longitudinal mobility captures information that is not captured by persistent poverty.
The evidence we present in this note is purely descriptive. The methods we employ are not suited to isolate the causal impacts of nonstructural mobility on students’ academic outcomes. But causal inference is not necessary for longitudinal information on student mobility to be put to good policy use. In particular, we show that longitudinal measures of mobility can be used by policymakers, administrators, and teachers to better identify at-risk students. A concrete policy recommendation based on our findings is that state education agencies construct panel measures of student mobility to help educators identify students who are likely in need of additional supports. Repeated mobility information over the span of K–12 schooling is unlikely to be readily available to individual districts, schools, or teachers, which highlights a valuable role that states can play as information providers by leveraging their broader data systems.1

Data and Measures

Our analysis is based on state administrative microdata covering nearly all students enrolled in public schools in three states: Massachusetts, Missouri, and Washington. In each state we track two cohorts of students—enrolled in the third grade in either the 2006–2007 or 2007–2008 school years—from Grades 3 to 12. Students who exit the public school system at any point prior to the 12th grade, either because they enroll in private schools or leave the state, are excluded from the data.2 Our samples include 113,938 unique students from Massachusetts, 101,629 unique students from Missouri, and 120,294 unique students from Washington.

Massachusetts, Missouri, and Washington comprise a convenience sample of states from which we have access to appropriate data to track longitudinal mobility. The states differ in many respects, ranging from geographic location in the United States, the racial-ethnic composition of students, poverty rates, and school governance structure, as shown in Table 1. The states also share some similarities, most notably in terms of their size (all three states have total enrollment very similar to the U.S. average) and overrepresentation of White students (and corresponding underrepresentation of students of other race-ethnicities) relative to the United States as a whole. Recent data from the Stanford Education Data Archive identify Massachusetts as a state with above-average achievement in the United States, and Missouri and Washington as states with achievement near the national average.

We follow students in these states as they progress through public schools and track their school transitions from the 3rd through 12th grades. Transitions are assessed based on year-to-year changes in school enrollment, inclusive of changes due to mid-year and end-of-year moves.3 The number of moves per year is also capped at one—that is, we produce one annual mobility measure for each student based on whether the current-year and previous-year school differ given a snapshot of where students are enrolled on a particular date from year to year.

We distinguish between structural school transitions, which are associated with normal promotion from one grade to the next, and nonstructural transitions that are unexpected given school and district grade configurations. Our preferred definition of a nonstructural move has two parts. First, we identify the highest grade in each school in each year (e.g., Grade 5 in a K–5 school) and identify all school transitions in years other than those following a school’s terminal grade as nonstructural moves. Second, if a school transition occurs immediately after a school’s terminal grade, the student moves to a new district, and the previous school’s terminal grade is not the highest grade served by the district, we also treat this as a nonstructural school move.4

### Table 1

**Summary Statistics for the Sample States Compared With the United States**

| State characteristics | Massachusetts | Missouri | Washington | U.S. average |
|-----------------------|---------------|----------|------------|--------------|
| Race-ethnicity         |               |          |            |              |
| American Indian/Alaska Native | 0.3 | 0.4 | 2.6 | 1.2 |
| Asian/Pacific Islander | 5.0 | 1.8 | 8.6 | 4.8 |
| Black                  | 8.3 | 17.9 | 5.7 | 17.0 |
| Hispanic               | 14.1 | 3.7 | 15.1 | 21.1 |
| White                  | 72.2 | 76.1 | 68.0 | 55.8 |
| Percent in poverty, 5- to 17-year olds | 18.1 | 17.0 | 11.2 | 17.4 |
| Enrollment             | 962,958 | 917,188 | 1,030,247 | 984,282 |
| No. of districts       | 392 | 550 | 308 | 349 |
| Pupil-teacher ratio    | 13.6 | 13.4 | 19.1 | 15.5 |
| Average teacher salary (highly experienced with master’s degree) | $68,590 | $54,300 | $58,670 | $63,050 |

*Note. Data source is the Digest of Education Statistics 2009 (Snyder & Dillow, 2010). All values are from the 2007–2008 school year, or 2007 or 2008 calendar year.*
In one sense our definition of nonstructural moves is conservative—namely, it likely understates the total number of moves associated with disruptions because school transitions that take place after a school’s terminal grade to another school in the same district are not counted as nonstructural moves. This is despite the fact that some of these moves may be to schools other than the “next-in-line” zoned school. Unfortunately, we are unable to cleanly identify next-in-line school moves within districts because we do not observe student addresses (and hence cannot identify zoned schools). To the extent this measurement issue results in the miscoding of some nonstructural moves, it will attenuate the average relationships we identify between nonstructural moves and student outcomes.6,7

However, in another sense our definition of nonstructural moves may be too broad. A simpler definition would identify a move as nonstructural only if it is in a year other than the terminal grade of the school (i.e., it would use only the first part of our two-part definition). This would ignore potentially disruptive student moves across districts as long as they coincide with normal school-transition years. It is not obvious ex ante which definition is better for identifying at-risk students. Our preferred definition is the broader, two-part definition, which we use for most of our analysis. We also explore the use of the simpler, narrower definition in the extensions section.

Leading with our preferred definition of nonstructural mobility, we document the relationships between persistent mobility and three primary performance measures—achievement in third grade, achievement in high school, and high school graduation. We measure achievement in the third grade and high school by percentiles of the statewide test distribution.8 The third-grade tests are common statewide exams in math and English language arts (ELA). The high school exams we use in each state are the MCAS ELA exam in Massachusetts, the English II end-of-course exam in Missouri, and the HSPE ELA exam in Washington. For the graduation outcome, a student is considered a graduate if she is observed graduating high school within 1 year of her expected graduation year based on normal grade progression from the third grade forward. To be included in the nongraduate sample, a student must be observed with an enrollment record indicating a dropout. Students who simply disappear from the cohort without a graduation or dropout record are treated as state leavers and omitted from the graduation portion of the analysis.

Table 2 provides descriptive information about structural and nonstructural student mobility in each state, overall and broken out by student race-ethnicity and FRL status. Across the three states, students experience an average of 1.7 to 2.0 structural school moves during Grades 3 to 12 and 0.66 to 0.95 nonstructural moves. Consistent with the idea that nonstructural mobility serves as a general indicator of risk status, underrepresented-minority (Black and Hispanic) and FRL-eligible students are much more likely to experience nonstructural moves than their economically more-advantaged peers.9

Figure 1 provides complementary distributional information about nonstructural mobility in the form of student shares in each state with 0, 1, 2, 3, and 4+ nonstructural moves between Grades 3 and 12. About 50% to 60% of students across the sample states have zero nonstructural school moves, which leaves 40% to 50% with at least one move. Fifteen percent to 25% of students across the three states experience two or more nonstructural moves.

Note that the move counts and shares in Table 2 and Figure 1 understate total nonstructural mobility because, as noted above, we restrict our sample to students who remain in our sample states from Grades 3 to 12. This excludes students who cross state boundaries, who are also nonstructural movers using our preferred definition. This constraint on the sample may also affect the gradients we show below connecting the number of nonstructural moves to student outcomes. If nonstructural movers who cross state boundaries are more (less) likely to be at-risk than nonstructural movers who remain within their states, then the gradients we show below will be understated (overstated).

Using Longitudinal Nonstructural Mobility to Identify At-Risk Students

Figure 2 shows percentile ranks on the high school test for students who had 0, 1, 2, 3, or 4+ nonstructural moves during Grades 3 to 12. The chart shows that the relationship between achievement rank and mobility events is roughly linear and very similar in all three states, which points to the value of tracking mobility longitudinally. For example, knowing a student moved twice during Grades 3 to 12 indicates roughly double the disadvantage of a student who moved just once (relative to a student with zero moves).10

Next, Figure 3 replicates the same trends for graduation rates. The trends are somewhat flatter, especially for lower numbers of mobility events, likely reflecting the fact that graduation is a less differentiated outcome than test scores. There are also clear differences in the gradients across states, unlike in Figure 2. The gradient is flattest in Massachusetts, followed by Missouri, and is steepest in Washington. This pattern aligns with evidence from Austin et al. (2021), who show that graduation rates are lowest among initially low-performing students in Washington, followed by Missouri, and then Massachusetts using similar data. That is, graduation appears to be a more discriminate outcome in the states with the steeper gradients in Figure 3. This is consistent with interpreting the number of nonstructural mobility events as an indicator of risk status—the relationship becomes more apparent as the outcome metric becomes more discriminate.

We again note that these relationships are descriptive and should not be interpreted causally. As a way of
illustrating this, Figure 4 replicates the mobility-event trends using students’ test percentile ranks in the third grade. The third-grade tests are taken prior to mobility measured between Grades 3 and 12. The time inconsistency does not entirely preclude causal impacts of mobility on achievement because unmeasured mobility prior to the third grade is likely correlated with later-grade mobility. However, the similar trends for the third-grade and high-school tests in Figures 2 and 4 suggest that what we are largely capturing is not causal; rather, nonstructural mobility is serving as a general indicator of risk status. This interpretation is consistent with available research that aims to estimate causal effects of mobility, which finds negative but small mobility effects (e.g., Brummet, 2014; Grigg, 2012; Hanushek et al., 2004; Xu et al., 2009) or mixed effects depending on the type of move (Cordes et al., 2019; Schwartz et al., 2017).

TABLE 2
Mean Mobility and Outcome Values Overall and for Student Subgroups, by State

| Mobility/outcome measure | All   | White | Asian | Black | Hispanic | Low poverty (non-FRL) | High poverty (FRL) |
|--------------------------|-------|-------|-------|-------|----------|-----------------------|-------------------|
| Massachusetts            |       |       |       |       |          |                       |                   |
| # of structural moves    | 1.692 | 1.757 | 1.650*| 1.406*| 1.528*   | 1.755                 | 1.541*            |
| # of nonstructural moves | 0.664 | 0.557 | 0.548 | 1.090*| 1.031*   | 0.500                 | 1.054*            |
| Third grade test         | 48.827| 53.029| 54.742*|32.730*| 32.385*  | 54.832                | 34.571*           |
| Tenth grade test         | 49.474| 52.882| 64.685*|34.615*| 33.355*  | 55.739                | 34.600*           |
| High school graduation   | 97.721| 98.450| 99.119*|94.841*| 94.933*  | 98.989                | 94.711*           |
| Missouri                 |       |       |       |       |          |                       |                   |
| # of structural moves    | 1.997 | 2.053 | 2.080 | 1.735*| 2.006*   | 2.115                 | 1.838*            |
| # of nonstructural moves | 0.770 | 0.563 | 0.452*| 1.730*| 0.863*   | 0.419                 | 1.246*            |
| Third grade test         | 52.034| 55.757| 61.194*|35.935*| 42.607*  | 59.184                | 42.340*           |
| Tenth grade test         | 51.846| 54.772| 65.969*|36.555*| 45.203*  | 58.925                | 41.477*           |
| High school graduation   | 94.121| 95.501| 97.485*|88.069*| 91.268*  | 97.564                | 89.453*           |
| Washington               |       |       |       |       |          |                       |                   |
| # of structural moves    | 1.798 | 1.804 | 1.826*| 1.675*| 1.858*   | 1.840                 | 1.739*            |
| # of nonstructural moves | 0.954 | 0.893 | 0.742*| 1.550*| 1.013*   | 0.699                 | 1.325*            |
| Third grade test         | 49.476| 53.847| 54.846*|37.536*| 34.840*  | 56.961                | 38.584*           |
| Tenth grade test         | 50.693| 54.520| 60.057*|37.943*| 36.725*  | 58.876                | 38.787*           |
| High school graduation   | 87.148| 88.421| 93.236*|80.003*| 83.583*  | 92.485                | 79.381*           |

*Indicates a value that is statistically significantly different from the comparison category at the 5% level or better.

Note. The poverty split divides students who are and are not eligible for free- or reduced-price lunch (FRL) in third grade. Students coded as “other” race-ethnicity are omitted for brevity. The values for the racial-ethnic subgroups are compared with White students for these tests; the values for high-poverty students are compared with low-poverty students.

FIGURE 1. Student shares by the number of nonstructural school moves. 
Note. The numbers used in this figure are provided in Table A1.

FIGURE 2. Relationships between high school achievement (percentile ranks) and nonstructural mobility events. 
Note. The numbers used in this figure are provided in Table A2.
Tables A2 to A4 provide tabular data corresponding to Figures 2 to 4, with additional subgroup splits by race-ethnicity and FRL status measured in the third grade. Qualitatively, the relationships between mobility and performance outcomes are similar within all race-ethnicity and poverty groups. There are modest fluctuations in the magnitude of the mobility relationship depending on the outcome measured and student group, and the relationships are generally less steep for students from more disadvantaged backgrounds. The flatter relationships are the product of weaker positive selection into the low-mobility categories among Black, Hispanic, and FRL students relative to Asian, White, and non-FRL students.\textsuperscript{11}

Figures 2 to 4 (and the corresponding appendix material) provide strong empirical support for the use of repeated nonstructural mobility events as indicators of student risk. However, if mobility in some grades (and at some ages) is more predictive than in others, it could influence the appropriate time at which to measure mobility and the optimal strategy for intervention.\textsuperscript{12} We test whether nonstructural mobility events are differentially predictive of student outcomes depending on the grade span over which mobility is measured in Figure 5. In the figure, we separately measure the number of nonstructural moves among students over Grades 3 to 12, 3 to 8, and 3 to 5, then relate these measures to student achievement in the 10th grade (for brevity we omit the other outcomes). The gradients over the full 3 to 12 grade span in Figure 5 are repeated from Figure 2 for ease of comparison; the gradients over the shorter grade spans are new.

The results show that the mobility gradients are similar when mobility is measured across different grade spans in all three states, although they are slightly steeper when we use the narrower grade spans, especially Grades 3 to 5. These findings indicate that policymakers looking to incorporate information about persistent mobility into real-time policies can do so—measures of persistent mobility consistently identify at-risk students regardless of the grade span over which they are constructed.

In Figure 6, we compare results using our preferred definition of nonstructural moves to results using the narrower...
definition in which nonstructural moves are defined solely based on whether they occur outside of the origin school’s terminal grade (i.e., students who switch districts after a school’s terminal grade are no longer treated as nonstructural movers). For ease of presentation, we focus only on 10th grade test scores for this comparison as well. Figure 6 shows our findings are broadly similar regardless of how we define nonstructural moves, although the narrower definition identifies students at greater risk of poor academic performance (albeit modestly). We conclude from Figure 6 that both definitions of nonstructural moves similarly identify at-risk students.

Next, we examine whether longitudinal mobility predicts variation in student risk *above and beyond persistent poverty*. These results are presented in Tables A5 and A6. First, Table A5 shows (1) the distribution of nonstructural school mobility and (2) average high school test scores and high school graduation rates by student mobility, conditional on persistent poverty. We define a student as being in persistent poverty if he or she is FRL-eligible in every year during Grades 3 to 12. Table A6 repeats the same exercise for students with different levels of partially persistent poverty based on the number of years the student was FRL-eligible. Both tables show a strong and consistent link between nonstructural
mobility and student outcomes holding the level of (measured) persistent poverty constant. For example, among persistent FRL students, those who do not change schools nonstructurally score about 9 percentile points higher on high school tests and are 8 to 21 percentage points more likely to graduate from high school compared with those who change schools nonstructurally three times (see Table A5).

Finally, we conduct two other extensions, for which the results are omitted for brevity. First, we explore the potential for heterogeneity in the prevalence of nonstructural mobility and the predictive validity of mobility events over student performance separately based on whether students were initially enrolled at a school in a major metropolitan statistical area (MSAs) in each state. The focal MSAs are in and around Boston in Massachusetts, St. Louis or Kansas City in Missouri, and Seattle in Washington. In Missouri, the average number of nonstructural moves is higher among students who start in the major MSAs, but in the other states, the nonstructural move rates are similar inside and outside the MSAs. In all three states, the relationships between the number of moves and student outcomes are similar for students regardless of whether they first appear in our sample in a major MSA. Second, we conducted a parallel analysis of nonstructural district mobility. Nonstructural district mobility is less common than nonstructural school mobility, but the mobility-outcome gradients are similar to what we show here for school mobility.

**Conclusion**

We show that longitudinal data on nonstructural student moves between schools can help identify at-risk students. These findings have implications for both research and policy similar to those articulated by Michelmore and Dynarski (2017) in their related study on longitudinal poverty status based on FRL data. The longitudinal mobility metrics are complementary to persistent FRL designations as they identify dimensions of risk status not captured by FRL information alone. They are appealing to use not only because they supplement FRL-based information but also because they are not affected by district and school adoptions of the Community Eligibility Provision.

Our findings also indicate that research relying on cross-sectional mobility information to proxy for student risk status, which is the current norm, will not fully capture differences across student circumstances captured by longitudinal mobility. To the extent that these differences are correlated with specific interventions and/or teacher and school assignments, they could cause bias in causal studies if left uncontrolled.

From a policy perspective, the main takeaway from our study is that state longitudinal data systems contain information that policymakers and practitioners can use to better target resources toward high-need students. It is unlikely that individual districts, schools, and teachers will have the ability to effectively collect data on longitudinal mobility. However, state education agencies can produce this information at low (marginal) cost given recent investments in state longitudinal data systems. Our findings point to a clear role of state education agencies in providing this type of information to local education actors in an effort to better serve students at risk of poor academic performance.

**Appendix A**

**TABLE A1**

Fractions of Students With Different Numbers of Nonstructural Moves, Overall and for Student Subgroups

| Number of moves | (1) All | (2) White | (3) Asian | (4) Black | (5) Hispanic | (6) Low poverty (non-FRL) | (7) High poverty (FRL) |
|-----------------|--------|----------|----------|----------|-------------|--------------------------|------------------------|
| **Massachusetts** |        |          |          |          |             |                          |                        |
| 0               | 0.550  | 0.597    | 0.582*   | 0.371*   | 0.387*      | 0.622                    | 0.377*                 |
| 1               | 0.302  | 0.291    | 0.311*   | 0.334*   | 0.341*      | 0.283                    | 0.344*                 |
| 2               | 0.102  | 0.081    | 0.086    | 0.180*   | 0.171*      | 0.072                    | 0.173*                 |
| 3               | 0.033  | 0.022    | 0.017*   | 0.076*   | 0.067*      | 0.017                    | 0.071*                 |
| 4+              | 0.014  | 0.008    | 0.003*   | 0.038*   | 0.034*      | 0.005                    | 0.034*                 |
| **Missouri**    |        |          |          |          |             |                          |                        |
| 0               | 0.610  | 0.681    | 0.689*   | 0.295*   | 0.539*      | 0.736                    | 0.440*                 |
| 1               | 0.195  | 0.183    | 0.220*   | 0.236*   | 0.235*      | 0.171                    | 0.227*                 |
| 2               | 0.096  | 0.076    | 0.057*   | 0.186*   | 0.123*      | 0.056                    | 0.150*                 |
| 3               | 0.050  | 0.033    | 0.022*   | 0.128*   | 0.060*      | 0.022                    | 0.088*                 |
| 4+              | 0.049  | 0.027    | 0.012*   | 0.155*   | 0.043*      | 0.015                    | 0.096*                 |

(continued)
### TABLE A2

Nonstructural Mobility and Tenth Grade Test Performance (in Percentiles) Overall and for Student Subgroups

| Number of moves | All | White | Asian | Black | Hispanic | Low poverty (non-FRL) | High poverty (FRL) |
|----------------|-----|-------|-------|-------|----------|------------------------|---------------------|
|                | (1) | (2)   | (3)   | (4)   | (5)      | (6)                    | (7)                 |
| Massachusetts  |     |       |       |       |          |                        |                     |
| 0              | 0.491 | 0.514 | 0.543* | 0.304* | 0.464* | 0.576                  | 0.366*              |
| 1              | 0.255 | 0.250 | 0.276* | 0.268* | 0.260* | 0.247                  | 0.265*              |
| 2              | 0.139 | 0.131 | 0.114* | 0.192* | 0.152* | 0.111                  | 0.180*              |
| 3              | 0.068 | 0.063 | 0.042* | 0.117* | 0.076* | 0.044                  | 0.104*              |
| 4+             | 0.048 | 0.043 | 0.025* | 0.119* | 0.049* | 0.023                  | 0.086*              |
| Missouri       |     |       |       |       |          |                        |                     |
| 0              | 0.491 | 0.514 | 0.543* | 0.304* | 0.464* | 0.576                  | 0.366*              |
| 1              | 0.255 | 0.250 | 0.276* | 0.268* | 0.260* | 0.247                  | 0.265*              |
| 2              | 0.139 | 0.131 | 0.114* | 0.192* | 0.152* | 0.111                  | 0.180*              |
| 3              | 0.068 | 0.063 | 0.042* | 0.117* | 0.076* | 0.044                  | 0.104*              |
| 4+             | 0.048 | 0.043 | 0.025* | 0.119* | 0.049* | 0.023                  | 0.086*              |
| Washington     |     |       |       |       |          |                        |                     |
| 0              | 0.491 | 0.514 | 0.543* | 0.304* | 0.464* | 0.576                  | 0.366*              |
| 1              | 0.255 | 0.250 | 0.276* | 0.268* | 0.260* | 0.247                  | 0.265*              |
| 2              | 0.139 | 0.131 | 0.114* | 0.192* | 0.152* | 0.111                  | 0.180*              |
| 3              | 0.068 | 0.063 | 0.042* | 0.117* | 0.076* | 0.044                  | 0.104*              |
| 4+             | 0.048 | 0.043 | 0.025* | 0.119* | 0.049* | 0.023                  | 0.086*              |

*Indicates significantly different mobility-count shares across groups at the 95% confidence level or higher.
### TABLE A4
**Nonstructural Mobility and Third Grade Test Performance Overall and for Student Subgroups**

| Number of moves | All     | White  | Asian  | Black  | Hispanic | Low poverty (non-FRL) | High poverty (FRL) |
|-----------------|---------|--------|--------|--------|----------|------------------------|---------------------|
| **Massachusetts** |         |        |        |        |          |                        |                     |
| 0               | 53.32   | 56.32  | 56.42  | 35.84  | 35.29    | 57.41                  | 37.29               |
| 1               | 46.05*  | 49.88* | 54.22* | 32.75* | 32.30*   | 52.06*                 | 34.28*              |
| 2               | 39.71*  | 45.09* | 48.73* | 30.03* | 29.32*   | 47.20*                 | 32.30*              |
| 3               | 35.16*  | 41.35* | 40.54* | 27.77* | 27.42*   | 43.69*                 | 30.43*              |
| 4+              | 30.57*  | 36.71* | 37.88  | 24.94* | 25.21    | 38.73*                 | 27.72*              |
| **Missouri**    |         |        |        |        |          |                        |                     |
| 0               | 56.87   | 58.49  | 64.06  | 42.19  | 45.66    | 61.23                  | 46.99               |
| 1               | 50.20*  | 53.89* | 59.13* | 38.06* | 41.20*   | 57.13*                 | 43.12*              |
| 2               | 42.29*  | 47.27* | 46.19* | 33.26* | 38.95    | 50.14*                 | 38.31*              |
| 3               | 37.94*  | 43.40* | 42.99  | 31.41* | 36.29    | 45.87*                 | 35.29*              |
| 4+              | 32.67*  | 38.77* | 38.63  | 27.75* | 31.44    | 36.02*                 | 31.94*              |
| **Washington**  |         |        |        |        |          |                        |                     |
| 0               | 54.28   | 58.34  | 57.69  | 43.46  | 37.80    | 59.84                  | 41.53               |
| 1               | 48.60*  | 52.81* | 54.89* | 37.79* | 33.78*   | 55.67*                 | 39.01*              |
| 2               | 43.69*  | 47.80* | 49.94* | 35.19* | 31.98*   | 51.28*                 | 36.89*              |
| 3               | 39.47*  | 43.44* | 42.85* | 33.15  | 29.94*   | 47.41*                 | 34.62*              |
| 4+              | 36.05*  | 39.80* | 35.40* | 29.91* | 28.98    | 43.92*                 | 33.02*              |

*Note.* See notes to Table A2. FRL = free or reduced-price lunch.
### TABLE A5
Nonstructural Mobility and High School Outcomes, Conditional on Persistent Poverty

| Number of moves | Distribution of nonstructural mobility | Average tenth grade test performance (in percentiles) | Average high school graduation rate |
|-----------------|----------------------------------------|------------------------------------------------------|-----------------------------------|
|                 | Not persistently FRL eligible | Persistently FRL eligible | Not persistently FRL eligible | Persistently FRL eligible | Not persistently FRL eligible | Persistently FRL eligible |
| Massachusetts   |                                 |                                  |                                 |                                  |                                 |
| 0               | 56.77 | 42.51 | 56.49 | 36.90 | 99.24 | 97.56 |
| 1               | 29.85 | 32.44 | 48.90* | 34.05* | 98.04* | 95.72* |
| 2               | 9.37  | 15.62 | 40.12* | 31.12* | 95.19* | 93.02* |
| 3               | 2.82  | 6.42  | 33.36* | 27.93* | 90.40* | 89.84* |
| 4+              | 1.18  | 3.01 | 26.49* | 25.11* | 83.34* | 83.92* |
| Missouri        |                                 |                                  |                                 |                                  |                                 |
| 0               | 64.09 | 48.34 | 58.65 | 42.21 | 98.79 | 96.98 |
| 1               | 18.50 | 23.46 | 52.79* | 39.14* | 94.24* | 90.88* |
| 2               | 8.44  | 14.37 | 43.91* | 36.47* | 89.08* | 86.54* |
| 3               | 4.33  | 7.65  | 38.80* | 33.44* | 80.52* | 80.08* |
| 4+              | 4.64  | 6.18  | 31.55* | 29.82* | 67.15* | 69.53* |
| Washington      |                                 |                                  |                                 |                                  |                                 |
| 0               | 49.18 | 48.4 | 59.83 | 41.68 | 96.23 | 92.75 |
| 1               | 25.44 | 25.49 | 52.11* | 37.81* | 87.11* | 85.03* |
| 2               | 13.76 | 14.42 | 44.68* | 35.12* | 78.26* | 77.97* |
| 3               | 6.76  | 6.96  | 38.61* | 32.56* | 67.81* | 71.45* |
| 4+              | 4.85  | 4.74 | 33.57* | 28.69* | 53.11* | 62.68* |

*Note.* See notes to Table A2. “Persistent poverty” is defined as being FRL-eligible in all Grades 3 to 12. Comparisons using less strict measures of repeated poverty status are shown in Table A6. FRL = free or reduced-price lunch.
| Number of moves | Massachusetts | Missouri | Washington |
|----------------|--------------|----------|------------|
|                | Distribution of nonstructural mobility | Average tenth grade test performance in percentiles | Average high school graduation rate |
| Number of years of FRL eligibility | 0 | 1–3 | 4–6 | 7–9 | 10 | 0 | 1–3 | 4–6 | 7–9 | 10 | 0 | 1–3 | 4–6 | 7–9 | 10 |
| Number | 67.71 | 53.02 | 45.52 | 39.09 | 42.51 | 61.25 | 50.16 | 45.56 | 40.22 | 36.90 | 99.72 | 98.96 | 98.20 | 97.79 | 97.56 |
| 1 | 26 | 32.13 | 32.88 | 34.58 | 32.44 | 56.85* | 46.24* | 41.69* | 37.17* | 34.05* | 99.45* | 97.86* | 97.52 | 96.87* | 95.72* |
| 2 | 5.21 | 10.96 | 14.74 | 16.35 | 15.62 | 50.92* | 40.91* | 38.59* | 33.76* | 31.12* | 98.20* | 96.60* | 96.08* | 93.24* | 93.02* |
| 3 | 0.87 | 2.91 | 4.92 | 6.67 | 6.42 | 46.89* | 38.78 | 33.29* | 30.04* | 27.93* | 95.89* | 95.75 | 93.08* | 89.77* | 89.84* |
| 4+ | 0.21 | 0.99 | 1.93 | 3.3 | 3.01 | 38.80* | 28.67* | 28.48* | 26.01* | 25.11* | 94.70 | 86.31* | 87.92* | 82.74* | 83.92* |

| Number of moves | Massachusetts | Missouri | Washington |
|----------------|--------------|----------|------------|
| Number of years of FRL eligibility | 0 | 1–3 | 4–6 | 7–9 | 10 | 0 | 1–3 | 4–6 | 7–9 | 10 | 0 | 1–3 | 4–6 | 7–9 | 10 |
| Number | 81.34 | 63.51 | 51.79 | 35.62 | 49.93 | 63.32 | 55.32 | 51.14 | 46.85 | 42.14 | 99.52 | 98.66 | 97.55 | 97.09 | 96.63 |
| 1 | 14.83 | 22.57 | 22.82 | 21.65 | 23.03 | 61.87* | 53.52* | 47.89* | 41.49* | 39.31* | 97.55* | 95.53* | 91.67* | 86.43* | 94.80* |
| 2 | 3.04 | 8.87 | 12.52 | 16.95 | 14.06 | 55.56* | 47.27* | 45.56* | 37.86* | 36.33* | 96.10* | 91.14* | 85.94* | 83.09* | 91.70* |
| 3 | 0.61 | 3.46 | 6.10 | 11.46 | 7.28 | 54.37 | 48.43 | 38.39* | 35.20* | 33.30* | 90.08* | 84.94* | 77.43* | 75.00* | 87.78* |
| 4+ | 0.18 | 1.60 | 6.77 | 14.32 | 5.70 | 47.94 | 40.21* | 35.30 | 29.65* | 29.73* | 72.22* | 75.94* | 56.61* | 65.15* | 79.78* |

Note: See notes to Table A2. FRL = free or reduced-price lunch.
Acknowledgments

We gratefully acknowledge financial support from CALDER, which is funded by a consortium of foundations (for more information about CALDER funders, see www.caldercenter.org/about-calder). All opinions expressed in this article are those of the authors and do not necessarily reflect the views of our funders, data providers and partners, or the institutions to which the author(s) are affiliated, and all errors are our own. This work would not have been possible without the support of our state partners, and we make the following acknowledgments and disclaimers regarding the provision of data:

Massachusetts: The authors wish to thank partners at the Massachusetts Department of Elementary and Secondary Education for the provision of data to support this work, and for useful comments from Matthew Deninger, Elana McDermott, and Aubree Webb.

Missouri: The authors wish to thank the Missouri Department of Elementary and Secondary Education for the provision of data to support this work.

Washington: The research presented here would not have been possible without the support of our state Office of Superintendent of Public Instruction through data-sharing agreement 2015DE-030.

The data access instructions and analysis files for this article can be found at https://doi.org/10.3886/E156641V1.

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Notes

1. In states with existing or emerging “early warning systems,” repeated student mobility is a strong candidate for inclusion. The National Forum on Education Statistics (2018) reports that mobility is used by most existing systems, although information on whether longitudinal mobility is considered in most systems is not provided.

2. We set the initial cohorts based on all students who have either third grade math or reading/ELA test scores. Although most students in our initial third-grade cohorts remain in-state in the public school system through high school (about 80%), our samples of state stayers are more advantaged and higher achieving, on average, than the full population (Austin et al., 2021).

3. We do not test for heterogeneity based on whether moves occur mid-year or at the end of the year, although this is a potentially fruitful direction for future research.

4. There are, for instance, K–5, K–6, and K–8 school districts in each of the three states.

5. And, as noted previously, the number of nonstructural moves that we count per year is capped at one.

6. There is also some measurement error in the mobility data stemming from district restructurings and mergers. These can create excess structural and nonstructural moves and will cause very modest attenuation bias in our estimates (because most students do not experience restructurings or mergers). If states collect and send information on longitudinal student mobility to districts and schools per our policy recommendation, data on restructurings and mergers could be used to remove the small amount of measurement error in the data created by these events.

7. In principle, we could improve our measures of mobility if we had access to students’ addresses. This would allow us to distinguish nonstructural moves within districts per the preceding paragraph and, more broadly, would allow us to capture a key dimension of risk we aim to proxy for with nonstructural school moves: residential disruption. However, school mobility may proxy for student risk status independently of residential mobility, and more important, there are limitations of using residential mobility data in practice. The two most prominent concerns are (1) data on students’ addresses will be much more error-prone than their school assignments in any state data system and (2) using address data adds an additional layer of complication to tracking mobility, which combined with the increased measurement error, could inhibit the use of these data by state education agencies.

8. Percentile ranks are cohort-specific and based on the full entry cohort with values imputed for students with missing exam scores (to account for sample attrition over time). Details of the imputation procedure are available from the authors on request.

9. We also observe discrepancies in the number of structural moves across racial groups and groups based on FRL eligibility. This could be driven by the fact that students from disadvantaged backgrounds (e.g., racial minorities and FRL-eligible students) are more likely to attend schools with wider grade bands in the three states we examine.

10. Michelmore and Dynarski (2017) find a similar near-linear relationship between exam scores and the number of grades spent in economic disadvantage.

11. Put another way, within mobility categories there is less variation across student groups in the high-mobility categories than the low-mobility categories.

12. A specific concern would be if our findings over the full 3 to 12 grade span are driven primarily by the association between student outcomes and late-career mobility events. That is, if there is predictive heterogeneity such that moves in the early grades have little or no predictive power over student outcomes but moves in later grades are strongly predictive of negative outcomes. If this were true, states intervening based on early-grade mobility patterns would be misguided. While this scenario does not have a strong theoretical rationale, we cannot rule it out ex ante, which motivates the analysis shown in Figure 5.

13. This finding is also indirectly informative about student mobility associated with the availability of choice schools because charter schools are disproportionately found in the focal MSAs in each state (and in Missouri, charter schools only operate in these MSAs by law). To be thorough, we further examined mobility-outcome gradients within these MSAs excluding moves that involve charter schools. We focus on Massachusetts and Missouri in this exercise as Washington did not have any charter schools before 2014. The mobility gradients are similar regardless of whether moves involving charter schools are included.

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