Abstract Title Page
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Title:
Inequality and Educational Attainment: Evidence from Massachusetts

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Abstract Body

Limit 4 pages single-spaced.

Background / Context:

Description of prior research and its intellectual context.

For the first three-quarters of the twentieth century, educational attainments in the United States grew rapidly as more students than ever before graduated from high school, entered college, and completed a four-year college degree. The increases in educational attainments spurred economic growth and contributed to rising standards of living for several generations of American families. In the past thirty years, however, educational attainments have stagnated, particularly for low-income Americans. As a result, income-related gaps in educational attainments have grown. For example, nearly 80% of students whose families were in the top income quartile nationally attend college, compared to just 29% of students in the lowest quartile (Bailey & Dynarski, 2011).

These gaps are important because education has historically been the key mechanism for intergenerational socio-economic mobility in the U.S. This is even more the case today than 40 years ago because education-related earnings differentials are much greater today than they were in the 1970s (Goldin & Katz, 2008). Thus, large income-related educational disparities threaten a belief that many Americans of all political persuasions hold dear – that education can be a "great equalizer." However, these income-related gaps have been relatively understudied. While the research and policy community has spent a great deal of energy documenting and exploring the important issue of racial gaps in education, less attention has been paid to income-related gaps. Recent evidence suggests that while racial achievement gaps have narrowed over the past few decades, income-related achievement gaps have grown substantially (Reardon, 2011).

Purpose / Objective / Research Question / Focus of Study:

Description of the focus of the research.

We document income-based gaps in educational attainments and marshal evidence to examine the role of schooling and school-related policies in accounting for them. Most of the past evidence on such gaps derives from large, national datasets. These studies are valuable because they provide a broad-based and nationally representative picture of educational inequality. However, these national datasets have several limitations. Most importantly, they typically rely on self-reported data on educational credentials, which are subject to substantial measurement error, and they measure students as of a single point in time rather than following them longitudinally. Our state dataset provides more precise information about when students fall out of the educational pipeline than the national surveys do. Finally, our richer dataset enables us to examine a range of possible mechanisms that may contribute to these gaps.

Most of our analyses are purely descriptive and seek to demonstrate important trends; we note where our analyses support causal conclusions. Specifically, we ask:

1. How do the eventual educational attainments of Massachusetts 8th graders from low-income families compare to those of their peers from more affluent families?
2. How have the educational outcomes of low-income students in Massachusetts changed over the past decade?
3. To what extent do (a) pre-high-school achievement and attendance; (b) school-level factors; (c) student mobility patterns, in-state and across states; and (d) exit examination policies predict these income-based gaps in attainment?

Setting:
Description of the research location.

We focus on data from Massachusetts, a state widely recognized for having developed a successful standards-based reform program and for producing rapid growth in student test scores. The education system in Massachusetts ranks at or near the top of the nation on a wide range of measures. Thus, evidence from Massachusetts provides a case study of the best job the U.S. does in preparing children from low-income families to acquire the skills and educational credentials they need to thrive in a changing economy and society.

Population / Participants / Subjects:
Description of the participants in the study: who, how many, key features, or characteristics.

In most of our analyses, we focus on students who were first-time 8th graders in the 2002-03 and 2003-04 school years. We choose 8th grade because nearly all students in the state are in school in 8th grade; students cannot drop out of school until age 16. Our final dataset includes nearly 155,000 students across the two years.

Intervention / Program / Practice:
Description of the intervention, program, or practice, including details of administration and duration.

Our primary focus is on gaps between low-income and higher-income students. There is growing evidence that living in poverty puts students at serious disadvantage (Duncan & Murnane, 2011). We seek to examine these gaps in detail and to explore how student, school, and state policy factors moderate them.

Research Design:
Description of the research design.

To examine income-related gaps in educational attainments, we use simple cross-tabulations and we fit OLS regressions using each of the attainments of interest as an outcome and controlling for relevant characteristics. Here, we use observational data and present purely descriptive results. To examine how pre-existing student characteristics affect income gaps, we condition on students' standardized 8th grade mathematics test scores and their 8th grade standardized attendance. To examine the role of schools, we include school fixed effects. In all cases, we fit linear probability models for ease of interpretation, although we find nearly identical substantive results with logistic regression models.

We also explore not only whether students attain different levels of education, but also the timing of these educational events using discrete-time survival analysis (Singer & Willett, 2003). For example, we examine when students drop out of school by family income. Here, we develop a person-period dataset, with each period representing one year after students leave 8th grade. We fit discrete-time hazard models using a logistic link function, specifying the hazard of dropping out of school in each period as a function of time and our key predictors, as follows:

(1) $$\text{logit } h(t_{ij}) = [\alpha_1 D_{1ij} + \alpha_2 D_{2ij} + ... + \alpha_J D_{Jij}] + [\beta_1 * LOWINC_i + X_i'\delta] + [\gamma_1 * LOWINC_i x D_{1ij} + ... + \gamma_J * LOWINC_i x D_{Jij}]$$

We represent time as a set of indicators (D_{ij}) and we include the main effect of low family income ($LOWINC_i$) as well as the two-way interaction between $LOWINC_i$ and each of the time period dummies. From this logistic hazard function, we extract fitted hazard probabilities.

Finally, we use a regression-discontinuity design to analyze the effect of barely failing the 10th grade exit examination on students' educational attainments. The state assigns students

to either pass or fail the exit examination on the basis of a rigidly applied cutoff score on the test. As a result, students scoring just on either side of the cutoff have similar academic skills, but are assigned to a different status (see Murnane & Willett, 2011, and Lee & Lemieux, 2010 for detailed discussions). In essence, we are looking for a discontinuous disruption in the probability of earning each educational attainment for students on either side of the cut score. We follow closely the approach laid out by Imbens & Lemieux, 2008.

Data Collection and Analysis:

Description of the methods for collecting and analyzing data.

To address our research questions, we have integrated several datasets provided by the Massachusetts Department of Elementary and Secondary Education. The first comes from the state's longitudinal data system, which tracks students throughout their public school careers (K-12). The dataset indicates whether each student graduates, drops out, transfers out of the public school system (to a private school or to another state), or experiences any of several other outcomes (e.g., dies, etc.). Using the student identifiers, we can create a longitudinal record for each student that records the semester in which each of these events occurs. To these data, we have matched information from the state GED testing service database and information on post-secondary attainment from the National Student Clearinghouse (NSC). Thus, by combining these datasets we can track students throughout the Massachusetts public school system and through college, and we can identify which students earned a GED in Massachusetts.

Findings / Results:

Description of the main findings with specific details.

We document large income-related gaps in educational attainments at each of these levels (see Figure 1). For example, 95% of higher-income 8th graders go on to graduate from high school in Massachusetts in 6 years, compared to just 75% of low-income students. The gaps are even greater for college-going and college persistence. We also track when in the educational pipeline students drop out of the system (see Figure 2); not surprisingly, low-income students drop out of school at greater rates than their higher-income peers at all stages, but this differential is greatest near the end of high school.

Importantly, we find evidence that income-related gaps in both educational credentials and academic skill have narrowed over the past several years, indicating that the state's investments in improving education are paying off (see Figure 3). We also show that low-income students who have spent several years in Massachusetts public schools outperform students who have transferred in from other systems (see Figure 4).

Documenting the income-related gaps in educational attainments is important. However, especially valuable for policymakers is an understanding of their causes and possible solutions. We examine how three important factors contribute to income-related educational gaps. First, much has been written about the importance of early educational experiences in determining later-life outcomes (e.g., Heckman, 2008). Although there are no real educational attainment gaps in 8th grade because nearly all children attend school, low-income students have much lower academic skill levels as 8th graders and demonstrate less attachment to school than their higher-income peers. We find that these differences are important in predicting students' ultimate educational attainments (see Table 1). However, since substantial attainment gaps by income emerge in high school among students who have similar educational profiles and academic achievements as 8th graders, these pre-existing gaps do not tell the entire story.

A second possible explanation is that low-income students tend to attend different – and

perhaps lower-quality – schools than their higher-income peers. Moreover, this pattern is more pronounced in the 1990s than in the 1970s (Altonji and Mansfield, 2011). One likely explanation is that income-based residential segregation increased during the 1980s (Reardon & Bischoff, 2011). Again, though, we find substantial income-related gaps even when we compare students who attend the same school (see Table 2).

Finally, over the past two decades U.S. policymakers have adopted standards-based reform strategies to boost educational performance. These strategies hold schools, and in some cases students, accountable for their scores on state standardized tests. In many states, students have to pass an exit examination to graduate from high school. Because low-income students perform much worse on these tests, on average, than their higher-income peers, these requirements are more likely to bind and to cause low-income students to drop out of school. Not surprisingly, students who fail the exit examination have much lower educational attainments than students who pass it. However, we also find causal evidence that barely failing the high school exit examination in mathematics on the first try reduces the educational attainments of low-income students more than those of higher-income students (see Table 3 and Figure 5). For example, barely failing the exit examination reduces the probability of attending college by 4.5% points for low-income students ($p<0.001$), but not at all for higher-income students.

Conclusions:

Description of conclusions, recommendations, and limitations based on findings.

Clearly, many of our results are descriptive and we cannot state that low family income itself produces these gaps in educational attainments. However, our results suggest several important lessons for educators and policymakers. First, income-related gaps are large and important. They reflect differences in skills and behaviors that emerge early in students' educational careers, often even before they enter the public school system. Early intervention to remediate these gaps is critical. Massachusetts appears to be having some success in this regard. While we cannot yet study the effect of early childhood policies on educational attainments in Massachusetts, our findings that the time a student has spent in the state's public school system is strongly related to their achievement and attainment is heartening. That income-related gaps in both academic achievement and educational attainments are smaller for students who have been in school in the state longer suggests that the system is having some success in closing these gaps.

Furthermore, while early gaps exist, they do not tell the whole story and even high school does not appear to be too late for intervention. Something appears to be happening to low-income students in high school that makes them fall out of the educational pipeline. Even among demographically similar students who persist to 10th grade, have similar test scores, and say that they plan to attend college, low-income students drop out of the pipeline at much greater rates than their higher-income peers. This suggests that high schools matter.

Of course, none of these mechanisms – differences in skills that emerge by 8th grade, school segregation by income, and exit examination policies – fully accounts for income-related gaps in educational attainments that emerge in Massachusetts. The existence of these large gaps, even in a highly-performing state educational system, suggests that much work needs to be done. But, these gaps appear to be narrowing after large investments – both political and financial – in public education in Massachusetts. Understanding the nature of this improvement will require a more detailed analysis of the school-level and classroom-level practices that have facilitated it.

Appendices

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Appendix A. References

References are to be in APA version 6 format.

Altonji, J.G. & Mansfield, R. (2011). The role of family, school and community characteristics in inequality in education and labor market outcomes. In G.J. Duncan & R.J. Murnane, eds., *Whither Opportunity? Rising Inequality, Schools, and Children's Life Chances.* New York: Russell Sage Foundation.

Bailey, M.J., & Dynarski, S.M. (2011). Inequality in post-secondary education. In G.J. Duncan & R.J. Murnane, eds., *Whither Opportunity? Rising Inequality, Schools, and Children's Life Chances.* New York: Russell Sage Foundation.

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Heckman, J.J. (2008). Schools, skills and synapses. *Economic Inquiry*, 46(3): 289-324.

Imbens, G., & Lemieux, T. (2008). Regression discontinuity designs: A guide to practice. *Journal of Econometrics, 142*(2), 615-35.

Lee, D.S. & Lemieux, T. (2010). Regression Discontinuity Designs in Economics. *Journal of Economic Literature, 48*(2), 281-355.

Murnane, R.J. & Willett, J.B. (2011). *Methods matter: Improving causal inference in educational and social science research.* New York: Oxford University Press.

Reardon, S.F. (2011). The widening academic achievement gap between the rich and the poor: New evidence and possible explanations. In G.J. Duncan & R.J. Murnane, eds., *Whither Opportunity? Rising Inequality, Schools, and Children's Life Chances.* New York: Russell Sage Foundation.

Reardon, S.F. & Bischoff, K. (2011). Income inequality and income segregation. *American Journal of Sociology*, *116*(4): 1092-1153.

Singer, J.D., and Willett, J.B. (2003). *Applied longitudinal data analysis: Modeling change and event occurrence.* New York, NY: Oxford University Press.

Appendix B. Tables and Figures
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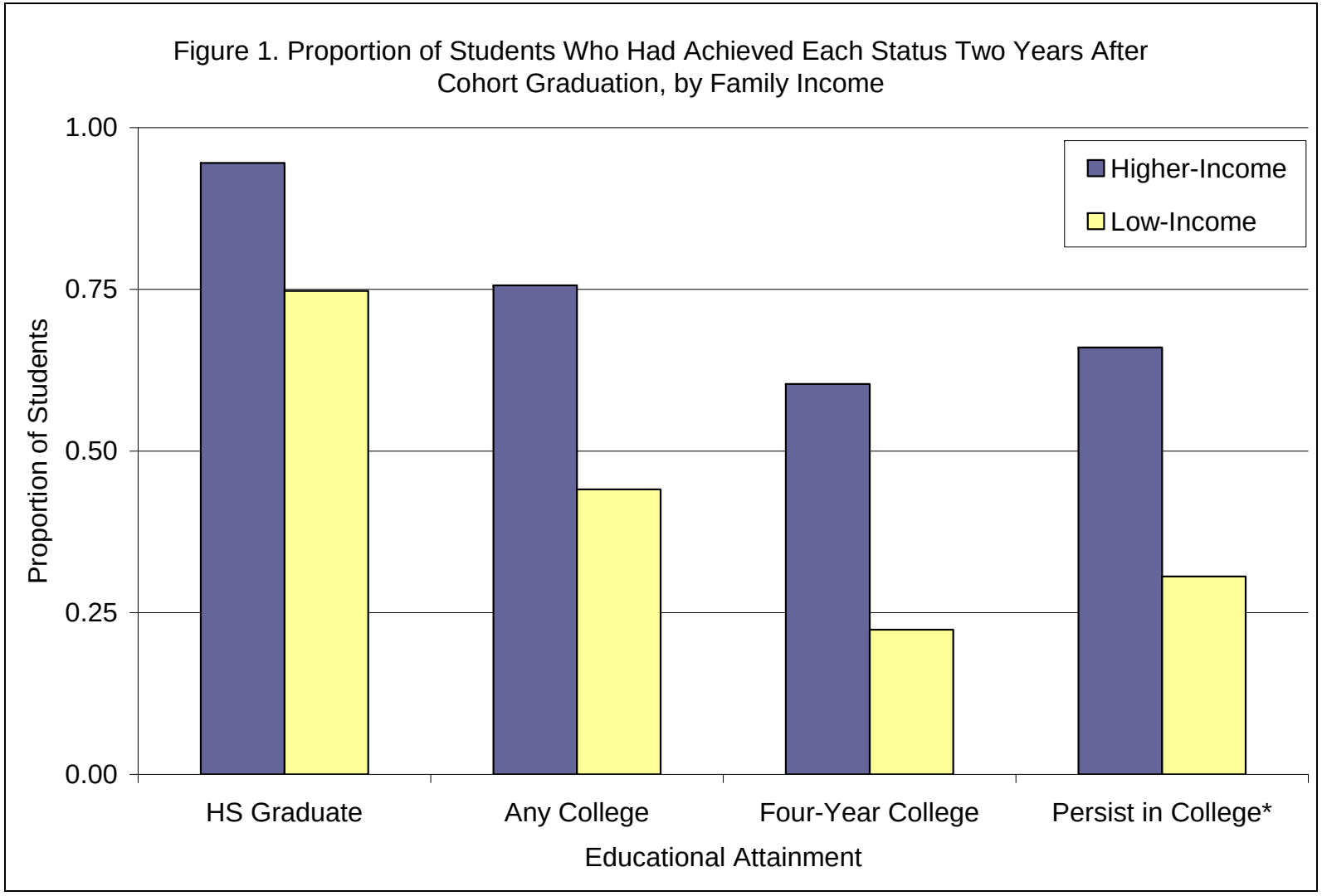
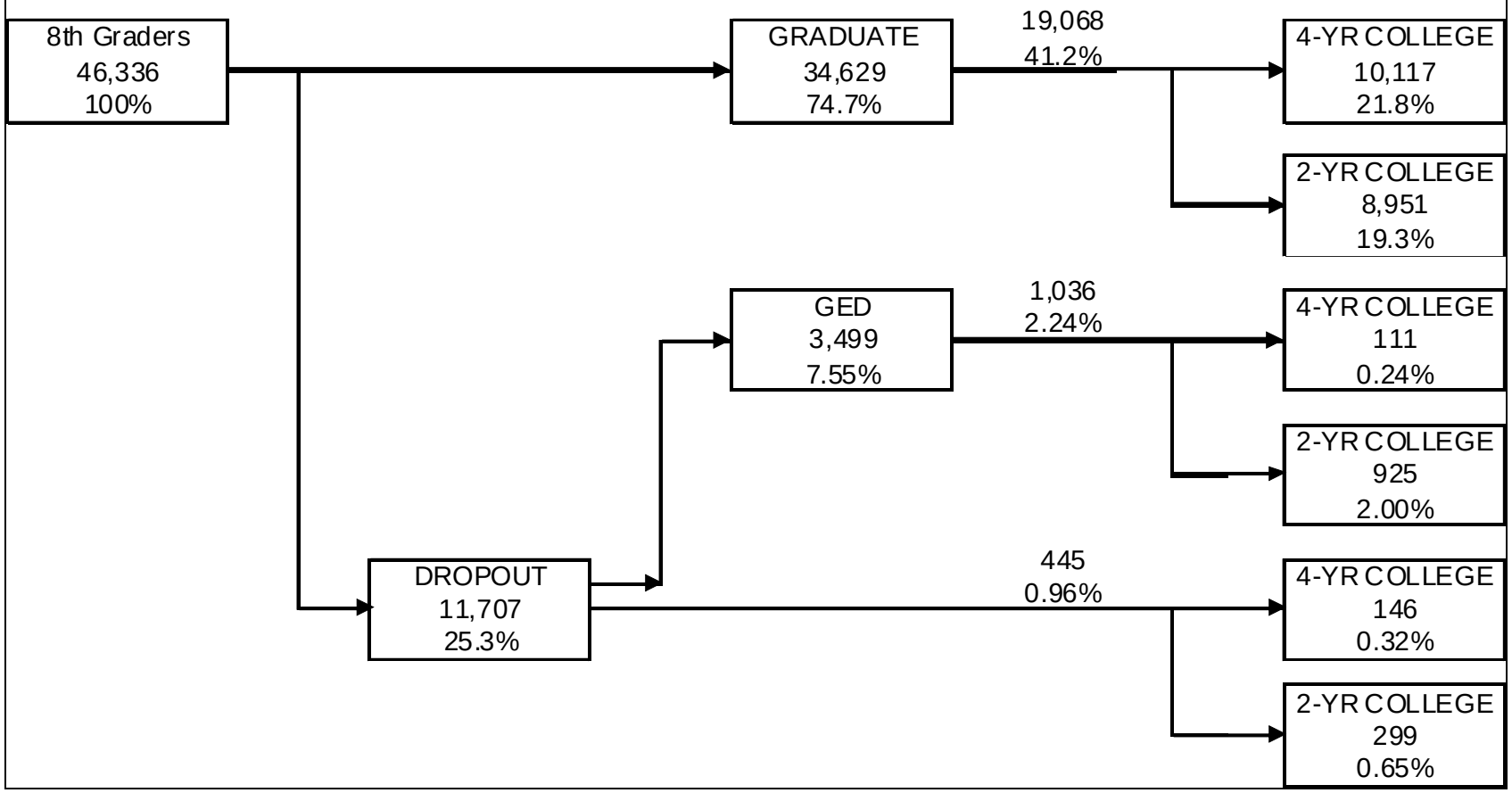


Figure 2. Pathways of Low-Income Students From 8th Grade Through College, with the Percentage of All 8th Graders who Achieve Each Status



NOTE: Percentages refer to the total number of low-income 8th graders. To calculate the percentage of GED recipients who attend college, for example, we could compare the total number of GED recipients who go to college (1,036) to the total number of GED recipients (3,499). Dividing these numbers shows that 29.6% GED recipients attend college.

Figure 3. Income Gaps Over Time: 8th Grade MCAS Mathematics (SD)

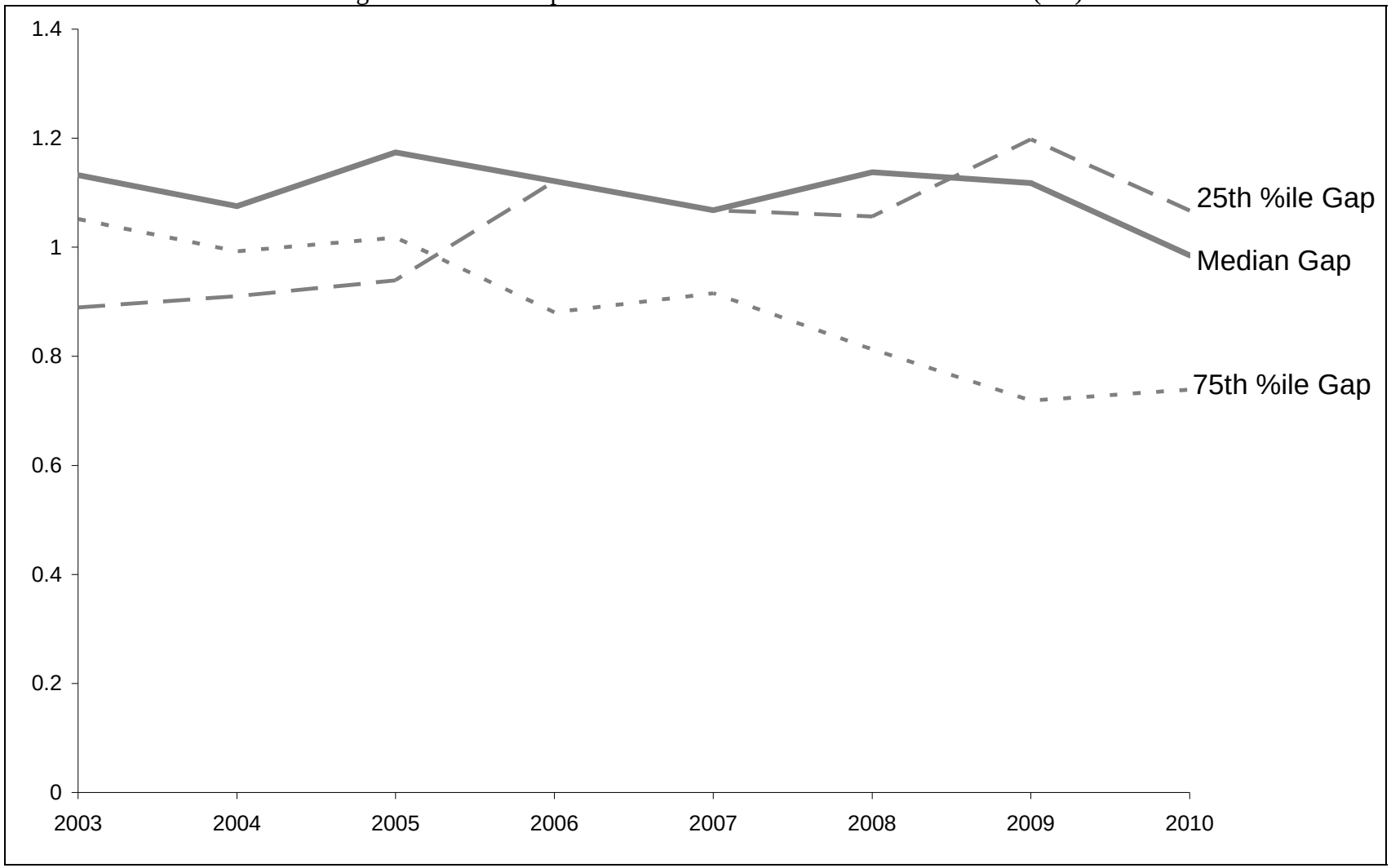
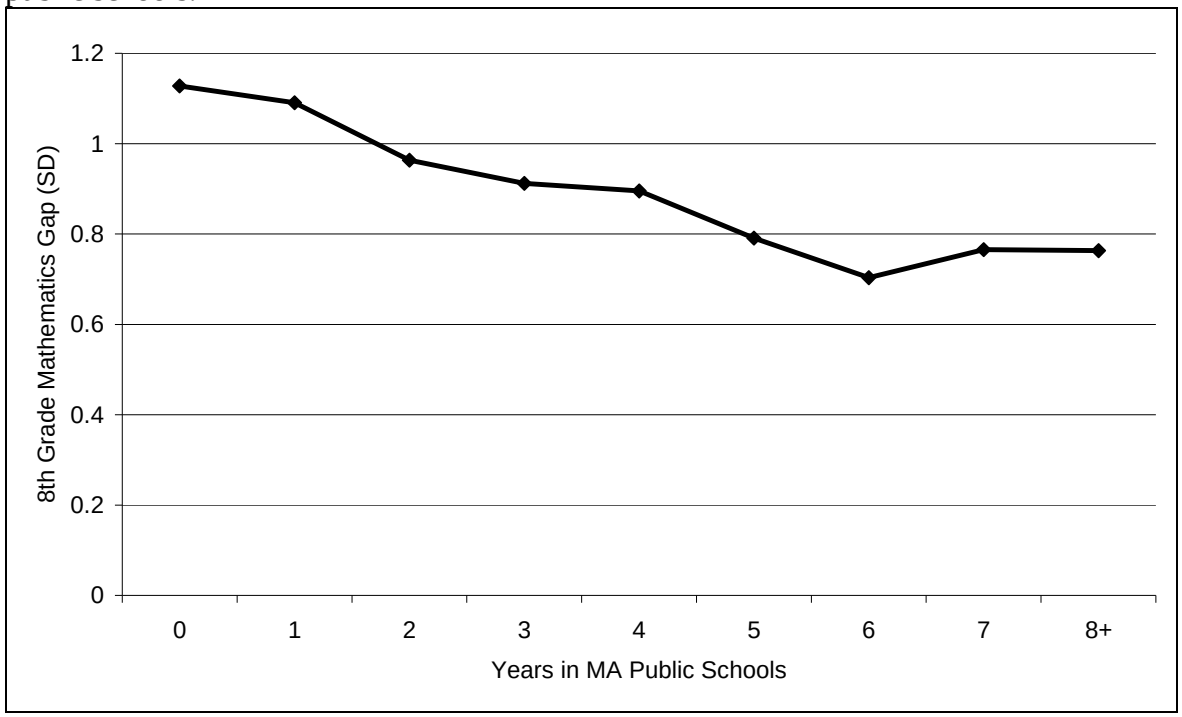


Figure 4. Income gap in 8th grade mathematics MCAS scores for 2010 8th grade cohort, by years in MA public schools (top panel) and the proportion of low-income students who had achieved each status two years after cohort graduation, by amount of time in MA public schools.



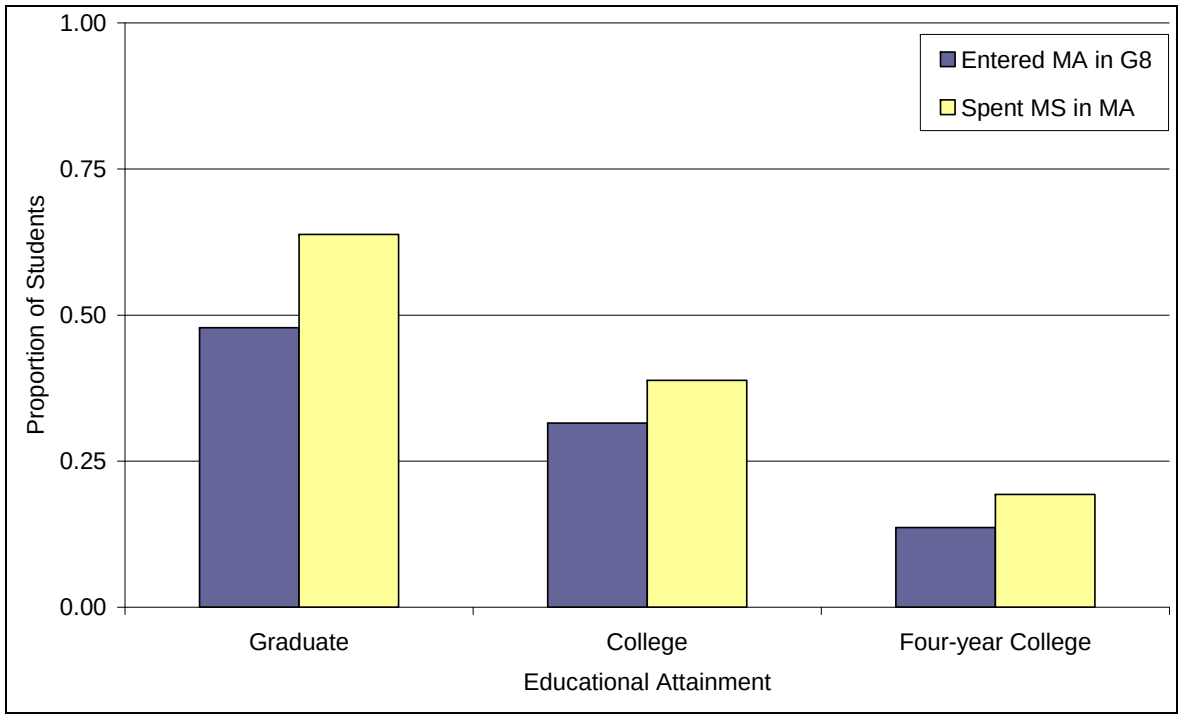

1.00
0.75
0.50
0.25
0.00
Proportion of Students
Entered MA in G8
Spent MS in MA
Graduate
College
Four-year College
Educational Attainment

Figure 5. Fitted local linear-regression relationships between the probability of dropping out (left panel), graduating (middle panel) or attending college (right panel) and 10th grade mathematics score relative to the *Passing/Failing* cutoff (h^*=3), with the sample mean probabilities overlaid, for low-income and higher-income students.

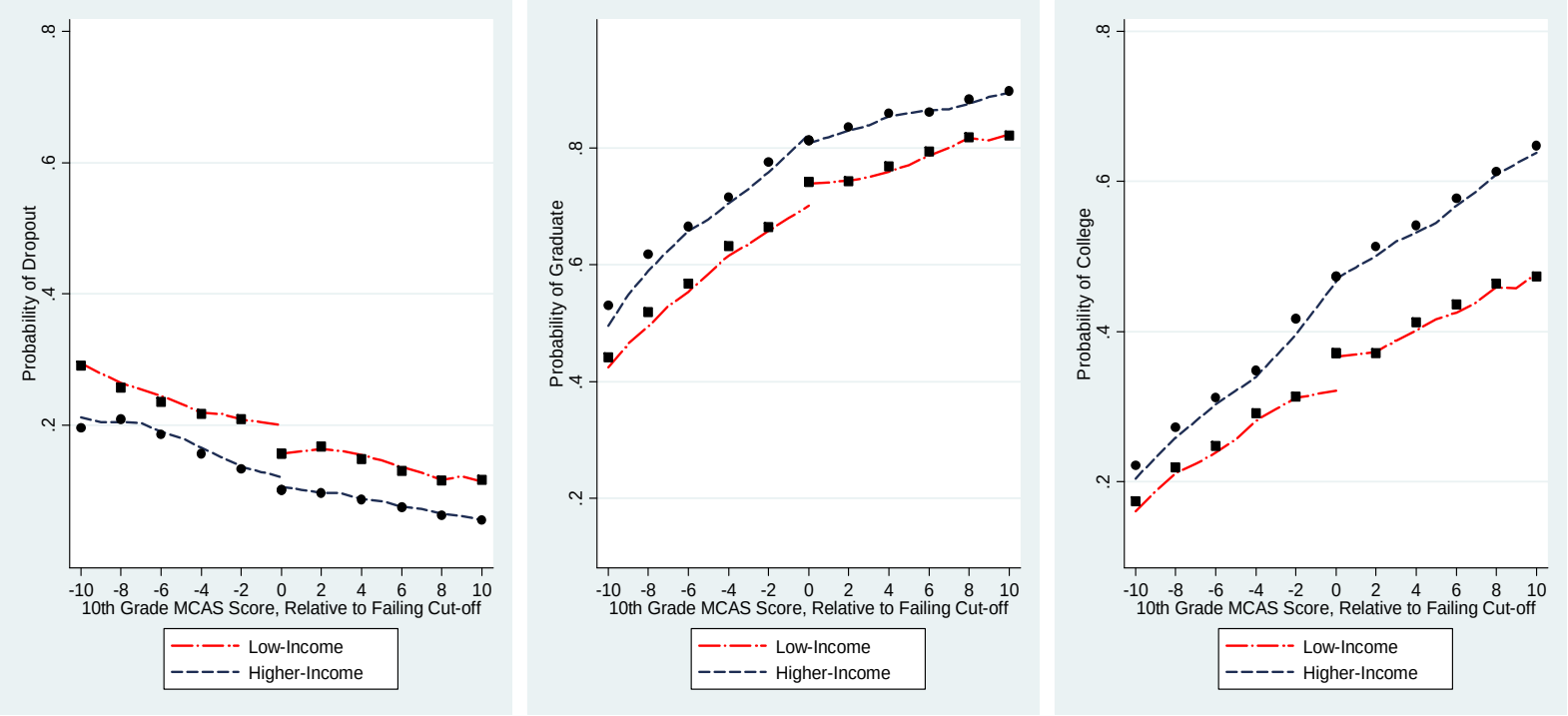


Table 1. Gap in attainments between low-income and higher-income students in the 2002-03 and 2003-04 8th grade with defined high school completion outcomes, controlling for 8th grade student achievement and school attendance, among students with non-missing values on all covariates.

	Overall Income Gap	Income Gap Controlling For:			
		8th Grade Achievement	8th Grade Attendance	Achievement & Attendance	Including Student Demographics
HS Graduate	-0.188	-0.124	-0.144	-0.102	-0.075
Any College	-0.310	-0.178	-0.272	-0.163	-0.163
Four-Year College	-0.378	-0.185	-0.337	-0.173	-0.177
Persist in College*	-0.352	-0.197	-0.315	-0.185	-0.181
Control Predictors					
8th Grade Math Achievement		X		X	X
8th Grade Attendance			X	X	X
Other Student Demographics					X

NOTE: College persistence is one-year persistence and is only measured for 2002-03 8th grade students. Other student demographics include student age in grade 8, indicators for student race/ethnicity, gender, and whether the student was enrolled in special educational services, was limited English proficient, was from an immigrant family, and attended an urban school.

Table 2. Gap in attainments between low-income and higher-income students in the 2002-03 and 2003-04 8th grade, overall and within-school, controlling for student characteristics and grade 8 achievement.

	Overall Income Gap	Within-High-School Income Gap
HS Graduate	-0.075	-0.072
Any College	-0.163	-0.136
Four-Year College	-0.177	-0.138
Persist in College*	-0.181	-0.149

NOTE: College persistence is one-year persistence and is only measured for 2002-03 8th grade students. Other student demographics include student age in grade 8, indicators for student race/ethnicity, gender, and whether the student was enrolled in special educational services, was limited English proficient, was from an immigrant family, and attended an urban school.

Table 3. Causal effect of barely passing the 10th grade MCAS mathematics exit examination on initial and final educational attainments (estimates with p<0.05 are highlighted).

	Low-Income Students	Higher-Income	Difference	Sample Size
HS Dropout	-0.045 (0.008) p=0.002	-0.014 (0.003) p=0.008	-0.032 (0.006) p=0.002	h=3 23,756
HS Graduate	0.037 (0.017) p=0.064	-0.013 (0.003) p=0.003	0.050 (0.018) p=0.032	h=3 23,756
College	0.045 (0.005) p=0.000	0.001 (0.011) p=0.917	0.044 (0.016) p=0.034	h=3 23,756