College Attendance among Low-Income Youth: Explaining Differences across Wisconsin High Schools

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Executive Summary

Nationally and in Wisconsin, economically disadvantaged high school graduates attend college, especially baccalaureates colleges, at much lower rates than their more advantaged peers. Schools play an important role in helping economically disadvantaged students go to college. Indeed, in Massachusetts and Texas, schools vary more in their tendency to send students to college than in their tendency to improve students' test scores (Jennings, Deming, Jencks, Lopuch, & Schueler, 2015). This considerable variation among schools suggests that specific high school characteristics benefit or harm students' postsecondary outcomes. Identifying those characteristics is a step toward equalizing postsecondary outcomes.

We have attempted to identify such school characteristics in Wisconsin. In this report, we describe Wisconsin's economic disparities by postsecondary outcomes, assess the magnitude of between-school variation in school effects on economically disadvantaged students' baccalaureate college attendance, and show which school characteristics explain this variation.

Key findings in this report include:

- The most economically disadvantaged students, those who persistently qualify for free- and reduced-price lunch, are 35 percentage points less likely to attend a baccalaureate college (4-year) than students who never qualify. Even adjusting (or controlling) for differences among students in high school academic achievement, the most economically disadvantaged students are 12 percentage points less likely to attend.
- Wisconsin high schools vary substantially in the extent to which they facilitate baccalaureate college attendance among their economically disadvantaged students. With controls for student characteristics like eighth-grade test scores, an economically disadvantaged student attending one of the schools most likely to send economically disadvantaged students on to baccalaureate colleges is 20 percentage points more likely to attend a baccalaureate college than an economically disadvantaged student attending one of the schools least likely to do so.
- Suburban schools, schools in Milwaukee, and schools near a University of Wisconsin 4-year institution send a greater share of their economically disadvantaged students to baccalaureate colleges, holding constant student characteristics. An economically disadvantaged student who attends high school within five miles of a University of Wisconsin 4-year institution is about 5 percentage points more likely to attend a baccalaureate college than a student whose high school is 40 miles away.
- School organizational features such as student-personnel ratios, course offerings, and expenditures explain little of the between-school variation in economically disadvantaged students' baccalaureate college attendance rates.

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In Wisconsin, racial disparities in K-12 achievement have taken center stage, and justifiably so: the black-white and Hispanic-white test score gap is wider in Wisconsin than in any other state (Wisconsin Department of Public Instruction, 2014). However, Wisconsin also sees inequality along economic lines and disparities in postsecondary outcomes, both of which warrant attention. If Wisconsin is like the rest of the nation, closing its gaps in academic achievement is not sufficient to equalize educational attainment.

Nationally, low-income youth are far less likely to go to college than their more economically advantaged counterparts. A low-income individual is less likely to attend college, especially a baccalaureate (4-year) college, than an economically advantaged individual of even the same academic ability (Belley & Lochner, 2007). At minimum, this disparity is important because college attendance is associated with a hefty wage premium. The value of attending a baccalaureate college for the typical high school graduate is estimated to be $85,000 to $300,000 over the life course, even adjusting for the increasing costs of attendance (Webber, 2016). This premium is driven by those who ultimately earn a degree, but the expected payoff is positive for nearly all high school graduates, even considering the uncertainty of graduating. Disparities in college attendance help keep society stratified, with low-income youth becoming low-income adults and high-income youth becoming high-income adults. In addition, given that increases in statewide educational attainment bring public rewards like increased tax revenue and civic involvement (Baum, Ma, & Payea, 2013), all of Wisconsin stands to benefit when more low-income youth attend college.

A wealth of work has shed light on the important role of primary and secondary schools in boosting low-income students' test scores, but research has given less attention to the contribution of high schools to postsecondary outcomes for economically disadvantaged youth (Jennings, Deming, Jencks, Lopuch, & Schueler, 2015). Using data from Massachusetts and Texas, Jennings and colleagues argue that differences among schools are even more important for college attendance than they are for improving standardized test scores. While their study demonstrates that high schools vary in the extent to which they send students to college, knowledge is sparse on what specific school-level characteristics explain this variation, especially for low-income students. Existing studies use small-scale data or focus on a single school characteristic (Engberg & Wolniak, 2010; Hill, 2008; Turley, 2009).

To determine which types of schools are more successful in sending economically disadvantaged students to baccalaureate colleges, our study uses a relatively dense set of student-level and school-level characteristics. We draw these data from the population of Wisconsin public school students who entered ninth grade for the first time between the 2006-07 and 2011-12 school years. Three principal questions guide this study:

1. How large are economic disparities in college attendance in Wisconsin?

2. How much variation is there among high schools in the share of their low-income students who attend college, controlling for student characteristics?
3. Which high school characteristics explain this between-school variation?

We approach these questions using the Wisconsin State Longitudinal Data System, the National Student Clearinghouse, and the National Center for Education Statistics' Common Core of Data.

This report proceeds in six sections. First, we describe our data sources and measurement strategies. Second, we show the magnitude of economic disparities in postsecondary outcomes in Wisconsin. Third, we demonstrate that school effects vary widely. Fourth, we present estimates of how specific school-level characteristics influence low-income students' postsecondary outcomes, highlighting the importance of geographic characteristics such as location in a suburb, proximity to a University of Wisconsin (UW) 4-year campus, and the education level of adults in the district. Fifth, we examine facets of school organization. Finally, we offer concluding comments.

Section 1: Data and Approach

In this report, the main analytic sample consists of Wisconsin public school students who entered ninth grade for the first time in the 2006-07 through the 2011-12 school years, with the exception of those whose eighth-grade test scores are missing (14% of population[1]), plus those whose primary high school was one of the 67 schools with missing school-level data (1% of population). In total, the sample consists of 352,421 students from 513 high schools. These schools are spread across 382 school districts, 329 of which have only one high school. The student-level data are made available to us by the Wisconsin Department of Public Instruction (DPI) through the State Longitudinal Data System, and they cover information about individual students as well as the schools they attend, including demographics, test scores, and enrollment patterns.

We track high school graduates from Wisconsin into college using data from the National Student Clearinghouse. For every semester, the clearinghouse records the postsecondary institution where students enroll, whether they enroll full- or part-time, and the types of degrees they earn. These data cover between 93% and 97% of all national postsecondary enrollment over the period we study. DPI conducts a data linkage twice per year—in March and November—for all students who graduate from a Wisconsin public high school, and so captures enrollment and degree attainment even long after students have graduated. We include enrollment in all public, private not-for-profit, and private for-profit institutions in our study, and further distinguish among post-secondary institutions in two ways: 2-year versus baccalaureate institutions, and, among baccalaureate institutions, less selective and highly selective, or elite, institutions. We define the latter group as being one of the 236 colleges rated "very competitive plus" or higher in Barron's Profiles of American Colleges (2009). Notably, 57% of low-income college goers that attend an elite college attend UW–Madison. We focus on the first college students attend at least half time within two years of completing high school. This emphasis eliminates dual enrollment

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[1] The majority—about 80%—of these missing students did not attend Wisconsin public middle schools in eighth grade, and according to our correspondence with DPI, were likely enrolled in private schools.

of students taking college courses while in high school as well as transfers after the initial half-time college matriculation.[2] In this report, we focus mainly on the results for baccalaureate colleges generally but note results for elite colleges when they diverge from those for all baccalaureate colleges.

We employ a variety of student, school, and district-level measures in our analysis. We present descriptive statistics for these measures in Appendix A. Students' characteristics include race (white, black, Hispanic, or other/multiple race), sex (male or female), the percentage of observed years students were designated English language learners, whether a student was ever recorded as having a disability, a student's total absences in eighth grade, whether the student was suspended in eighth grade, and a student's eighth-grade math and language arts scores from the Wisconsin Knowledge and Concepts Examination (WKCE). As in many other studies using administrative school data, we are restricted to measuring students' economic disadvantage using their receipt of free- or reduced-price lunch. Students are eligible for reduced-price lunch if their family income is at or below 185% of the federal poverty line, which in the 2015-16 school year was $44,863 of annual income for a family of four (U.S. Department of Agriculture, 2015). Families may qualify automatically because they are registered for other federal programs such as the Supplemental Nutrition Assistance Program, or they may apply for eligibility.

Among students who receive subsidized lunch, those who do for more years tend to have less family income and lower test scores (Michelmore & Dynarski, 2016). In our own data, we observe a large gradient in test scores and college attendance across students' years of measured disadvantage. Therefore, we measure economic disadvantage as the percentage of observed years that students receive subsidized lunch. In our report, we define low-income students as those who receive subsidized lunch for at least one year, and middle/high income students as those who never do. The former category comprises about 44% of ninth graders in Wisconsin, so it may be useful to think of this group as being the bottom half of the family income distribution among the state's public school students. When we refer to persistently disadvantaged students, we mean students who were eligible for subsidized lunch in all observed years.

We also examine characteristics of schools and districts that may be associated with college outcomes. At the school level, we measure average enrollment across the study period, the racial/ethnic composition of students, the percentage of students eligible for subsidized lunch, the student-to-school counselor ratio, the student-to-teacher ratio, the number of Advanced Placement or International Baccalaureate subjects offered, per-pupil educational expenditures, and whether the school is a charter. We additionally measure the segregation of economically disadvantaged students among classrooms within schools using the dissimilarity index.[3] We use data from the American Community Survey aggregated at the school district level in years 2011-2015, made available through the tabulations from the National Center for Education Statistics.

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[2] We experimented with evaluating whether students ever attend a 4-year college and the results are substantively similar, likely because the rate of attendance does not rise very much when such students are included.

[3] In our case, the dissimilarity index can be interpreted as the percentage of students who would have to be moved across classrooms within a school to completely equalize classrooms with respect to free or reduced-price lunch status.

The center classifies districts' urbanicity using 12 categories based on population density and distance from urban centers, which we winnow to six: Milwaukee, Madison, medium to small city, suburb, town, or rural. We also measure median household income, and the percentages of adults 25 and older in each district who are employed and who hold a bachelor's degree or higher.

Section 2: Economic Disparities in Postsecondary Education

Figures 1 and 2 show the educational outcomes of low-income and middle- to high-income students, respectively, who were ninth graders in Fall 2005. Of every 100 of these low-income ninth graders, 72 hold Wisconsin high school diplomas 11 years later, by Spring 2016 (Figure 1). Baccalaureate college entry and completion are both uncommon, with 19 of every 100 low-income ninth graders enrolling in a baccalaureate college and nine of every 100 holding bachelor's degrees or higher by Spring 2016. Low-income students were about as likely to enter 2-year colleges as they were baccalaureate colleges, but degree attainment is especially rare for those who start at 2-year colleges. Of the 18 in 100 who enter a 2-year college, one held a bachelor's degree by Spring 2016, and four held associate's degrees. An additional one of every 100 achieved an associate's degree through "reverse transfer" from a baccalaureate college to a 2-year college.

Figure 1: Educational trajectories of low-income students a decade after they enter high school.

Population: 26,481 low-income ninth graders in 2005-06

FALL 2005 → SPRING 2016

18 2-year
4 associate's
1 bachelor's
2 still enrolled

19 4-year
1 associate's
8 bachelor's
2 still enrolled

100 ninth graders   72 high school graduates   37 college entrants   14 college degrees
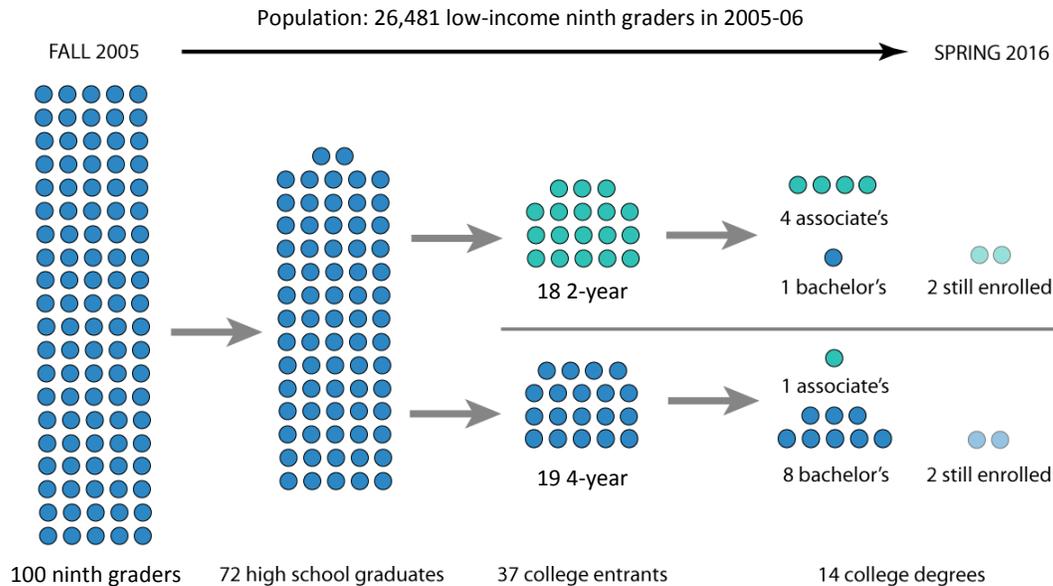
The state of affairs is drastically different for middle- and high-income students (Figure 2). In Fall 2005, of every 100 middle/high-income ninth graders, 92 held high school diplomas and 37 held bachelor's degrees by Spring 2016. Forty-seven entered a baccalaureate college, more than twice the frequency of low-income students who were in ninth grade in 2005. Almost four times the share of middle/high-income students earned bachelor's degrees by 2016 as low-income students. Whereas low-income individuals attended baccalaureate colleges and 2-year colleges at

similar rates, middle/high-income students were more than twice as likely to attend a baccalaureate college as a 2-year college. When middle/high-income students did attend a 2-year college, they were more likely to attain degrees than low-income 2-year college students.

Figure 2: Educational trajectories of middle/high-income students a decade after they enter high school.

Population: 49,097 middle/high-income ninth graders in 2005-06

FALL 2005   SPRING 2016

6 associate's

3 bachelor's   2 still enrolled

22 2-year

2 associate's

47 4-year   34 bachelor's   3 still enrolled

100 ninth graders   92 high school graduates   69 college entrants   45 college degrees
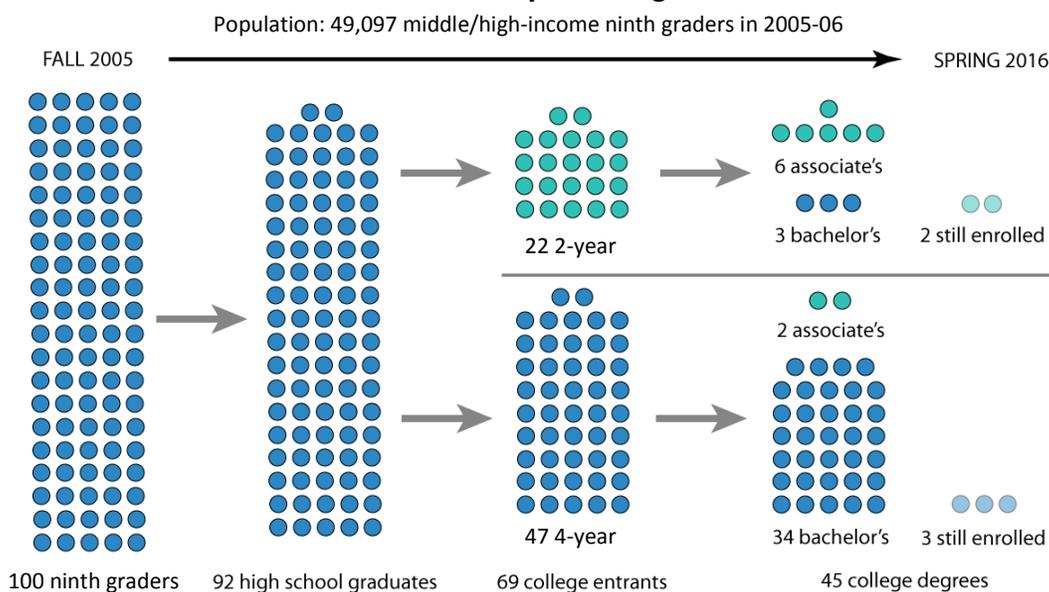
Looking at our main analytic sample of public school students entering ninth grade in 2006-12, rather than those in ninth grade in Fall 2005, we find large unconditional inequality in baccalaureate college attendance. Persistently disadvantaged youth have a baccalaureate college attendance rate of 17%, versus 52% among those who were never economically disadvantaged.

Do disparities in academic achievement fully explain this gap, or do additional mechanisms come into play? To answer this question, we estimate a statistical model of baccalaureate college attendance that gives the association between economic disadvantage and baccalaureate college attendance while controlling for 12th-grade grade-point average (GPA) and 10th-grade math and language arts test scores.[4] Net of high school academic achievement, persistent economic disadvantage is associated with a 12 percentage point drop in the probability of attending a baccalaureate college (see Appendix B for detailed results). Thus, academic achievement does not fully explain economic disparities in baccalaureate college attendance. While 12th-grade GPA and 10th-grade test scores do not fully capture a student's level of academic achievement, unmeasured aspects of achievement would need to be extremely predictive of baccalaureate college attendance to undermine the claim that economically disadvantaged and advantaged students of comparable achievement have unequal attendance rates.

How many college-ready, low-income students forgo attending a baccalaureate college? Since students with high school GPAs of 2.8 have a 50% chance of obtaining a first-year college

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[4] Data on students' coursework and grades are available only in limited years, and thus this analysis consists only of students who finished 12th grade in the 2013-14 school year and only their senior-year grades.

GPA of 2.5 or greater (Sanchez, 2013), we define students as college-ready if they have at least a 2.8 senior-year GPA. About 58% of college-ready, low-income high school graduates do not attend baccalaureate colleges, compared to 31% of middle/high-income high school graduates (Figure 3). In every Wisconsin high school graduating cohort, about 6,000 college-ready, low-income graduates do not enter baccalaureate colleges. These findings suggest that Wisconsin is failing to cultivate the academic potential of numerous low-income youth. This failure harms the individual low-income graduates because they do not reap the private benefits of a 4-year college education, and additionally harms the state as a whole: when a state has more people with bachelor's degrees, its populace enjoys public benefits such as increased tax revenues and civic involvement (Baum, Ma, & Payea, 2013).

Figure 3: Rates of 4-year college attendance among college-ready students, by income group
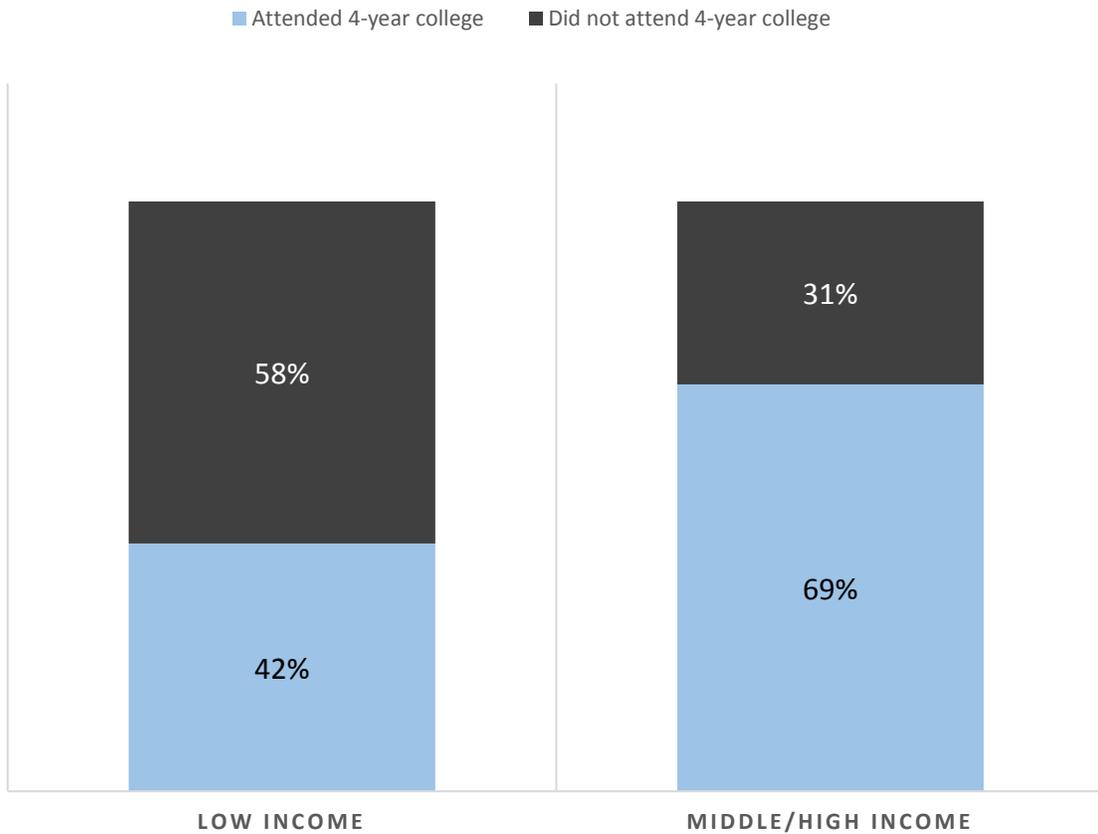
Section 3: Differences across Wisconsin High Schools

Having described the income gap in college attendance in Wisconsin, the next step in our analysis is to assess differences across public high schools. By looking to high schools that are especially effective, we may be able to glean actionable policies that will bring more college-ready low-income students into baccalaureate colleges.

Public high schools serve student populations that differ on a variety of dimensions, and many of those differences are outside the control of high schools themselves. For instance, a high school serving a population whose math achievement in middle school is lower than the state average will likely see fewer students attending college after graduation, but part of this difference will be attributable to events prior to high school. To address variation in the population of students entering different high schools, we use statistical methods that are similar to those typically employed in "value-added" assessments of gains in test scores within classrooms or schools. In estimating the effect of schools on students' postsecondary outcomes, we control for students' math and English standardized test scores in the eighth grade, race/ethnicity, sex, English learner status, disability status, absences, and suspensions in eighth grade (see Appendix D for the technical model specification). Our strategy compares students who are like each other in all the ways we can observe prior to ninth grade but attend different high schools. The estimates that we produce below therefore more closely approximate the effect that attending one high school over another will have on a low-income student. However, we likely do not observe other important student characteristics; the results we present below should be interpreted in light of that fact.

We further distinguish different categories of school effects using a schema motivated by prior research (Jennings et al., 2015; Raudenbush & Willms, 1995). Going to one high school over another could affect students' college outcomes through two broad mechanisms: the context of the school, including factors like the composition of the student body, the surrounding neighborhood, or local economy; and the actual practices and organizational structure of the school, including elements like course offerings, teaching practices, counseling, or leadership. Our estimates of the total effect of schools do not distinguish among these categories. An intuitive way to think about the total effect of the school is what a parent would be interested in knowing about when choosing a high school. In Section 5, however, we explore the measurable features of schools that may be of more interest to policymakers.

Net of demographic characteristics of students and their levels of eighth-grade achievement, how much do high schools vary in the share of their economically disadvantaged graduates they send on to baccalaureate colleges? Figure 4 plots the distribution of these conditional school differences relative to the average Wisconsin school. The least successful high schools reduce the chances their low-income graduates attend college by 10 percentage points net of differences among students in demographic attributes and levels of academic achievement in middle school. On the other hand, the most successful high schools add about 20 percentage points to the chances that their low-income graduates will attend a baccalaureate college. Low-income students who attend high schools in the dark blue region of Figure 4—68th through 95th percentiles of high school effectiveness—are 5 to 11 percentage points more likely to attend 4-year colleges within 2 years of graduating high school compared to the average high school in the state—a substantial boost considering that the overall baccalaureate college attendance rate among low-income students is about 20%. We conclude that high schools can make a substantial difference in the postsecondary trajectories of their low-income graduates. In the following two

sections we look at the features of schools' local contexts or their organizational features that are associated with better outcomes for low-income students.

Figure 4: Variation in school total effects on 4-year college attendance.
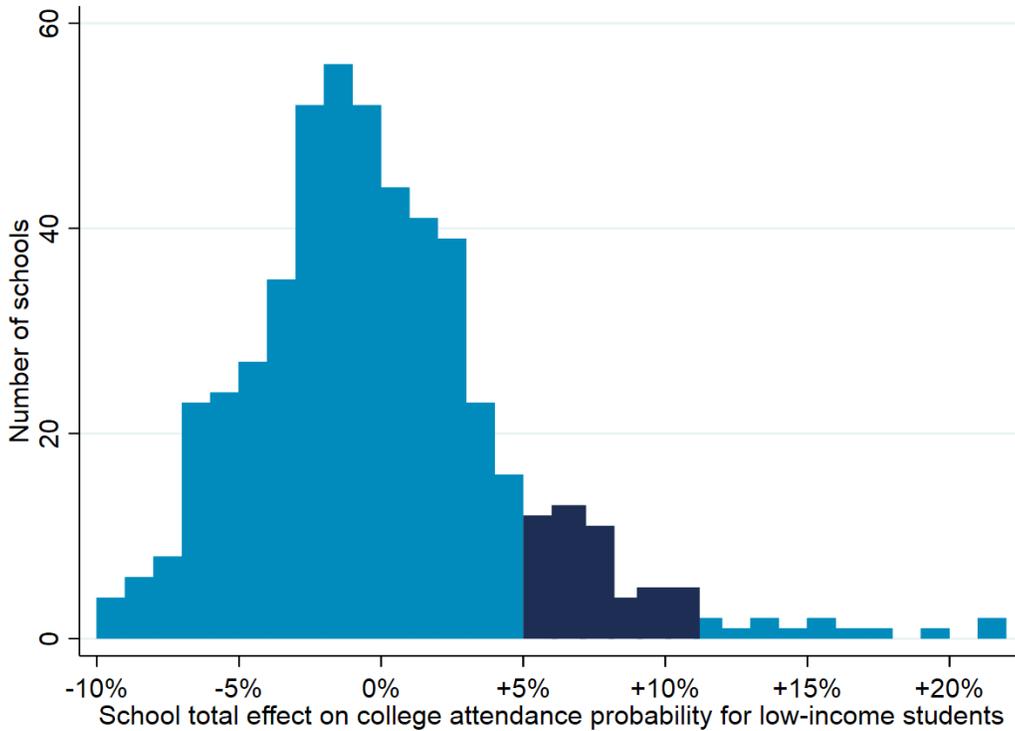
Model controls for eighth-grade test scores and other student-level pre-high school controls. Sample includes all low-income ninth graders entering high school for the first time from 2006 to 2011.

Section 4: Local Geography and Context

Much of the variation that we see across schools also manifests across districts with distinct patterning—geography appears to be significant. To show variation in effects of schools across place, we use districts as the unit of analysis instead of schools and show the result as a map in Figure 5. With students' eighth-grade characteristics held constant, the districts with the largest positive influence, shaded the darkest, are Milwaukee Public Schools and the surrounding districts, some districts surrounding Madison and Green Bay, districts in northwestern Wisconsin near River Falls and Minneapolis, and some districts in the southwest. In general, Wisconsin's more rural areas see less 4-year college attendance than more densely populated areas. On average, a low-income student in Milwaukee is nearly 6 percentage points more likely to attend a baccalaureate college compared to an otherwise similar student living in a rural district. A student in a district classified as suburban is about 3 percentage points more likely to attend compared to a rural student.

Figure 5: Map of district total effects on baccalaureate college attendance.
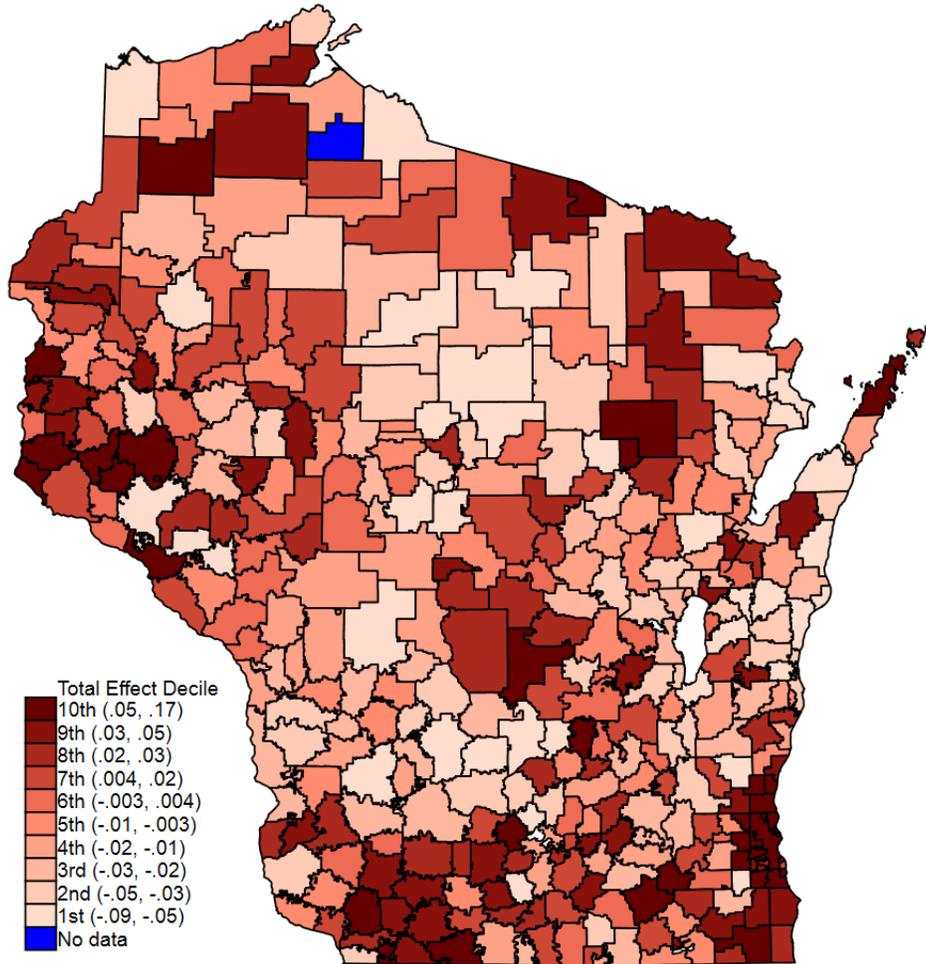
Total effects for districts generated from a model equivalent to the total effects for schools using districts as the cluster variable. Model controls for eighth-grade test scores and other pre-high school controls. Sample includes all low-income ninth graders entering high school for the first time from 2006 to 2011.

The parts of the state with the highest conditional rates of college attendance also tend to be near UW 4-year campuses. In order to investigate the role of distance to college campuses, we measure the linear distances from students' high schools to the nearest UW 4-year and public 2-year campus. We restrict our distance measures to these campuses because public 2-years cover virtually all 2-year enrollment, and the eleven UW 4-year campuses cover 62% of 4-year enrollment among low-income students. Figure 6 shows students' propensity to attend a 4-year college by the distance between their high school and the nearest UW 4-year campus. The relationship between distance and college attendance is strong. On average, a low-income student who attends high school within five miles of a UW baccalaureate college is about 5 percentage points more likely to attend one compared to a student whose high school is 40 miles away, all else equal. Proximity to a college may influence attendance for a few reasons. Students may be more likely to attend colleges nearby because they can live at home and save money. Staying close could help students maintain connections with and draw support from family and friends. Growing up near a college may give students a rich network of college graduates and

other connections to higher education that in turn encourage their attendance. However, we cannot conclusively differentiate among these possible explanations.

Figure 6: Distance to the nearest colleges and 4-year college attendance.
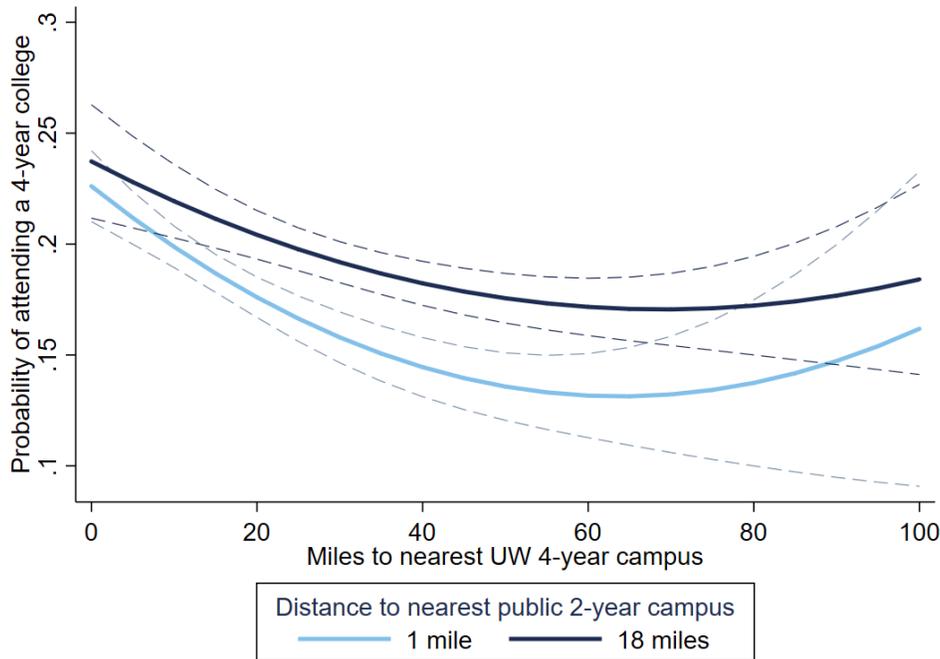
Predicted probabilities are from a model that controls for student demographics, eighth-grade test scores and other pre-high school controls, district-level education, median income, and employment rate. Distance operationalized as a quadratic transformation of nearest 4-year UW campus, a linear term for nearest public 2-year college, and an interaction between the two distance measures. All other covariates held at their sample means. Dashed lines are 95% confidence intervals. Sample includes all low-income ninth graders entering high school for the first time from 2006 to 2011.

The influence of nearby UW 4-year colleges varies by students' high schools' proximity to 2-year colleges. The light blue line in Figure 6 plots predicted probabilities for students whose high school is one mile from a public 2-year college, while the dark blue line plots probabilities for students who are 18 miles from the nearest public 2-year college.[5] Students whose high schools are far from UW 4-year campuses, and yet have a public 2-year college nearby, are less likely to attend a 4-year college. This finding provides suggestive evidence that otherwise similar low-income students may be diverted from a 4-year to a 2-year college if there is one nearby[6]. Past research has shown similar spatial attendance patterns nationally, but has revealed little about mechanisms (Rouse, 1995; Turley, 2009). However, other research has shown that students' and their parents' preferences to remain close to family and community are predictive of whether and where students attend college (Johnson, Elder, & Stern, 2005; Turley, 2006).

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[5] In our sample, 1 and 18 miles are the 10th and 90th percentile of the distribution of distance to the nearest 2-year college, respectively.

[6] In analyses not shown, we find that low-income students are more likely to attend a 2-year college if their high school is farther from a 4-year campus.

To get a better sense of what distinguishes high schools with better outcomes, we also explore the associations among the observable features of schools' local contexts and composition and college outcomes. We include the full set of coefficient estimates from these models in Appendix C. In general, schools with a higher percentage of local adults with bachelor's degrees, a higher proportion of black and Hispanic students, higher average test scores, higher median household incomes, and lower employment rates are slightly more likely to send low-income students to baccalaureate colleges and elite colleges. However, these associations are quite small for baccalaureate college attendance. For instance, a high school in a district that is exceptionally highly educated—concretely, 24% more local adults have bachelor's degrees compared to adults in the average district—increases the probability that a low-income student will attend a baccalaureate college by 2 percentage points. However, the same type of district increases probability that a low-income student attends an elite college by 1 percentage point. This association is more substantial given that the overall attendance rate among low-income students is 2%.

Section 5: School Organizational Features

Though the context and composition findings are suggestive of patterns, these measures are not easy targets of policy to improve low-income students' outcomes—shifting the average education level of the local population or moving closer to a UW college is not a reasonable policy recommendation. However, when we turn to school features we consider easier to manipulate, such as personnel ratios or course offerings, we find little evidence that these factors contribute to variation in the chances that low-income students attending different high schools go on to attend baccalaureate colleges. This finding is striking given the substantial variation across high schools in the characteristics we measure (see Appendix A, panel 2).

Figure 7 presents the results of our analysis of these measures for baccalaureate and elite college attendance. Each point estimate can be interpreted as the change in a low-income students' attendance probability associated with the stated change in each measure, holding constant students' own characteristics, their geographic context, and the composition of their school. School size, school-counselor-to-student ratio, and teacher-to-student ratio are not associated with college attendance among low-income students.[7] The extent to which low-income students are segregated across classrooms within schools also shows no association with college going. Students who attend public charter schools are 2 percentage points less likely to attend baccalaureate colleges than otherwise similar students in non-charter public schools. However, charter schools serve only about 3% of public high school students and may often serve populations that were not successful in other public schools and who are therefore less likely to go to college. Finally, schools that have higher per-pupil expenditures and offer more Advanced Placement and International Baccalaureate courses do send slightly more low-income students to both baccalaureate and elite colleges. This last relationship is intuitive but is not necessarily causal. For instance, a school offering many different advanced classes may simply be responding to demand from its college-bound students. Taken together, these results indicate

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[7] Our findings on school counselors may be especially surprising to some readers. However, the absence of a relationship in our data persists regardless of how we operationalize the measure (e.g., schools' total counselor full-time equivalency) and regardless of which control variables we include.

that many of the resources we expect to matter for low-income youth are not playing a substantial role in the variation we see across schools. However, our analysis leaves open the possibility that school policies or leadership practices we do not measure play a significant role.

**Figure 7: Influence of school organizational features
on college outcomes among low-income students.**
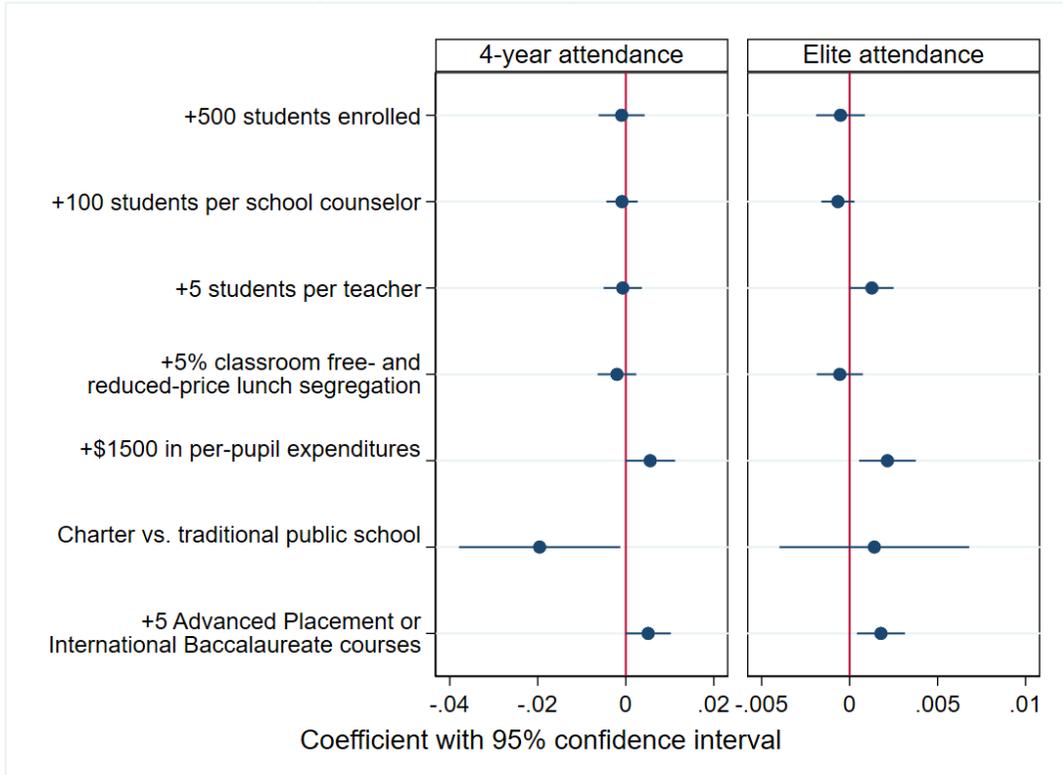
Coefficients are from models that control for student demographics, eighth-grade test scores, and other pre-high school characteristics, as well as district socioeconomic context, school compositional measures, and geographic measures. Each organizational measure is entered in a separate model and scaled to the stated metric unit. Bounds show 95% confidence intervals. Sample includes all ninth graders entering high school for the first time from 2006 to 2011.

Conclusion

This report presents four main findings for college attendance among low-income students at Wisconsin high schools. First, the economic disparity in baccalaureate college attendance is staggering, with the most economically disadvantaged students 35 percentage points less likely to attend baccalaureate colleges than students who are not economically disadvantaged. Second, high schools vary substantially in their propensity to send low-income students to baccalaureate colleges, even accounting for the fact that students at some high schools have characteristics, such as high eighth-grade achievement, that make them more likely to attend even before the high school can influence them. Third, the geographic context of the high school matters considerably—low-income students' baccalaureate college attendance is negatively associated with being far from a four-year UW campus, in a rural area, and in an area where adults have low educational attainment. Fourth, school effects still vary considerably after including our full

set of controls, suggesting the need for qualitative and survey data to help uncover what leads some high schools to send more low-income students to baccalaureate colleges than others.

Economic inequality in baccalaureate college attendance warrants sustained attention in Wisconsin. While inequality in K-12 achievement is hugely important, our findings highlight that inequality does not end at 12th grade. We find a large baccalaureate college attendance gap between economically disadvantaged youth and their more advantaged peers, even controlling for high school academic achievement. Narrowing the achievement gap can go a long way in reducing postsecondary disparities, but the disparities will persist without further attention to other reasons low-income students attend at lower rates.

The important geographic component of low-income students' postsecondary outcomes raises many mechanistic questions. Is proximity to a UW 4-year campus beneficial because it allows students to attend college near (or at) home, or because growing up around a university instills a taste for and familiarity with the university atmosphere? Is rurality unfavorable because baccalaureate colleges recruit less in rural areas, because the labor markets in rural areas offer fewer opportunities for workers with baccalaureate degrees, or for other reasons? Is the educational composition of the adults in the district causally related to low-income students' baccalaureate college attendance, or is the composition merely a proxy for students' own parents' educational attainment? We have strong evidence that the way low-income students are distributed across space is consequential, but we have few clues as to *why*. Any attempt to interpret our geographic results should consider the numerous possible explanations, including those not listed here.

Controlling for all student- and school-level characteristics that we look at, school effects still vary widely: A low-income student attending one of the top 5% of schools most likely to send low-income students on to baccalaureate colleges is 20 percentage points more likely to attend a baccalaureate college than a low-income student attending one of the schools in the bottom 5%. This variation is due to some combination of unobserved student characteristics, geographic context, school composition, and school organizational characteristics. While we have not identified any school organizational characteristics that are strongly associated with low-income students' baccalaureate college attendance rates, we cannot rule out that such characteristics explain part of the remaining variation in school effects, and that some of these characteristics are within the schools' control. The longitudinal data system does not include a lot of information about high school practice, organizational structure, or climate. We applaud the Wisconsin Department of Public Instruction for its recent efforts to increase participation in a school climate survey, which in the past has been taken by only a small, nonrepresentative sample of schools. We are optimistic that greater coverage on this survey will provide insight into how school climate is related to college attendance, as well as other outcomes. Qualitative research provides another possible means to discover school characteristics that promote baccalaureate college attendance, since schools may differ in important ways that no one has thought to measure. Regardless of the means, a search for *manipulable* characteristics of high schools that promote low-income students' baccalaureate college attendance has the potential to guide practice in schools and reduce disparities between low-income students and their more economically advantaged peers.

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Appendix A: Descriptive Statistics for Student, School, and District-level Variables

Variable	Mean	Standard Deviation	Minimum	Maximum
Panel 1: Student level (N = 352,421)				
% years eligible for free or reduced price lunch	0.31	0.40	0	1
White	0.79	-	-	-
Black	0.09	-	-	-
Hispanic	0.07	-	-	-
Other race	0.05	-	-	-
% years English language learner	0.04	0.16	0	1
Ever recorded with a disability	0.16	-	-	-
Wisconsin Knowledge and Concepts Examination eighth-grade math scores	0	1.00	-3.99	3.79
Wisconsin Knowledge and Concepts Examination eighth-grade English language arts scores	0	1.00	-3.60	3.00
Absences in eighth grade	9	12	0	225
Suspended at least once in eighth grade	0.07	-	-	-
Panel 2: School level (N = 513)				
School size	554	528	5	2291
% economically disadvantaged	0.34	0.19	0.00	0.92
% white	0.81	0.24	0.01	0.99
% black	0.08	0.20	0.00	0.98
% Hispanic	0.06	0.10	0.00	0.97
Eighth-grade composite Wisconsin Knowledge and Concepts Examination scores	-0.11	0.43	-1.70	0.87
Student-to-counselor ratio	269:1	144:1	5:1	1248:1
Student-to-teacher ratio	16:1	6:1	3:1	81:1
Classroom segregation (dissimilarity index)	0.29	0.07	0.00	0.69
Charter school	0.13	-	-	-
Per-pupil educational expenditures	$12,123	$1,552	$8,583	$21,163
Panel 3: District level (N = 382)				
Urbanicity:				
Madison or Milwaukee	0.10	-	-	-
Medium or small city	0.10	-	-	-
Suburb	0.19	-	-	-
Town	0.16	-	-	-
Rural	0.46	-	-	-
% adults employed in district	0.81	0.07	0.41	0.97
Median household income in district	$68,105	$17,049	$32,619	$141,250
% adults with bachelor's or more in district	0.23	0.12	0.06	0.83

Sample includes all first-time low-income ninth graders in Wisconsin public schools observed in eighth grade from 2006 to 2011. Measures are calculated at the level indicated by the panel title.

Appendix B: Regression Coefficients Predicting Baccalaureate College Attendance, Specified Using a Linear Probability Model (N = 352,421).

	Coefficient	Standard Error
Percentage of Years Eligible for Free and Reduced Price Lunch	-0.32	0.002
Black (Reference: White)	-0.01	0.003
Hispanic (Reference: White)	-0.06	0.004
Female	0.09	0.002
Percentage of Years as English language learner	-0.05	0.005
Ever Classified as Disabled	-0.24	0.002
Intercept	0.48	0.001

Appendix C: Influence of District Context and School Composition on College Outcomes
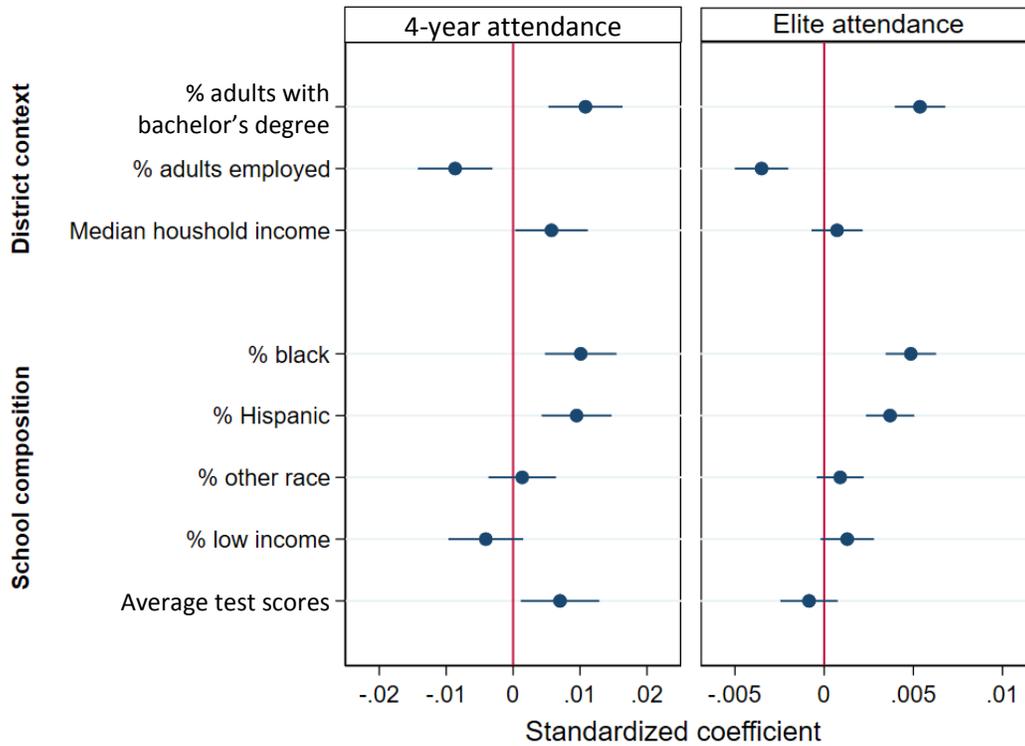
Coefficients are from models that control for student demographics, eighth-grade test scores, and other pre-high school characteristics. Each context and compositional measure is entered in a separate model and scaled to its standard deviation across schools (see Appendix A, panel 2). Bounds show 95% confidence intervals. Sample includes all ninth graders entering high school for the first time from 2006 to 2011.

Appendix D: Methods for School-level Estimates

The model for estimating total school effects is a hierarchical linear model with student-level independent variables; interaction terms between race and the proportion of years eligible for free or reduced-price lunch, between eighth-grade English language arts score and the proportion of years eligible for free or reduced-price lunch, and between eighth-grade math score and the proportion of years eligible for free or reduced-price lunch; and a random intercept for each school. In particular, the model is

$$(1) \qquad \text{COLLEGE}_{ij} = \alpha + \beta_k X_{ijk} + \delta_j + \gamma_l \text{INTERACTION}_{ijl} + \varepsilon_{ij}$$

where COLLEGE_{ij} is a binary indicator of whether student i in school j attended a baccalaureate college, X_{ijk} is the value of the kth student-level variable for student i in school j, INTERACTION_{ijl} is the lth interaction term evaluated for student i in school j, ε_{ij} is the student- and school-specific error term, and α, β_k, δ_j and γ_l are all parameters to be estimated. The student-level variables are those listed in Appendix A, panel 1, with cubic transformations of the eighth-grade test scores. The interaction terms are in place to capture how students' baccalaureate college attendance is less sensitive to their economic disadvantage when they are black and high-achieving. The school-specific intercept δ_j is an estimate of the total effect of school j on low-income students' baccalaureate college attendance. To reduce bias due to students' selection into different schools, this estimate is conditional on student-level characteristics. The estimate is not, however, conditional on any school-level characteristics, including those that the school cannot manipulate, such as its locale type. We therefore distinguish this total effect estimate from a value-added estimate, which measures how efficacious a school is net of factors outside its control.

The general model for estimating the effect of school-level characteristics is

$$(2) \qquad \text{COLLEGE}_{ij} = \alpha + \beta_k X_{ijk} + \delta_j + \gamma_l \text{INTERACTION}_{ijl} + \zeta_m S_{jm} + \varepsilon_{ij}$$

Where S_{jm} is the value of the mth school-level variable for school j, each ζ_m is a parameter to be estimated, and all other expressions are defined as before. The school-level variables are those listed in Appendix A, panel 2, with continuous variables z-transformed. Rather than estimate the effects of all school characteristics simultaneously in a model containing all school-level variables, we estimate the effect of each school characteristic with a unique specification that controls for only those variables we conceive of as potential confounders, not mediators, on the path to baccalaureate college attendance. Therefore, (a) we estimate the effect of each geographic context variable with a model controlling only for student-level variables; (b) we estimate the effect of each school composition variable with a model controlling only for student-level and geographic context variables; and (c) we estimate the effect of each school organizational feature with a model controlling for student-level, geographic context, and school composition variables, but not controlling for other school organizational features. Our design does not exploit exogenous variation in any school-level characteristic, so we cautiously interpret results as only crude estimates of how school characteristics affect baccalaureate college attendance.