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The Impact of Dual Enrollment on College Degree Attainment: Do Low-SES Students Benefit?

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*Dual enrollment in high school is viewed by many as one mechanism for increasing college admission and completion of low-income students. However, little evidence demonstrates that these students discretely benefit from dual enrollment and whether these programs narrow attainment gaps vis-à-vis students from middle-class or affluent family backgrounds. Using the National Education Longitudinal Study (*N *= 8,800), I find significant benefits in boosting rates of college degree attainment for low-income students while holding weaker effects for peers from more affluent backgrounds. These results remain even with analyses from newer data of college freshman of 2004. I conduct sensitivity analyses and find that these results are robust to relatively large unobserved confounders. However, expanding dual enrollment programs would modestly reduce gaps in degree attainment.*

Keywords: *dual enrollment, dual credit, concurrent enrollment, accelerated programs, college completion*

Although college participation rates have increased, especially since the 1980s, the proportion of adults attaining a bachelor's (B.A.) degree has stagnated at about 30% for the past two decades (Hoffman, 2005). Most alarming is the socioeconomic status (SES) disparity in educational attainment where high-SES students are more likely to attain a college degree than low-SES students. These SES gaps are likely to continue and perhaps increase in the future as college costs increase, need-based aid decreases, and high-SES students remain better prepared academically than their low-SES counterparts (Doyle, 2010; Ellwood & Kane, 2000).

These trends in our state of postsecondary education have led several education leaders and policymakers to propose strategies to raise the level of educational attainment, especially for low-SES students. Among the key strategies to accomplish this task is to provide college-level learning experiences in high school such as dual enrollment programs. Dual enrollment provides students with an inexpensive way for them to take college courses and earn college credits while in high school—where some programs offer free (e.g., Florida) or discounted (e.g., Texas and Utah) tuition and fees for students (Hoffman, Vargas, & Santos, 2008).[1] Increasingly, high schools and colleges are forming agreements that offer dual enrollment for students. Dual enrollment programs are present in all 50 states, and 40 states have state-level policies that address dual enrollment (D. Allen, 2010; Karp, Bailey, Hughes, & Fermin, 2005).

Proponents of dual enrollment note several benefits of these programs for students, chief among them are preparation for college coursework and degree attainment (D. Allen, 2010; Hoffman et al., 2008). Indeed, studies show that dual enrollees are more likely to graduate from high school and earn higher grades in college than non-dual enrollees, even after controlling for preexisting student characteristics (D. Allen & Dadgar, 2012; Karp, Calcagno, Hughes, Jeong, & Bailey, 2007; Spurling & Gabriner, 2002). Research further shows that low-SES students may benefit more from dual enrollment than high-SES students (Karp et al., 2007). Several policymakers and educators therefore suggest increasing dual enrollment opportunities for a wider range of students, and some have considered dual enrollment as a way partly to reduce SES gaps in college degree attainment (*Dual Enrollment in Texas*, 2010; Hoffman et al., 2008).

Despite these positive results, prior studies are limited in four ways. First, researchers tend to examine the short- and medium-term influence of dual enrollment, rather than its longer term influence such as college degree attainment. Second, few studies consider the extent to which student self-selection may influence the relation between dual enrollment and college outcomes. Third, few researchers examine whether low-SES students benefit from dual enrollment (but see Karp et al., 2007). Fourth, I know of no studies that test whether SES differences in dual enrollment participation accounts for SES differences in degree attainment.

Given gaps in previous research, the continued SES disparities in educational attainment, and the increased importance of dual enrollment as a viable bridge between high school and college, I assess the influence of dual enrollment on college degree attainment. In my study, I accomplish three objectives. First, I conduct a propensity score matching model with sensitivity analysis to examine the impact of dual enrollment on college degree attainment. Second, I investigate whether the impact of dual enrollment varies by SES. Third, I assess the extent to which dual enrollment serves as a program that reduces SES gaps in college degree attainment. I address three research questions:

Research Question 1: Does participation in dual enrollment influence students' college degree attainment?

Research Question 2: Does dual enrollment benefit students differently based on their SES?

Research Question 3: Is dual enrollment a viable option to reduce SES gaps in college degree attainment?

What Problems Do Dual Enrollment Address?

Concerns Regarding Pre-College Academic Preparation

A driving force behind the popularity of dual enrollment is that these programs address two problems faced in postsecondary education: poor academic preparation among many college entrants and low graduation rates (Bound, Lovenheim, & Turner, 2010; Hoffman et al., 2008). Studies show that academic preparation in high school is a key determinant for college success (Adelman, 2006; J. Allen, Robbins, Casillas, & Oh, 2008; Bound et al., 2010). High school performance also increases students' confidence in their ability to perform in college (Chemers, Hu, & Garcia, 2001). Furthermore, high school coursework exhibits a larger influence on college degree attainment than high school rank and test scores (Adelman, 2006).

Despite the importance of pre-college academic preparation for college success, many students enter college underprepared. A national report shows that approximately 56% of high school graduates are highly qualified for admission at a 4-year institution (Berkner & Chavez, 1997). A consequence to academic underpreparation is the need for remediation, where approximately 28% of entering freshman enrolled in at least one remedial course in reading, writing, or math (Attewell, Lavin, Domina, & Levey, 2006; Parsad & Lewis, 2003).

Proponents of dual enrollment consider these programs as a means to prepare students for the rigors of college coursework (D. Allen, 2010; Hoffman et al., 2008). College courses allow high school students the opportunity to explore ideas that go beyond the scripted standards of the high school curriculum (Olszewski-Kubilius, 1998). Prior studies tend to support the contention that dual enrollment improves students' academic preparation for college. Students felt that they had a better understanding of the requirements necessary to succeed in college after they participated in dual enrollment (Marshall & Andrews, 2002; Medvide & Blustein, 2010). Research further shows that dual enrollees are less likely to participate in math remediation than non-dual enrollees (Kim & Bragg, 2008).

Concerns Regarding College Completion

In the past 70 years, the college participation rate of high school students has increased almost eightfold, from 9% in 1939 to 70% in 2009 (Clotfelter, Ehrenberg, Getz, & Siegfried, 1991; National Center for Education Statistics [NCES], 2011). Despite the increase in college participation, a notable portion of students do not attain a degree. In 2004, about one-third of first-time, full-time students did not reenroll at their college in the fall of the following year. About 57% of students who seek a bachelor's degree at a 4-year institution attained a bachelor's degree within 6 years of entry (Knapp et al., 2005; NCES, 2011).

An important factor that influences college completion is sufficient credit accumulation in the first year of college. Adelman (2006) estimates that 20 credits in a student's first year of enrollment significantly increase his or her likelihood to attain a college degree. Dual enrollment helps students reach the credit threshold and these programs help students secure a "nest egg" that builds academic momentum toward attaining a college degree (Karp et al., 2007; Swanson, 2008). A quarter of all students who attained a college degree earned at least 9 college credits through an accelerated program (Adelman, 2004). Swanson (2008) estimates that dual enrollees are 12% more likely to enroll in college within 7 months of high school graduation than non-dual enrollees.

Researchers find that dual enrollees are more likely to persist in college and attain a college degree than non-dual enrollees (Karp et al., 2007; Morrison, 2008; Swanson, 2008). For instance, Morrison (2008) estimates that participation in dual enrollment increases the odds of attaining an associate's degree by 61%. Swanson (2008) further finds that dual enrollees are 16% to 20% more likely to attain a bachelor's degree than non-dual enrollees. The lack of academic preparation and low college completion rates of several students have led some policymakers and educators to consider dual enrollment as a way to bridge the transition between high school and college. Moreover, policymakers have considered whether these programs can improve academic preparation and college completion for a wider range of students.

The Equity Agenda of Dual Enrollment

Research shows SES disparities in academic preparation and educational attainment. Approximately 26% of college students from the bottom quartile of the income distribution attained a degree by age 25 as compared to 59% of college students from the top quartile of the income distribution (Haveman & Wilson, 2007). Studies further show that high-SES students are more likely to participate in coursework that better prepares them for college than their low-SES counterparts (Lucas, 2001). Approximately 36% of high school graduates without parents who attended college are highly qualified for admission at a 4-year institution. By contrast, 64% of high school graduates with at least one college-educated parent (e.g., bachelor's degree or higher) are highly qualified for admission at a 4-year institution (Berkner & Chavez, 1997). It is not surprising, therefore, that high-SES students are more likely to participate in dual enrollment than low-SES students (Museus, Lutovsky, & Colbeck, 2007).

Given SES differences in dual enrollment participation and the potential benefits of these programs for college success, several proponents of dual enrollment have pushed forth an equity agenda where dual enrollment reaches a wider range of students. These proponents are interested in the extent to which dual enrollment can serve as a means to improve postsecondary outcomes for low-SES individuals (Bragg, Kim, & Barnett, 2006; Hoffman et al., 2008). Some even propose that equal access to dual enrollment programs may help mitigate SES gaps in college outcomes (*Dual Enrollment in Texas*, 2010; Hoffman et al., 2008).

Although dual enrollment programs have increased in popularity, research on the influence of dual enrollment on college outcomes is in its early stages, especially for degree attainment (Bailey, Hughes, & Karp, 2002; Karp et al., 2007). Early studies of dual enrollment matched students along few dimensions

(Perkings & Windham, 2002; Spurling & Gabriner, 2002). More recent studies considered multiple factors that influence a student's selection into dual enrollment (Delicath, 1999; Karp et al., 2007; Kim & Bragg, 2008; Morrison, 2008; Swanson, 2008). Although these studies improve on earlier research, dual enrollees may continue to differ from non-dual enrollees in ways that are unknown to the researcher. These studies devote less time in assessing the sensitivity of their results to unobserved confounders. Moreover, unequal access to dual enrollment across socioeconomic divides becomes relevant if low-SES students actually benefit from participation. With few exceptions (e.g., Karp et al., 2007), prior studies assume that dual enrollment benefits all students without considering that these programs may not improve college outcomes for low-SES students. It is therefore important to examine the influence of dual enrollment on college degree attainment and whether these influences equally benefit all students or only high-SES students, for example.

Methods

I conduct propensity score matching models to estimate the impact of dual enrollment on college degree attainment and I further assess the sensitivity of results to potential unobserved confounders that influence both selection to dual enrollment and degree attainment. I construct an assignment or selection equation where I estimate the likelihood that a student participates in dual enrollment ($D = 1$). The propensity score or the probability of a student, with a set of observed characteristics, participating in dual enrollment is (Morgan & Winship, 2007):

$$P(Z) = Pr(D = 1 \mid Z). \tag{1}$$

I assume that adjusting on the propensity score leads to a simulation of randomization on the conditional distribution of covariates and program assignment (Morgan & Winship, 2007):

$$(Y_1 Y_2) \perp\!\!\!\perp D \mid Pr(Z). \tag{2}$$

I am therefore able to estimate the program effect by matching dual enrolled participants with observationally equivalent—based on the propensity score—nonparticipants.

I use kernel matching to match individuals. For each individual who participated in dual enrollment, kernel matching uses all nonparticipants but weighs each nonparticipant based on his or her distance from a participant (Heckman, Ichimura, & Todd, 1998). Nonparticipants who are closest to the participant are given the greatest weight while nonparticipants who are furthest to the participant are given the least weight.

The propensity score matching model assumes selection on observables. However, unknown confounders may continue to influence program selection and college degree attainment. I assess the sensitivity of estimates from the propensity score model to potential unobserved confounders. I do so by simulating an unobserved confounder on program assignment and outcome.

Recall that the propensity score model assumes that Y_1 and Y_2 are independent of D given $Pr(Z)$, which researchers sometime refer to as the conditional independence assumption (CIA). Suppose that the CIA is not satisfied given the set of observed covariates. Suppose, however, that the CIA is satisfied if the researcher is able to observe a previously unobserved binary covariate (U) that relates to both the program assignment and response. I identify the distribution of the unobserved confounding U by specifying the parameters (Ichino, Mealli, & Nannicini, 2008):

$$\begin{aligned} &Pr(U = 1 \mid D = i, Y = j, X) = \\ &Pr(U = 1 \mid D = i, Y = j) = p_{ij} \ , \end{aligned} \tag{3}$$

where i represents program assignment and j represents outcome value, with $i, j \in \{1, 2\}$.

I artificially create and use this unobserved covariate as an additional indicator in the selection model. Manipulating the parameters p_{ij}, I assign hypothesized associations of U to selection and response and obtain program estimates under different manipulation schemes. Comparing the program estimate between models with and without the simulated variable U, I am able to assess the extent to which the program estimate is robust to targeted failures of the CIA (Ichino et al., 2008).

Data

I use data from the National Education Longitudinal Study of 1988 (NELS:88) to estimate the impact of dual enrollment on college degree attainment. The NELS:88 base year sample consists of eighth-grade students in 1988. Investigators administered follow-up questionnaires to respondents in 1990, 1992, 1994, and 2000 (Curtin, Ingels, Wu, & Heuer, 2002). Because of my interest in college degree attainment, I use the fourth follow-up survey and limit the sample to respondents who attended a postsecondary school. I compare those who participated in dual enrollment to those who participated in other high school programs (e.g., traditional and Advanced Placement [AP] programs), which leaves a sample of 8,800.

NELS:88 investigators collected information about dual enrollment participation for only those who attended a postsecondary school. Therefore, these estimates capture the influence of dual enrollment on college degree attainment for those who participated in college. However, individuals who did not attend college are likely different from dual enrollees and as a result may provide a poor comparison group for dual enrollees. Nevertheless, in prior analysis (not shown), I estimated an additional selection model that captures the likelihood that a student attends college. I used the inverse probability of attending a college as a weight and found that estimated effects of dual enrollment on college degree attainment did not substantially change with the inclusion of the weight.

I use multiple imputation techniques to handle missing information, in which I create 10 replications of the data. I include the dependent variable in the imputation approach but later remove imputed values of the dependent variable because these values add little to regression estimates and may induce noise in estimates (von Hippel, 2007).

Dependent and Independent Variables

The first dependent variable is a binary outcome of whether a student attained any postsecondary degree and the second dependent variable is whether a student attained a bachelor's degree. For both indicators, a value of 1 represents a student who attained a degree. The independent variable is whether a student participated in dual enrollment.

Control Variables for the Selection Model

The control variables include a rich array of indicators that influence dual enrollment participation and college degree attainment (see appendix for a description of variables). These measures include race, gender, parental education, parental occupation, family income, family structure, and the number of siblings. I measure race as Black, Asian, Latino, and White (omitted category). I drop Native Americans from analyses due to their small number in the sample.

I include several indicators that capture the role of significant others on schooling outcomes. A teacher or counselor's college aspiration for a student is based on whether a student's favorite teacher or school counselor thought that going to college was the most important thing for the student to do right after high school. Parent-child academic discussions is based on the frequency in which parents discussed school academics and activities with their child and the frequency in which parents discussed college and college preparation with their child. The next two indicators measure the frequency in which parents discussed postsecondary educational plans with other parents and the frequency in which parents contacted their child's school to discuss postsecondary plans. I further include indicators that capture friends' influence on schooling outcomes, such as whether a student's close friend dropped out of high school and the importance of academics among the student's friends.

I include early college aspirations and expectations and indicators that capture what a student considers important when choosing a college (surveyed at the 10th grade). Measures include the importance of college costs, the reputation of a college's academic programs, and the importance of easy admission standards when choosing a college.

I include academic indicators such as the extent to which a student was unprepared for class and the number of days a student was absent from class. Other academic indicators include whether students repeated a grade, their 10th-grade test scores, and their course history. Burkam (2003) and Burkam and Lee (2003) have identified and organized course-taking patterns into a quantitative metric, which they refer to as an academic pipeline. Coursework rigor by 11th grade captures academic pipeline.

TABLE 1
Effects of Dual Enrollment on Degree Attainment

	Panel A	
Main program effect	Any degree	B.A. degree
Propensity score matching	.08***	.07***
	(.02)	(.02)

	Panel B	
Effects by socioeconomic status (SES)	Any degree	B.A. degree
Parental education		
High school or less	.08*	.08*
	(.04)	(.04)
Some college	.09**	.06†
	(.03)	(.03)
Bachelor's degree	.03	.01
	(.04)	(.04)
Post-bachelor's	.04	.05
	(.03)	(.03)

Note. National Education Longitudinal Study of 1988 (NELS:88). Standard errors are in parentheses. Sample size is 8,800.
†$p < .10$. *$p < .05$. **$p < .01$. ***$p < .001$ (two-tailed).

I include contextual school factors that influence opportunity, such as school sector, urbanicity, median household income in a school's zip code, racial composition, school climate, and course offerings. These course offerings include several types of academic programs (e.g., regular, AP, and college level) that schools offer. Finally, proximity to college is the distance of a nearest college to a high school based on the central point of each zip code area (in miles).

Results

Panel A of Table 1 shows the impact of dual enrollment on college degree attainment from the propensity score matching model. Results show that dual enrollment participation increases the likelihood of degree attainment, even after accounting for covariates. Dual enrollment participation increases the probability of attaining any postsecondary degree and a bachelor's degree by 8 percentage points and 7 percentage points, respectively.

Results thus far confirm prior studies that show a positive impact of dual enrollment on college degree attainment. These findings hold in spite of accounting for observed covariates that affect selection into dual enrollment. However, propensity score matching assumes that, once conditioning on covariates, selection into dual enrollment is unrelated to unobserved indicators that affect college degree attainment. In the next section, I examine the sensitivity of results from propensity score matching models to potential unobserved confounders.

Setting aside Panel B of Table 1, I draw attention to the sensitivity analysis in Table 2. I begin with the assumption of unconfoundedness—a general assumption of propensity score matching—and then examine how the results hold to measured violations of this assumption. The sensitivity analysis shows results of simulated estimates based on incremental changes to the values of p_{ij}. I create a two-by-two table of different configurations of selection and outcome effects of U where columns represent selection effects ($s = p_{1\bullet} - p_{2\bullet}$) while rows represent outcome effects ($r = p_{21} - p_{22}$). A selection effect (s) of .05 indicates that the unobserved confounder U produces a 5 percentage point increase in the marginal probabilities of participating in dual enrollment. Similarly, an outcome effect (r) of .05 indicates that U produces a 5 percentage point increase of attaining a degree among untreated individuals.

Within each cell of the two-by-two table, I report simulated estimates of dual enrollment based on properties of the unobserved confounder U. Results in bold represent statistically significant effects and values in the brackets

TABLE 2

Effect of "Killing" Confounders on the Relation Between Dual Enrollment and Degree Attainment

Any degree	Selection effect (*s*)						
Outcome effect (*r*)	0.05	0.10	0.15	0.20	0.25	0.30	0.35
0.05	**0.07**	**0.07**	**0.07**	**0.07**	**0.06**	**0.06**	**0.05**
	[1.3, 1.4]	[1.3, 1.7]	[1.3, 2.2]	[1.2, 2.7]	[1.2, 3.3]	[1.2, 4.0]	[1.2, 4.9]
0.10	**0.07**	**0.07**	**0.07**	**0.06**	**0.06**	**0.05**	**0.04**
	[1.7, 1.3]	[1.6, 1.7]	[1.6, 2.1]	[1.5, 2.7]	[1.5, 3.3]	[1.5, 4.1]	[1.5, 5.0]
0.15	**0.07**	**0.07**	**0.06**	**0.06**	**0.05**	**0.05**	**0.04**
	[2.1, 1.3]	[1.9, 1.7]	[1.9, 2.1]	[1.8, 2.6]	[1.8, 3.3]	[1.8, 3.9]	[1.8, 4.9]
0.20	**0.07**	**0.07**	**0.06**	**0.05**	**0.05**	**0.04**	*0.03*
	[2.7, 1.3]	[2.5, 1.7]	[2.3, 2.1]	[2.2, 2.6]	[2.2, 3.2]	[2.2, 3.9]	[2.2, 4.9]
0.25	**0.07 (p, a)**	**0.06**	**0.06**	**0.05**	**0.04**	*0.03*	0.02
	[3.6, 1.3]	[3.2, 1.7]	[2.9, 2.1]	[2.8, 2.7]	[2.7, 3.2]	[2.7, 4.0]	[2.7, 4.9]
0.30	**0.07**	**0.06 (c)**	**0.05**	**0.05**	**0.04**	0.02	0.01
	[4.9, 1.3]	[4.1, 1.7]	[3.6, 2.1]	[3.4, 2.6]	[3.3, 3.2]	[3.3, 4.0]	[3.5, 5.0]
0.35	**0.07**	**0.06**	**0.05**	**0.04**	0.03	0.01	–0.01
	[7.6, 1.3]	[5.9, 1.7]	[5.1, 2.1]	[4.7, 2.6]	[4.5, 3.2]	[4.6, 4.0]	[4.8, 4.8]

B.A. degree	Selection effect (*s*)						
Outcome effect (*r*)	0.05	0.10	0.15	0.20	0.25	0.30	0.35
0.05	**0.06**	**0.06**	**0.06**	**0.05**	**0.05**	**0.05**	**0.04**
	[1.3, 1.3]	[1.3, 1.7]	[1.2, 2.1]	[1.2, 2.7]	[1.2, 3.3]	[1.2, 4.0]	[1.2, 4.8]
0.10	**0.06**	**0.06**	**0.06**	**0.05**	**0.05**	**0.04**	*0.04*
	[1.6, 1.3]	[1.6, 1.7]	[1.5, 2.1]	[1.5, 2.7]	[1.4, 3.2]	[1.4, 4.0]	[1.4, 4.9]
0.15	**0.06**	**0.06**	**0.05**	**0.05**	**0.04**	*0.03*	0.03
	[2.3, 1.3]	[2.1, 1.7]	[2.0, 2.1]	[1.9, 2.6]	[1.9, 3.3]	[1.8, 4.0]	[1.9, 4.9]
0.20	**0.06**	**0.06**	**0.05**	**0.04**	**0.04**	0.03	0.02
	[3.2, 1.3]	[2.8, 1.7]	[2.5, 2.1]	[2.4, 2.6]	[2.3, 3.2]	[2.3, 4.0]	[2.3, 4.9]
0.25	**0.06**	**0.05**	**0.05**	**0.04**	*0.03*	0.02	0.01
	[4.2, 1.3]	[3.4, 1.7]	[3.0, 2.1]	[2.8, 2.6]	[2.7, 3.2]	[2.7, 4.0]	[2.7, 4.9]
0.30	**0.06 (p, a)**	**0.05**	**0.05**	**0.04**	0.03	0.02	0.00
	[6.4, 1.2]	[4.7, 1.6]	[4.0, 2.1]	[3.6, 2.6]	[3.4, 3.2]	[3.3, 4.0]	[3.4, 4.8]
0.35	**0.06**	**0.05 (c)**	**0.04**	*0.03*	0.02	0.01	–0.01
	[11.2, 1.3]	[7.0, 1.7]	[5.5, 2.1]	[4.9, 2.6]	[4.5, 3.2]	[4.4, 4.1]	[4.4, 4.9]

Note. National Education Longitudinal Study of 1988 (NELS:88). [Outcome effect (Γ), Selection effect (Λ) as odds ratio]. Sample size is 8,800. Significant program estimates at $p < .05$ and $p < .10$ are in **bold** and *italics*, respectively (two-tailed). Approximate values of calibrated confounders. p = parental education (post-B.A.), a = academic achievement (one standard deviation), and c = rigorous coursework (one standard deviation).

represent the outcome effect (Γ) and selection effect (Λ), respectively, of *U* as odds ratio. The letters *p*, *a*, and *c* in certain cells represent the approximate effect of *U* if the unobservable exerted an influence on dual enrollment and degree attainment similar to parental education (post-bachelor's, p), academic achievement (one standard deviation increase from the mean, a), and rigorous academic coursework (one standard deviation increase from the mean, c).

Results from Table 2 show that *U* would need to exert a relatively large influence to undermine the positive effect of dual enrollment on attainment of any degree. *U* would need an outcome effect as strong as coursework (Γ = 4.1) and a selection effect about 2.3 times as large as coursework ($\ln(\Lambda_{\text{killing confounder}}) / \ln(\Lambda_{\text{coursework}}) = \ln(3.2) / \ln(1.7)$) to reduce the estimate to statistical insignificance. All three calibrated confounders (e.g., parental education, academic achievement, and rigorous academic coursework) exert an outcome effect strong enough to confound the relation between dual enrollment and attainment of any degree. However, *U* would need to exert a selection effect that is stronger than the calibrated confounders—about 2.3 times the log-odds of coursework and about 5.4 times the log-odds of parental education or academic achievement—to undermine the impact of dual enrollment on attainment of any degree.

Similarly, the estimated effect of dual enrollment on B.A. attainment is resilient to minor, moderate, and even major violations of the CIA. However, these results may be more vulnerable to unobserved confounders due to the greater difficulty of attaining a 4-year degree than attaining any postsecondary degree, which includes an associate's degree and certificates. If calibrated confounders are any indication, then U exerts a stronger influence on B.A. attainment, by about 1.4 times the log-odds, than on any postsecondary attainment. Nevertheless, U would need to exert a stronger influence than parental education, academic achievement, or coursework to undermine the influence of dual enrollment on B.A. attainment. For example, if U affects B.A. attainment as strongly as academic achievement ($\Gamma = 6.4$), then U would need to influence selection to dual enrollment that is 4.4 times the log-odds of academic achievement ($\ln(2.6) / \ln(1.2)$) to make spurious the relation between dual enrollment and B.A. attainment.

Overall, the sensitivity analysis shows that results are robust to relatively large confounders that positively affect both selection to dual enrollment and college degree attainment. It is important, however, to state two points. First, the sensitivity analysis does not demonstrate that hidden bias does or does not exist; instead, this analysis poses the question that if hidden bias exists, then to what extent are the results vulnerable? Second, even if the analysis shows that it would require a large confounder to undermine the results, it does not imply that such a confounder does not exist.

In supplemental analyses (results not shown but available upon request), I employ endogenous switching regression. This approach jointly estimates both selection into dual enrollment and degree attainment. Unlike propensity score matching in which selection is based solely on observables, endogenous switching regression estimates the extent to which common, unobserved confounders affect both program assignment and outcome (Mare & Winship, 1988). I find that the substantive results from the propensity score matching model and sensitivity analysis do not change when I estimate endogenous switching regression models.

Do the Effects of Dual Enrollment Differ by Parental Education?

I return to Panel B of Table 1, which shows results from the propensity score matching model by SES. For simplicity, I measure SES as parental education. Among the three SES indicators—parental education, parental occupation, and family income—parental education exerts the largest influence on selection to dual enrollment and college degree attainment.

I find a positive relation between dual enrollment participation and degree attainment among first-generation students—those whose parents did not attend college. The proportion of first-generation students who attained any postsecondary degree is 8 percentage points higher if they participated in dual enrollment than not. I find a similar result for B.A. attainment. These results provide evidence that first-generation students benefit from dual enrollment participation.

I find partial support that first-generation students benefit from dual enrollment more than those with a college-educated parent. Consistent with prior research (e.g., Karp et al., 2007), dual enrollees with less educated parents (e.g., first-generation students and students with parents who did not attain a B.A. degree) are more likely to attain a college degree than similar non-dual enrollees. Moreover, students with college-educated parents are as likely to attain a degree regardless of whether they participated in dual enrollment. Although the point estimates for the effect of dual enrollment is greatest for students with less educated parents, these estimates do not statistically differ across levels of parental education (inconsistent with prior research). Even between first-generation students and students with a parent who attained a B.A. degree—where the difference is greatest—I find statistically insignificant differences in the effect of dual enrollment on degree attainment. Although I find mixed support that the influence of dual enrollment differs across levels of parental education, perhaps the important finding is that dual enrollment programs are not detrimental for low-SES students.

Dual enrollment potentially raises college opportunity and success for a wider audience of students, which is important for the equity agenda of dual enrollment. An emerging question in the

TABLE 3

Total, Direct, and Indirect Effects of Parental Education on Degree Attainment

	Any degree			B.A. degree		
	Column A	Column B	Column C	Column A	Column B	Column C
Some college						
Total effect	0.05***	–0.01	–0.03*	0.11***	0.04***	0.00
Direct	0.03*	–0.005	–0.03*	0.09***	0.04***	0.00
Indirect						
Dual enrollment	0.001	0.0004	0.001	0.001	0.0002	0.0004
Percentage reduced	1.7	–7.92	–2.48	0.56	0.47	25.92
Advanced Placement	0.02***	–0.001	0.00	0.02***	–0.001	–0.0002
Percentage reduced	34.6	14.55	0.83	18.98	–1.59	–11.81
Bachelor's degree						
Total effect	0.23***	0.10***	0.04*	0.33***	0.16***	0.07***
Direct	0.18***	0.10***	0.04*	0.27***	0.16***	0.07***
Indirect						
Dual enrollment	0.001†	0.001	0.001†	0.001†	0.0002	0.001
Percentage reduced	0.61	0.52	3.05	0.31	0.15	1.07
Advanced Placement	0.05***	0.001	0.001	0.06***	0.001	0.001
Percentage reduced	21.56	0.95	2.35	18.09	0.50	1.12
Post-bachelor's						
Total effect	0.37***	0.18***	0.09***	0.49***	0.24***	0.10***
Direct	0.28***	0.17***	0.09***	0.38***	0.24***	0.09***
Indirect						
Dual enrollment	0.002*	0.001	0.002†	0.001*	0.0003	0.001
Percentage reduced	0.54	0.4	1.77	0.3	0.14	1.03
Advanced Placement	0.09***	0.01***	0.01***	0.11***	0.01***	0.004***
Percentage reduced	24.10	3.55	5.53	21.92	2.28	4.38

Note. National Education Longitudinal Study of 1988 (NELS:88). Sample size is 8,800. I report average partial effects. Column A: No controls. Column B: Academic achievement and coursework. Column C: Full selection equation.
†$p < .10$. *$p < .05$. ***$p < .001$ (two-tailed).

equity agenda is whether expanding participation in dual enrollment helps reduce SES gaps in college degree attainment. In the next section, I report results of an analysis in which I examine the extent to which SES gaps change after accounting for dual enrollment.

Does Participation in Dual Enrollment Reduce SES Gaps in Degree Attainment?

I use Breen, Karlson, and Holm's (2011) decomposition approach to examine whether dual enrollment reduces SES differences in college degree attainment. This approach allows me to conduct decomposition analysis on models with a dichotomous outcome. I perform a simple decomposition analysis where accelerated programs mediate the relation between parental education and college degree attainment. I further control for academic achievement and the rigor of academic coursework as well as the full array of covariates from the selection equation as possible confounders to the decomposition analysis.

Table 3 shows total, direct, and indirect effects of parental education on degree attainment. I report average partial effects derived from a probit regression model. Column A shows the decomposition analysis of parental education on college degree attainment with only accelerated programs. Results in Column B control for academic achievement and coursework, and results in Column C control for the full selection equation (i.e., the same selection equation as the propensity score matching model minus parental education).

I find that dual enrollment accounts for little of the parental education gap in college degree attainment (see "Percentage Reduced" in Column A). In general, dual enrollment mediates less than 1% of the gap in degree attainment between first-generation students and students whose parents attended at least some postsecondary schooling. Instead, a notable portion of the parental education gap is due to differences in AP participation, which accounts for at least 18% of the parental education gap in college degree attainment.

The parental education gap in degree attainment is largely due to differences in student background characteristics. For example, controlling for academic achievement and coursework reduces the gap in B.A. attainment between first-generation students and students with a parent who attained a B.A. degree by almost half, from 33 percentage points in Column A to 16 percentage points in Column B. With these controls, moreover, AP participation mediates a modest share of the parental education gap in B.A. attainment. These results suggest that reducing parental education gaps in degree attainment would require more than equalizing participation in dual enrollment or even AP. Perhaps not surprisingly, students bring different characteristics when they enter dual enrollment or AP programs and they leave these programs at different places in the college-preparatory distribution as well.

Supplemental Analyses

In addition to the main analysis, I conduct four supplemental analyses. First, I examine whether the relation between dual enrollment and college degree attainment has changed over time. Second, I measure participation of dual enrollment as a "dosage" rather than as a binary response. Third, I compare students who participated in dual enrollment to students who participated in a traditional high school program (i.e., nonaccelerators). Fourth, I compare whether dual enrollment exerts a stronger (or weaker) influence on degree attainment than AP.

In the first supplemental analysis, I examine whether the relation between dual enrollment and college degree attainment has changed over time. Readers may be concerned that the target population for dual enrollment has changed since NELS:88 and results from this study may no longer hold for a newer cohort of students. I use data from the Beginning Postsecondary Students Longitudinal Study of 2004/09 (BPS:04/09) and I compare results from BPS:04/09 to results from NELS:88. The advantage of BPS:04/09 is that respondents represent a newer cohort of students—first-time undergraduate students in 2004. Interviewers surveyed these students again in 2006 and 2009.

Although respondents in BPS:04/09 represent a newer cohort of students than NELS:88, I prefer NELS:88 over BPS:04/09 because BPS:04/09 investigators did not collect respondents' high school transcripts and BPS:04/09 contains far fewer pre-college covariates than NELS:88. For pre-college covariates that BPS:04/09 contains, investigators asked incoming college students their cumulative high school experience instead of their year-to-year experiences. Therefore, some indicators (e.g., high school coursework and GPA) came after a student participated in dual enrollment.

Nevertheless, I use BPS:04/09 to get some leverage of whether the influence of dual enrollment on degree attainment has changed over time. I harmonize NELS:88 and BPS:04/09 data, in which I use the same covariates and data-coding procedures to estimate the effect of dual enrollment on college degree attainment. I include measures of race, gender, parental education, family size, important considerations when choosing a college, test scores, high school GPA, high school sector, and coursework in English, math, science, social studies, and language.

There is some evidence that dual enrollment has weakened over time—at least for attainment of any degree (see Panel A of Table 4). The effect of dual enrollment on attainment of any degree declined by 34% across cohorts, from .09 in NELS:88 to .06 in BPS:04/09. However, the effect of dual enrollment in the BPS:04/09 sample remains statistically significant. Moreover, the decline in the estimated coefficient in dual enrollment is attributed entirely to declined effects of students with a parent who attained a B.A. degree.

There are little cohort differences in the effect of dual enrollment on B.A. attainment. For NELS:88, the probability of B.A. attainment is 8 percentage points higher for dual enrollees than non-dual enrollees—which is about 2 percentage points lower than in the BPS:04/09

TABLE 4

Results of Supplemental Analyses That Compare National Education Longitudinal Study of 1988 (NELS:88) to Beginning Postsecondary Students Longitudinal Study of 2004/09 (BPS:04/09) (Panel A) and Considers Dual Enrollment as a Dosage (Panels B and C)

	Panel A			
	NELS:88		BPS:04/09	
	Any degree	B.A. degree	Any degree	B.A. degree
Main program effects	.09***	.08***	.06***	.10***
	(.02)	(.02)	(.01)	(.01)
Parental education				
High school or less	.09**	.11**	.07***	.12***
	(.03)	(.03)	(.02)	(.02)
Some college	.07†	.03	.07***	.13***
	(.04)	(.04)	(.02)	(.02)
Bachelor's degree	.10**	.06	.03	.06**
	(.03)	(.04)	(.02)	(.02)
Post-bachelor's	.03	.03	.03	.04*
	(.03)	(.03)	(.02)	(.02)
	Panel B		Panel C	
	Any degree	B.A. degree	Any degree	B.A. degree
Three dual credits earned	.01	.00	.07*	.09**
	(.03)	(.03)	(.03)	(.03)
Six dual credits earned	.11***	.12***	.17***	.19***
	(.03)	(.03)	(.03)	(.03)
Seven+ dual credits earned	.14***	.12***	.18***	.16***
	(.03)	(.03)	(.03)	(.03)
Comparison group	Students who participated in traditional and other accelerated programs		Students who participated only in traditional programs (nonaccelerators)	

Note. Standard errors are in parentheses. Sample size for Panel B is 8,800. Sample size for Panel C is 5,680.
†$p < .10$. *$p < .05$. **$p < .01$. ***$p < .001$ (two-tailed).

cohort. Moreover, students in the BPS:04/09 sample benefitted from participation in dual enrollment, regardless of parental education, but students with less educated parents exert larger effects of dual enrollment than college-educated parents. This finding is consistent with previous research that shows that students with less educated parents are more likely to benefit from dual enrollment than college-educated parents (Karp et al., 2007).

In the second supplemental analysis, I consider participation of dual enrollment as a "dosage" rather than as a binary indicator. I create three cut-points in dual enrollment participation: three credits (e.g., one course), six credits (e.g., two courses), and more than six credits. I estimate a series of propensity score matching models where I keep the comparison category constant throughout each model and change the participation dosage of dual enrollment.

Surprisingly, I find little evidence that students who earned three college credits through dual enrollment (e.g., one course) are more likely to attain a degree than nonparticipants (see Table 4, Panel B). However, students who earned more than three college credits through dual enrollment benefit from their participation. Students who earned six college credits through dual enrollment (e.g., two courses) are 12 percentage points more likely to attain a B.A. degree than nonparticipants. There is little evidence that students who earned more than six college credits through dual enrollment receive a boost in their probability of degree attainment over those who earned six college credits through dual enrollment. These results suggest that simply taking one course in dual enrollment (e.g., three credits) does not provide students with enough college credits to influence degree attainment compared to other high school options, which includes AP. As students begin to accumulate more college credits through dual enrollment, however, these credits serve as a nest egg toward degree attainment (Swanson, 2008).

In the third supplemental analysis (results not shown but available upon request), I compare dual enrolled students to those who did not participate in any accelerated program (e.g., a traditional high school program). In this analysis, I consider the likelihood of college degree attainment for a nonaccelerated student had he or she instead participated in dual enrollment. The influence of dual enrollment on degree attainment increases by 38% to 45% when I remove students who participated in other accelerated programs in the comparison group, but the general patterns do not substantially differ from the main analysis.

The main exception is that dual enrollees who earned three college credits are more likely to attain a college degree than nonaccelerators (Panel C of Table 4). For example, students who earned three college credits through dual enrollment are 9 percentage points more likely to attain a B.A. degree than nonaccelerated students. Because the third supplemental analysis restricts the comparison to nonaccelerators, these results limit inferences in regards to the impact of dual enrollment on degree attainment. However, these results provide useful information about the influence of dual enrollment for students who attend schools with limited academic options.

In the final supplemental analysis (results not shown but available upon request), I compare whether dual enrollment exerts a stronger (or weaker) influence on degree attainment than AP. Although AP and dual enrollment programs are designed to accelerate a student's postsecondary learning, these programs operate differently. For AP, the College Board supplies course materials and guidelines for high schools to follow, whereas the curriculum used in dual enrollment, though the same as offered at a college, varies across programs (D. Allen, 2010; Santoli, 2002). Naïve estimates show that AP students are more likely to attain a degree than dual enrollees, but these results reflect baseline differences between dual enrollees and AP students. After accounting for observed confounders, there is little difference in the effect of these accelerated programs on degree attainment.

Conclusions and Discussion

In this study, I examined whether dual enrollment serves as a means to improve college degree attainment as well as considered whether these programs benefit students from lower socioeconomic backgrounds. Proponents of dual enrollment contend that these programs give participants momentum into the next transition because students are able to accumulate college credit while in high school. Despite the increased popularity of these programs, few rigorous studies assess the impact of dual enrollment on college degree attainment. It therefore remains a priority to assess whether dual enrollment influences degree attainment.

I found that dual enrollment positively influences college degree attainment, even after accounting for a rich set of covariates that captures student, family, schooling achievements, and school context factors. These results were resilient to nontrivial failures of the conditional independence assumption. The unobserved confounder would have to exert a larger influence on selection into dual enrollment and degree attainment than academic coursework to undermine the results. I further confirmed these results with endogenous switching regression, which accounts for common, unobserved confounders that affect both the program assignment and the outcome.

Although I found results in favor of dual enrollment, I remind readers that these results potentially remain sensitive to unobserved confounders. The sensitivity analysis does not show whether hidden bias exists but rather considers the strength in which hidden bias would need to be in order to undermine the results. Moreover, the sensitivity analysis begins with the conditional independence assumption, which means that results from the sensitivity analysis would change based on specifications of the matching model. Although NELS:88 contains a rich array of indicators that influence selection into dual enrollment, this data set is limited in its collection of indicators that capture in-depth relations between students and their environment, such as parents' press on their children, peer influences, and college-going norms in high school. Continued efforts that focus on students' selection into dual enrollment are needed in order to understand better family, peer, and school influences that affect dual enrollment participation. This line of research, however, requires data that capture a fuller description of factors that influence the choice process of dual enrollment participation than NELS:88 provides.

I examined whether dual enrollment benefits all students across the SES spectrum or only those from affluent backgrounds and found encouraging results where dual enrollment did not hinder degree attainment for low-SES students. First-generation college students who participated in dual enrollment were more likely to attain a college degree than similar nonparticipants. Moreover, I found some evidence that first-generation students were more likely to benefit from dual enrollment participation than those with a college-educated parent. In both the NELS:88 and BPS:04/09 cohorts, there was a positive relation between dual enrollment and degree attainment for first-generation students and students whose parents attended college but did not attain a B.A. degree, but a smaller or statistically insignificant relation for students with a college-educated parent. This finding is prominent especially for the BPS:04/09 cohort. Overall, these findings suggest that students with college-educated parents are likely to attend college, and attain a degree, regardless of their participation in dual enrollment. Furthermore, while dual enrollment serves as a means to raise academic preparation for a wide range of students, these programs may especially benefit those lower in the socioeconomic distribution.

Although dual enrollment participation may increase college degree attainment for first-generation students and students whose parents did not attain a B.A., I caution readers that this increase may not translate necessarily to a reduction in parental education gaps in degree attainment. Results from the decomposition analysis show that participation differences in dual enrollment account for almost none of the attainment gap between first-generation students and students with college-educated parents. Students tend to bring different characteristics when they enter dual enrollment programs and they tend to leave these programs at different places in the college preparatory distribution as well.

However, the decomposition analysis partitions the parental education gap assuming that differences in program participation were removed. Therefore, policies should not only focus on efforts to make equal participation rates across levels of parental education, but policies should also concentrate on targeting low-income schools. Differential access, where first-generation students participate at greater rates than students from other family backgrounds, would further reduce parental education gaps beyond the predictions from the decomposition analysis.

Although I found evidence where students who participated in dual enrollment, in general, were more likely to attain a college degree than nonparticipants, I found the majority of the gain was for those who took two courses in these programs. In supplemental analyses, I found little added benefits beyond six credits. That is not to say that students who accumulated more than six credits did not benefit from dual enrollment, but rather that incremental gains were at the earlier levels of credit accumulation. Surprisingly, I found little evidence that students who earned three college credits through dual enrollment (e.g., one course) are more likely to attain a degree than nonparticipants. This result suggests that students who participated in dual enrollment may need to meet a college credit threshold before these credits serve as a nest egg toward attaining a degree.

However, these estimates compared students who participated in dual enrollment to students who participated in other programs, such as AP. When I removed students who participated in other accelerated programs (e.g., AP), I found that students who earned three college credits through dual enrollment are 9 percentage points more likely to attain a B.A. degree than nonaccelerators. Although comparing between dual enrollees and nonaccelerators limits inferences of dual enrollment, this comparison provides useful information for students who attend schools with limited program options. Schools that offer accelerated programs are, on average, likely to offer both dual enrollment and AP, but there is some variation in the type of accelerated course that schools offer (Speroni, 2011; Waits, Setzer, & Lewis, 2005). In a national report of dual-credit programs, Waits et al. (2005) find that among public high schools that offer AP or dual enrollment, about half offers both dual credit and AP courses, 20% offers only dual credit, and 16% offers only AP courses. Therefore, some schools and districts may favor one program over another (Speroni, 2011).

Finally, I compared the influence of dual enrollment on college degree attainment to AP. After accounting for baseline differences, there was little difference in the effects of these accelerated programs on degree attainment, which is consistent mainly with findings from previous research (Speroni, 2011). One question researchers and educators are beginning to ask is the type of accelerated program high schools should choose (Dutkowsky, Evensky, & Edmonds, 2009; Klopfenstein, 2010; Speroni, 2011). AP courses follow a standardized curriculum with possible training support and materials from the College Board whereas dual enrollment courses are the same as offered at a college but may vary across programs (D. Allen, 2010; Santoli, 2002). Some policymakers and educators prefer AP over dual enrollment because the standardized curriculum provides postsecondary administrators with a better signal about the quality of the coursework. Others favor dual enrollment in that these programs provide a better college experience for students and students are more likely to earn college credit through dual enrollment than through AP exams (Klopfenstein, 2010; Speroni, 2011).

Dutkowsky et al.'s (2009) recommendation may be useful when deciding which program to implement in that they do not suggest a "one-size-fits-all" approach. Instead, Dutkowsky et al. suggest that schools choose accelerated programs based on their clientele. In their expected benefit analyses, Dutkowsky et al. found that dual enrollment programs may favor districts whose students often attend institutions that charge high tuitions (e.g., private and public out-of-state colleges) and those who perform near the average on AP exams. By contrast, AP tends to favor districts whose students enroll in relatively inexpensive colleges or those who perform exceptionally well on AP exams. We need further research that compares the impact of different accelerated programs, which considers whether certain accelerated programs exert gains for certain college outcomes than other outcomes and consider whether particular accelerated programs benefit students differently based on their schooling and background characteristics.

Appendix

Description of Variables

Variables	Description	*M*	*SD*
Dependent variable			
Postsecondary attainment	Student earned any postsecondary degree (yes = 1)	0.59	0.49
Bachelor's degree attainment	Student earned a bachelor's degree (yes = 1)	0.46	0.50
High school program			
Dual enrollment	Student participated in dual enrollment (yes = 1)	0.10	0.30
Social background			
Black	Student is Black	0.09	0.28
Latino	Student is Latino, non-White	0.12	0.33
Asian	Student is Asian (White is omitted category)	0.09	0.28
Female	Student is female	0.54	0.50
Parental education (bachelor's degree)	The highest level of education a parent attained was a bachelor's degree	0.18	0.38
Parental education (advanced degree)	The highest level of education a parent attained was an advanced degree (less than a bachelor's degree was the omitted category)	0.18	0.38
Parental occupation	Parental occupation based on Hauser and Warren's (1997) occupational Socioeconomic Index scores	40.31	15.63

(continued)

Appendix (continued)

Variables	Description	*M*	*SD*
Family income	Total family income from all sources (averaged in 1987 and 1991; thousands)	49.13	38.20
Family structure	Nonbiological or single-parent households (two-parent households are omitted category)	0.23	0.42
Number of siblings	Number of siblings; ranges from 0 to 6	2.12	1.46
Significant others			
Teacher's college aspiration for student	Teacher or counselor's desire for respondent to attend college after high school, which I derived from two items (alpha = 0.80): whether a student's favorite teacher (item 1) or school counselor (item 2) thought that going to college was "the most important thing for [the student] to do right after high school" (yes = 1)	0.65	0.42
Parents discuss about school academics and activities	A composite measure that captures the frequency in which students and parents discuss school academics and activities based on the following three items (alpha = 0.76): selecting courses or programs at school, school activities or events, and things students studied in class; ranges from 1 (*never*) to 3 (*often*)	2.08	0.49
Parents discuss about college and college preparation	A two-item composite (alpha = 0.61) that captures the frequency in which students and parents discuss about college (item 1) and plans and preparation for college exams (item 2); ranges from 1 (*never*) to 3 (*often*)	1.98	0.52
Parents discussed postsecondary educational plans with other parents	The frequency in which parents talked to other parents about their child's educational plans after high school; ranges from 1 (*seldom or never*) to 4 (*almost daily*)	1.80	0.74
Parents contact school to discuss postsecondary plans	The frequency in which parents contact their child's school to discuss plans after high school; ranges from 1 (none) to 4 (four or more times)	1.64	0.74
Friend drops out of high school	Whether a close friend dropped out of school without graduating (yes = 1)	0.18	0.38
Importance of academics among friends	A composite measure that represents the importance of academics among the respondent's friends, based on three items (alpha = 0.75): study, good grades, and finish high school; ranges from 1 (*not at all important*) to 3 (*very important*)	2.53	0.43
College aspirations and expectations			
College plans	Respondent plans to go to college right after high school (yes = 1)	0.73	0.44
College exam plans	Respondent plans to take college exam (SAT or ACT) (yes = 1)	0.76	0.43
AP exam plans	Respondent plans to take Advanced Placement test (yes = 1)	0.30	0.46
College costs	How important are college expenses and financial aid in choosing a school you would like to attend? Ranges from 1 (*not important*) to 3 (*very important*)	2.37	0.58
Academic reputation	How important is a strong reputation of the school's academic programs in choosing a school you would like to attend? Ranges from 1 (*not important*) to 3 (*very important*)	2.48	0.61
Easy admission standards	How important is easy admission standards in choosing a school you would like to attend? Ranges from 1 (*not important*) to 3 (*very important*)	1.84	0.68

(continued)

Appendix (continued)

Variables	Description	*M*	*SD*
Academic performance and accomplishments			
Unprepared for class	A three-item composite (alpha = 0.69) that measures the frequency in which students attend class unprepared, such as without a pencil or paper, without their books, or without completing their homework; ranges from 1 (*never*) to 4 (*usually*)	1.71	0.53
Days absent	Average number of days absent (88–91)	9.05	7.64
Social promotion	Respondent ever repeated a grade (yes = 1)	0.10	0.30
Academic achievement	Standardized composite test score on four subject areas (reading, math, science, and social science) in 10th grade (alpha = 0.93)	0.19	0.84
Eighth-grade advanced courses	Enrolled in eighth-grade advanced courses (yes = 1)	0.55	0.50
Eighth-grade gifted class	Enrolled in eighth-grade gifted class (yes = 1)	0.22	0.41
Academic pipeline	Standardized academic pipeline measure from three subject areas (math, science, and English) by 11th grade where greater values represent more rigorous coursework (alpha = 0.79)	0.22	0.70
School context			
School sector (private)	Whether a student enrolled in a private or public school (private = 1)	0.16	0.37
School district is in suburban location	The urbanicity of a school district (suburban)	0.42	0.49
School district is in rural location	The urbanicity of a school district (rural); urban districts were the omitted category	0.28	0.45
School racial composition (Latino)	Percentage Latino in school (10% change)	1.02	1.95
School racial composition (Black)	Percentage Black in school (10% change)	1.08	1.83
Median household income	Median household income in a school zip code in 1989 (thousand)	32.88	13.03
Academic climate	An eight-item composite variable (alpha = 0.77) that represents a school's academic climate in regards to: students and teachers emphasizing learning, student and teacher morale, counselors and teachers' role in encouraging students to enroll in academic courses, and problems teachers have with students and administrators; I create this measure following Gamoran (1996); ranges from 1 (*not accurate at all*) to 5 (*very accurate*)	4.01	0.46
Advanced regular courses (1)	Advanced regular science and math courses (6 to 7 units)	0.27	0.44
Advanced regular courses (2)	Advanced regular science and math courses (8+ units, 1 to 5 units is omitted category)	0.34	0.47
Advanced AP courses (1)	Advanced AP science and math courses (1 to 3 units)	0.34	0.47
Advanced AP courses (2)	Advanced AP science and math courses (4+ units, no AP courses is omitted category)	0.32	0.47
Advanced college-level course	Advanced college-level science and math course (yes = 1)	0.34	0.47
Distance to nearest college			
College proximity (1)	Distance of high school to college (miles; public, 4-year)	17.48	19.24
College proximity (2)	Distance of high school to college (miles; private nonprofit, 4-year)	16.60	25.19
College proximity (3)	Distance of high school to college (miles; public, 2-year)	10.88	13.14
College proximity (4)	Distance of high school to college (miles; private nonprofit, 2-year)	25.54	30.78

Note. National Education Longitudinal Study of 1988 (NELS:88). Sample size is 8,800 respondents.

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Note

1. In dual enrollment programs, high school students take college courses but they may or may not earn college credit after completion of the course—although students typically do earn college credit (D. Allen, 2010). Dual enrollment in my data represents courses in which students earned college credit. Therefore, I refer to dual enrollment as programs where students earn college credit upon completion of the course, such as dual-credit programs. However, I use the term *dual enrollment* throughout my study rather than other terms (e.g., *dual credit*) because readers may be more familiar with the term *dual enrollment* than other terms. Proponents and researchers of dual enrollment often consider the credit accumulation mechanism of dual enrollment when they refer to these programs or have used the terms interchangeably (Estacion, Cotner, D'Souza, Smith, & Borman, 2011; Karp, Bailey, Hughes, & Fermin, 2004).

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