The Effect of High School Socioeconomic Composition on Student Attainment

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Abstract

This study uses a large sample of public school students from the Educational Longitudinal Study of 2002 to examine the effects of high school socioeconomic composition (SEC) on three sequential attainment milestones including high school graduation, enrollment in college, and persistence in college. The results show that high school SEC is a highly robust predictor of educational attainment. The magnitude of the SEC effect is larger than any other school effect on post-secondary attainment outcomes. Controlling for a broad array of student factors, the magnitude of the SEC effects are comparable to family socioeconomic status (SES), which is commonly considered one of the most robust predictors of educational outcomes. The SEC effect was found to be due to both peer effects and school effects. School practices that encourage academic and social engagement moderated the SEC effect on graduation, whereas practices that raised the academic press and relational trust at schools increased 4-year college enrollment and persistence rates. Two clear patterns emerged from the results: 1) the SEC effect is larger on enrollment and persistence at 4-year colleges than 2-year colleges, 2) the magnitude of the SEC effects becomes larger on each sequential attainment outcome. The implications of the results to educational policy are discussed.

Introduction

Educational attainment is associated with many important life outcomes including economic prosperity, health, and participation in society. For example, attainment is associated with voter participation, taxation, lifestyle behaviors (diet, exercise, smoking), and the incidence of various diseases (College Board, 2004). A recent study by the U.S. Bureau of Labor Statistics estimated that individuals who hold a bachelor's degree or higher earn, on average, one million dollars more during their working lifespan than those with less than a bachelor's degree (Dohm & Wyatt, 2002). Conversely, the economic costs to society associated with low educational attainment are enormous. It has been estimated that each annual cohort of high school dropouts in California costs the state's economy $46 billion over their life spans (Belfield & Levin, 2007). This is more than seven times the total annual state expenditures for the 23-campus California State University system, which has almost 450,000 students and 48,000 faculty and staff.

Unfortunately, low educational attainment remains the norm and is a barrier to social mobility for members of certain sectors of society. A recent descriptive study by the National Center for Educational Statistics estimated that children from low income families (family income less than $20K/year) were five times more likely to fail to earn a high school diploma than children from affluent families (family income GT $100K/yr) and that African American and Latino children were twice as likely as white children to fail to earn a high school diploma (Bozick & Lauff, 2007). Because educational attainment is a sequential process (e.g., a high school diploma or equivalent is typically required for college enrollment), these large differences in high school graduation rates across socioeconomic and ethnic groups can compound at subsequent attainment transitions such as enrolling in college. Of the young adults that graduate from high school, 40 percent from low SES families, 58 percent of Latinos, and 62 percent of

African Americans enroll directly into college, compared with 91 percent from affluent families and 75 percent of whites (Bozick & Lauff, 2007). And, these numbers do not capture the full differences in attainment among these groups. For example, of those who do enter college directly from high school, young adults from affluent families are also more likely to attend selective universities and less likely to attend community colleges (Bowen, Chingos, & McPherson, 2009). These figures suggest that equality of educational opportunity is still a critical issue in America. In fact, in terms of attainment, the education system presently seems to be more a social reproduction process (Bourdieu, 1977) than a social mobility process and hardly "the great equalizer of the conditions of men" of Horace Mann's vision.

Given the critical importance to individual well-being, social equity, and the economic property of society at large, improving educational attainment is arguably one of the more pressing policy issues, educational or otherwise. Over the past year, the Obama administration has begun to address this by intensifying the US Department of Education's commitment to improve college-going behaviors with the stated goal that "America will once again have the highest proportion of college graduates in the world" (Obama, 2009). The administration has committed billions of dollars of federal funds to states to implement large-scale reforms designed to increase graduation and college enrollment rates, among other educational objectives (Race To The Top Fund, 2009). A critical element of this policy is organizing high schools to better prepare students for college success. However, while there is considerable research on individual factors associated with college-going behaviors, much less is known about how high schools contribute. In particular, there is a dearth of research addressing how the socioeconomic

composition[1] (SEC) of schools impact students' college-going behaviors. The SEC of the school one attends has long been recognized as one of the more robust predictors of educational outcomes, but not in the literature on higher education. In recent years, as American schools have become increasingly segregated along racial and socioeconomic lines (Orfield, 2005), the effect of SEC has likely become more pervasive and more pronounced. As the Obama administration strives to increase college graduation, more research is needed on how high schools contribute to attainment. The present study is designed to address this shortcoming in the research literature.

Research Objectives and Research Questions

This longitudinal study examines how SEC impacts attainment at three sequential milestones – high school graduation, college enrollment, and persistence during the first 2 years of college. The general hypothesis is that SEC effects attainment above and beyond one's family and academic background, but that certain aspects of the high school, particularly school practices designed to enhance the academic orientation and educational values at the school, moderate that effect. Furthermore, it is hypothesized that the effects of SEC are stronger on college enrollment than on high school graduation because enrollment requires a greater commitment and sacrifice and therefore may be more susceptible to the school habitus (Bourdieu, 1977, 1986; McDonough, 1997). The following research questions will be addressed:

1. Is high school SEC associated with educational attainment at each of the three attainment outcomes? Is the magnitude of the effect of SEC consistent across the sequential

[1]Socioeconomic composition is the average socioeconomic status of students attending a school. In this study, socioeconomic status is measured using an equally-weighted composite of five components including mother's and father's educational attainment and occupational status, and family income.

outcomes? How does the magnitude of the effect compare with other robust predictors of attainment, such as family socioeconomic status?

2. To what degree do three types of effects moderate the association between SEC at each sequential attainment stage? The three types of effects include: 1) student background (family, behavioral, and academic), 2) school input factors (compositional effects, resources, and structures), 3) school practices (e.g., academic press, learning climate, etc.). This question addresses whether the SEC-attainment association is due to school effects or peer effects.

Literature Review

SEC has been recognized as an important school effect at least since the Coleman Report found that it had the strongest association with student achievement of any school factor (Coleman et al., 1966). In the past few decades a body of research has substantiated Coleman's finding; however, most of that work uses achievement outcomes, and very few of these studies focus on educational attainment. While some research has examined the association between SEC and attainment, the vast majority of those studies use high school graduation or dropout as the outcome (Byrk & Driscoll, 1988; Jencks & Mayer, 1990; McNeal, 1997; Murnane, 1981; Rumberger & Arellano, 2007; Rumberger & Palardy, 2005; Rumberger & Thomas, 2000), with only a handful of studies examining college going behaviors (Alexander & Eckland, 1977; Coleman & Hoffer, 1987; Hill, 2008; McDonough, 1997; Perna & Titus, 2005). Moreover, in almost all of the research that does examine the association between SEC and attainment, that association is a secondary element of a larger study. Detailed and focused studies on this topic are exceedingly rare, particularly research that centers on higher education attainment outcomes. The purpose of the present study is to begin to address this gap in the research literature using a

recently released and nationally representative dataset of students and schools.

The following review attends to two specific aspects of the research literature associated with SEC. First, the literature addressing theories on how SEC impacts educational outcomes, particularly attainment, are examined. Second, the research literature on individual and school factors associated with attainment is reviewed. Finally, a conceptual framework that builds on the empirical and theoretical literature on SEC is presented. This framework in turn guides the analysis of the present study.

Theories on the Effects of Socioeconomic Composition

Educational scholars have posited various theories of how SEC exerts its effect on educational outcomes. Perhaps the most widely accepted is that SEC is a proxy measure for peer effects that directly impact student outcomes. This theory suggests that academic skills, educational values, and social norms are associated with SEC and are transferred among students through peer interactions to influence behaviors, attitudes, and ultimately cognitive development and other educational outcomes (Dreeben & Bar, 1988; Hanushek, Kain, Markman, & Rivkin, 2003; Jencks & Mayer, 1990; Kahlenberg, 2001). These peer effects tend to depress educational performance in low SEC schools where peers often have lower levels of the educational and cultural attributes that enhance educational performances, attitudes, and values. Conversely, in high SES composition schools peers tend to have an abundance of those characteristics that serve as educational catalysts. The more general notion of peer effects is also consistent with Bourdieuian theories on Cultural Capital and Habitus (Bourdieu, 1977, 1986; McDonough, 1997).

A second theory posits that the effect of SEC is manifested indirectly through a variety of school effects, both contextual in nature (e.g., school resources and structural characteristics)

as well as school practices, which depend to some degree on the context. For example, low SEC schools may have lower levels of physical, human, and monetary resources such as inferior facilities, lesser qualified teachers, and lower levels of funding (Betts, Rueben, & Danenberg, 2000). Moreover, structural characteristics that typically challenge educational objectives at schools such as an urban location and large student enrollment may be more prevalent at low SEC schools. There is also evidence that disciplinary climate, access to college preparatory curriculum, and instructional expectations and rigor depend in part on school SEC. This theory suggests that equalizing school resources, structures, and practices will resolve—or at least moderate—the effect of SEC on achievement, attainment, and other educational outcomes. While there has been considerable debate about whether school resources are associated with school effectiveness (e.g., Greenwald, Hedges, & Laine, 1996; Hanushek, 1989, 1994, 1997; Hedges, Laine, & Greenwald, 1994), none has specifically examined whether resources moderate the effects of SEC on student attainment. The current study is designed to address whether peer effects or school resources account for any observed SEC effect on attainment.

To be clear, the two theories are not necessarily competing against each other. It is entirely possible that both school effects and peer effects contribute to the observed SEC effect on attainment. The present study was designed to provide empirical evidence to test those theories.

Individual and School Factors Associated with Attainment

Research has identified a number of individual and school factors associated with educational attainment besides SES and SEC (Choy, 2002; Light & Strayer, 2000; Rumberger & Larson, 1998; Lee & Burkam, 2003). Because many of these factors are correlated with SES or

SEC they may moderate the effects of SEC on attainment and therefore are very relevant to the present study.

Student Factors

Student factors can be broken down into background characteristics and school behaviors. Background characteristics cover a broad array of factors—both social and academic. For example, adolescents from low socioeconomic backgrounds or from historically disadvantaged ethnic groups, those with low prior achievement, or those who have been held back a grade are at greater risk of dropping out of high school. Indicators associated with failing to complete college include beginning post-secondary studies at community college, working full-time, and having parents who did not attend college (Choy, 2002). Moreover, students are more likely to complete college if their abilities matched the selectivity of the college they attended (Light & Strayer, 2000). Low-ability students were significantly more likely to complete college if they attended a less demanding school and high ability students were more likely to graduate if they attended a selective school.

Assessing student factors in terms of background characteristics and school behaviors is important because background characteristics are in place when students enter high school, while school behaviors may be the result of their background or may emerge due to their high school experiences and school environment. School behaviors are measures of students' academic and social performance at the school. Social and academic disengagement, low grades, poor attendance records, and misbehavior are examples of school behaviors that have been linked to an increased risk of dropping out. Some research has concluded that attainment is chiefly the result of academic disengagement at school, which may also be a consequence of learning problems, while other research suggests that dropping out is more an issue of social engagement,

which may impact academic commitment (Finn, 1989; Wehlage, Rutter, Smith, Lesko, & Fernandez., 1989). This is an important distinction because promoting social engagement may require different resources (e.g., counselors) and different policies (e.g., participation in sports) than promoting academic engagement and student learning.

School Factors

The literature also identifies school-based risk factors, which can be categorized into school input factors or school practices. While schools have control over practice, school inputs are conceptualized as being largely beyond the control of school site personnel (Rumberger & Thomas, 2001). School inputs include compositional effects (e.g., social and racial composition, average achievement), structural features of the school (size, urbanicity), and school resources (teacher salary, computers, quality and condition of physical structures). School practices are perhaps the most policy relevant type of school effect because they are aspects of the school that school site personnel have the greatest control to change. Practices may impact whether students graduate from high school and are sufficiently prepared to enroll in and succeed at college. Practices include the academic press and social climate (e.g., morale) at the school, the attitudes and practices of the teachers, or the leadership characteristics of the principal. They may also include policies that facilitate involuntary dropout due to low grades, poor attendance, misbehavior, or being over age—policies that can lead to suspensions, expulsions, or other penalties (Bowditch, 1993; Fine, 1991; Riehl, 1999; Romo & Falbo, 1996). A recent study at UCLA found that access to a college preparatory curriculum in high school played a central role in educational attainment (UC/ACCORD & UC/IDEA, 2007). High school curriculum can be conceptualized as a school practice as long as sufficient resources are available to implement the chosen curricula. For example, teachers with the appropriate background must be available if a

rigorous college preparatory curriculum is to be offered. Such a curriculum can affect student attainment in various ways, most obviously by preparing students for success in college studies and because universities typically require a list of college preparatory courses for admission.

While the literature on the effects of high schools on post-secondary attainment is underdeveloped, some important work exists. Attainment in higher education has been linked to access to financial aid, the selectivity of the institution, and opportunity for interaction with instructors and academic advisors. Financial aid is a particularly critical factor for students from low SES families and low SEC schools because their decision to attend college and persist is often contingent upon it. Paulsen and St. John (2002) noted that over the past generation the federal government college financial aid packages for promoting college access have shifted from offering primarily monetary awards to offering loans. This change puts a far greater long-term economic burden on low-income attendees who typically depend upon federal aid to attend. Bowen et al. (2009) point out that college going behaviors among low-income families are more dependent on cost as compared with affluent families. In addition, these authors indicate that the cost of attending 4-year colleges has risen rapidly even when compared with private colleges. For these reasons financial aid is perhaps a more important determinant of college attendance and persistence than ever. Therefore, when modeling the effects of SEC on higher education attainment it will be important to control for financial aid. In addition, affordability also constitutes another considerable difference between attending a 2-year and 4-year colleges. First and foremost, 2-year college students tend to be more sensitive to costs than university students (Heller, 1997; Leslie & Brinkman, 1988; Levin, 2007; Paulsen & St. John, 2002). Not only are 2-year colleges typically considerably less costly to attend, but they are also less selective, and

less rigorous. For these reasons when studying college enrollment and persistence, colleges will be separated into 2- and 4-year institutions.

Conceptual Framework

This study is guided by a conceptual framework that recognizes that educational attainment is a function of several individual and school factors which are often interrelated (see Figure 1). Individual factors such as family characteristics, academic background, and social experiences influence each of the sequential attainment milestones (high school graduation, college enrollment, college persistence). These factors affect attainment directly and also indirectly through the characteristics of the high school students attend. In addition, access to financial aid is critical for college enrollment and persistence among students from low SES families. Moreover, academic and social supports at college affect persistence.

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Figure 1 About Here

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While individual background plays perhaps the more prominent role in attainment, high school effects are of considerable interest because they are more readily influenced by policy initiatives and educational reforms. High school effects are divided into four types of factors (compositional, resources, structures, and practices), each with a distinct literature associated with it. Compositional factors are related to characteristics of the student body (including SEC). Resources include aspects of the school such as the quality of the teachers, school facilities, and equipment. School structures measure geographic and structural features of the school including urbanicity, student enrollment, and academic calendar. Composition, resources, and structures are considered "school inputs" because these factors constitute aspects of the school that are

generally "given" to school site personnel and therefore are largely beyond their influence in quantity or quality. School practices are perhaps the most important type of school effect because they are alterable and school site personnel have the ability to implement and change them. For these reason, practices are school effects that school personnel can reasonably be held accountable for. This type of school effect includes a wide range of factors such as the principal's leadership style, the degree of academic press, and instructional and disciplinary practices at the school. Although this study focuses on the effect of SEC on attainment, as the framework suggests, in order to obtain unbiased estimates of that effect using statistical models, it is necessary to account for other student and school factors that are associated with it. Furthermore, as described in more detail in the Methods section below, a modeling building process using variables for the 4 classes of school effects will help address how to minimize the potentially negative consequences of attending a low SEC high school.

Methods

Data Source

The *Education Longitudinal Study* (ELS), a survey of 2002 high school sophomores conducted by the National Center for Education Statistics, was used to address the research questions.[2] Students were surveyed at two-year intervals and transcript data was collected from their high schools in 2005, about one year after their expected graduation. ELS data are an excellent source for addressing the research questions posed in the present study for several reasons. ELS includes an extensive number of student background variables measuring aspects of the students' family background, academic background, attitudes, and behaviors. Having these student measures is critical when modeling school effects using survey data because it

[2] See http://nces.ed.gov/surveys/els2002/.

allows the researcher to statistically control for differences in student inputs across schools when modeling school effects using survey data (Aitkins & Longford, 1986; Palardy, 2008). The longitudinal nature of the data allow for the modeling of attainment at the three critical points that are the focus of this study. The large sample of schools provides sufficient statistical power to study how high schools contribute to attainment. Finally, the dataset is fairly new—the second follow-up was released in October of 2007—which will make the results more relevant for addressing current policy issues. This is especially the case as much of the literature on high school effects is based on data that is at least 15 years old, a period that witnessed considerable social and educational change.

Outcome Variables

Past research on the effects of social composition on educational attainment has concentrated on high school graduation. This study addresses the research questions by using three sequential attainment outcomes: 1) high school graduation, 2) college enrollment, and 3) persistence in college studies two years after enrollment. The attainment outcomes are all categorical variables and therefore the statistical models will be non-linear. The Graduation outcome is binary with non-graduates being the reference category (coded zero). The Enrollment outcome is multinomial with categories for graduates who enroll in 4-year colleges, 2-year colleges, and otherwise, with the latter being the reference category. This outcome is used to estimate the effects high schools have on enrollment in 4- and 2-year colleges compared with the reference category, those students who did not enroll in a 4- or 2-year college. The Persistence outcome is also multinomial with categories for students who persist at 4-year colleges, depart from 4-year colleges, persist at 2-year colleges, and depart from 2-year colleges. Note that the objective is to compare students who persist at 4-year colleges with students who

depart from 4-year colleges and students who persist at 2-year colleges with those who depart from 2-year colleges.[3]

Independent Variables

Variable selection is guided by the conceptual framework outlined in Figure 1. While the focus of this study is the effect of high school SEC on attainment, other student and school variables are included. Measures of the students' demographic, family, and academic background, as well as their level of engagement at school are included in the model as control variables to hold constant differences in the characteristics of students across schools. High school variables are divided into two general types including *School Inputs* and *School Practices*. *School Inputs* include a number of compositional effects (e.g., mean level of achievement), measures of school structures (e.g., size, urbanicity), and school resources (e.g., teacher salary, student to teacher ratio, teacher qualifications). Generally, *School Inputs* are characteristics of the school that are "given" to the school site personnel and that they have little control over. *School Inputs*, however, may be associated with attainment as well as social composition (which itself is a *School Input*) and if so will moderate the effect of social composition on attainment. Ignoring the *Inputs* will bias the effects of social composition. School Practices (sometimes referred to as "processes") are measures of the teaching, management, organization, and attitudes of the personnel at the school. These are typical of the highest interests because they tend to be more readily alterable through policy initiatives and school site personnel have a significant ability to influence them. The academic orientation of the school is a type of school practice that

[3] A single run of the multinomial model cannot produce both sets of comparisons. Therefore, the model was run twice; first with 4-year departers as the reference group and then with 2-year departers as the reference group. Note that changing the reference category in this way does not result in a new model in terms of the number of parameters estimated and the model log-likelihood. It only changes which groups are compared.

may be measured in several ways and is also very relevant to attainment. Of particular importance is whether the school provides the opportunity and encouragement for students to take the college preparatory coursework necessary for college admissions requirements and for developing the academic skills necessary for success in college. Variables of this type include the percent of students who are on the college preparatory track, the percent of the student body in Advanced Placement courses, and the percent of the student body in the International Baccalaureate program. Academic Press is a factor score (FS) of principal-reported items that measure the degree to which the school, courses, and teachers have an academic orientation. Other school process variables measure aspects of the school's climate such as the morale of the teachers, the amount of disorder and disruptions in classrooms, and whether students feel that the disciplinary policy is fair. A full list of the variables used in this study and their descriptive statistics are presented in Appendix Table 1.

Sampling Selection Criteria

The full ELS base year sample contains 16,197 10^{th} graders who attended 752 high schools in 2002. The present study uses 3 subsamples based on the selection criteria outlined in Table 1. Only students attending public schools and who had valid surveys for both the base year (2002) and second follow-up (2006) were retained.[4] This resulted in a sample of 10,936 students who attended 581 public high schools; this sample was used to study predictors of high school graduation. Two subsequent subsamples were developed to study predictors of college enrollment and college persistence. The first sample, which was for modeling predictors of college enrollment, included only students who were college-eligible in summer of 2004 (N = 9,358). This sample was limited to high school graduates who received their diploma on or

[4] The sample is restricted to public schools because their funding, policies, and practices are largely public domain. Selective bias also confounds public-private school comparisons, which is not the focus of the proposed study.

before their expected graduation date of June 2004. Those who did not meet this criterion were omitted because they were typically ineligible to enroll in college in the fall of 2004. The second sample, which was for modeling predictors of college persistence, retained only those who enrolled in college in 2004 (N = 6,305). Those who did not enter college in 2004 were omitted because the model was designed to examine persistence in college studies during the two year period from 2004 to 2006. Figure 2 illustrates the sample selection criteria employed to develop the 3 subsamples used in the present study and the outcomes each respective sample was used to model. This sequential sampling design is similar to that used in a study to examine educational pathways to becoming a teacher (Vegas, Murnane, & Willett, 2001). [5]

Table 1 About Here

Figure 2 About Here

Missing Values

Multiple imputations (MI) missing values methods were used in the present study (Rubin, 1987). This is commonly considered the "gold standard" for handling missing values. However, because data are multilevel in structure, standard multiple imputation methods are of questionable appropriateness. Recent methodology and software developments are providing

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[5] This sampling design is conservative in that it limits the sample for each sequential analysis to eligible students. For example, only students who were eligible to enroll in college (i.e., high school graduates) are included in the college enrollment sample. Retaining all students at each stage creates something of a carryover effect from one sequential outcome to the next. That is, if a variable is significantly associated with attainment on one outcome and ineligible students are retained for the analysis of the subsequent outcome, the earlier effect will be carried over to subsequent sequential analysis. Such an approach is undesirable because subsequent analyses are not independent and will tend to have inflated effects.

new and superior options for imputing multilevel data that accounts for the nested data structure. MLwiN software's MCMC estimation (Browne, 2009), which is on the cutting edge of multilevel MI, was used to impute five complete multilevel datasets, which were subsequently analyzed using Mplus. Five sets of parameter estimates and their standard errors were produced, which were combined by the software.

Sample Weights

A stratified two-stage sampling design was employed to collect ELS data. First, from the population of American schools that enroll 10th graders, 752 schools were selected with probabilities proportional to the student enrollment of the school. Next, individual students were sampled within the schools, Asian, Pacific Islanders, and Hispanic students were all oversampled. As a result, neither the student nor the school sample can be considered representative of the population of 2002 10th graders or schools that enroll 2002 10th graders. To correct this, NCES provides student and school sample weight. The present study uses the second follow-up, base year student panel weight (F2BYWT). This weight was designed for students who completed both the base-year and second follow-up surveys to produce a representative sample of 2002 10th graders. This study also uses the base year school sample weight (BYSCHWT), which is designed to create a representative sample of 2002 American schools that serve 10th graders.

Model Building

A hierarchical model building strategy was used to address the research questions. This involved estimating a series of models on each of the 3 samples, beginning with a base model and adding variables in sets that are both cohesive and theoretically informed. Instead of beginning with the fully unconditional model, per multilevel modeling convention, the first

model estimated is the *Baseline SEC* model, which includes only family SES in the student-level model and social composition in the school level model.[6]

The Baseline socioeconomic composition model provided estimates of the magnitude of the SEC effect on each attainment outcome before controlling for pertinent student background and school factors. However, the independent effect of SEC is likely to be substantially smaller than the estimates generated by this model because SEC covaries with many student and school predictors of attainment that are not included in this model. Nonetheless, the results of this model can be useful for comparisons with subsequent models to determine the degree to which certain types of covariates (e.g., student background or school inputs) moderate the effect of socioeconomic composition. Three subsequent models were estimated beginning with the student model, which controls for student inputs across schools. In the present study, student predictors are not a central substantive focus. As suggested above, they are included to statistically control for differences in student inputs across the sample of schools. This inclusion is critical because student intakes vary substantially across schools and can impact school effects, but are not within the control of school site personnel. Next the *School Input* model was estimated, which includes the student model and measures of school inputs outlined above and in Figure 1. Similar to the student model variables, school inputs are essentially control variables that are included to condition the effects of socioeconomic composition. The final model is the *School Practice* model.

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[6] The multilevel modeling convention of beginning an analysis with a fully unconditional model (which contains no independent variables) was not used because that convention is primarily for the purpose of tracking the variance that is explained by subsequent models. Variance explained is not tracked in the present study because when working with non-linear models there is no level-one variance component estimate and the level-two variance estimate may increase when variables are added to the model; this undermines the usefulness of tracking the proportion of the variance explained by subsequent models.

The Specification of Socioeconomic Composition and Other Variables

Compositional effects are sensitive to their specification in the multilevel model. In school effectiveness research, compositional effects are school variables that typically measure aspects of the student body using the mean of a student variable. However, compositional effects are not the sum of the student effect and the school effect for the given variable, but rather are the school effect independent of or controlling for the student effect. Therefore, to correctly estimate compositional effects using multilevel models, the variance in the outcome due to the student effect must be partialed out. This is most easily accomplished by including the variable in the individual model specified as either uncentered or grand mean centered. Typically, it should not be group mean centered because that specification does not adjust the school means on the outcome for the student effect. As a result, if the student measure is group mean centered the school measure will be the cumulative effect of the student and school effects. For this reason the student measure of socioeconomic status is included in the model grand mean centered in the present study.[7]

Socioeconomic composition and other continuous variables used in this study were converted to standard normal distributions with a mean of zero and standard deviation of 1.0. This was done to facilitate interpretation of the measures, many of which are factor scores with nearly standard normal distributions near or with ambiguous raw metrics. This also facilitates the comparison of the magnitude of the effects of SEC and other factors such as SES on attainment. Categorical independent variables were dummy coded.

[7] See Raudenbush and Bryk (2002, p. 134-142) for a detailed discussion on this issue.

Results

Baseline Socioeconomic Composition

The Baseline model results are summarized in Table 2. The intercept coefficient for the High School Graduation model indicates the odds of graduation for a student from an average SES family and average SEC school is 8.94, which simply means that students with those conditions are about 9 times more likely to graduate than not graduate.[8] This corresponds to a graduation probability of 0.90.[9] The intercept for 2-year College Enrollment pertains to students who either enroll in a 2-year college or do not enroll in college, indicating the odds of enrolling in a 2-year college is 1.37 for students with average SES and SEC. This corresponds to a 0.58 enrollment probability. Similarly, the 4-year college intercept coefficient is the odds of enrolling in a 4-year college compared with not enrolling in college, indicating students with this background are 2.32 times (probability = 0.70) more likely to enroll. The intercepts for the College Persistence model indicate that students with average SES attending average SEC schools who originally enrolled in a 2-year college have a 2.33 odds (probability = 0.70) of persisting in their enrollment after 2 years and students who originally enrolled in a 4-year college have a 9.28 odds (probability = 0.90) of persisting after 2 years.

Table 2 About Here

[8] Because multilevel non-linear models are not widely understood, the Baseline model results will be presented with greater explanation than usual. However, due to space limitations explanations of results for subsequent models will be less detailed.

[9] Note that an odds ratio can be converted to the probability metric using the following equation: $p_{ij} = \frac{1}{1+\exp\{-\eta_{ij}\}}$ where p_{ij} is the probability of success (e.g., graduation) for student i in school j, and $\exp\{-\eta_{ij}\}$ is the odds ratio.

The results show that high school socioeconomic composition is significantly associated with each of the sequential attainment outcomes, controlling for family SES. The SEC coefficient indicates the change in the odds of success on the outcome (the intercept) per unit change in SEC. For the Graduation model the SEC coefficient indicates that when holding constant SES at its mean the odds of graduation for students attending schools which differ by one standard deviation on SEC are 1.29 times greater in the higher SEC school. Therefore, the odds of graduation for a student with average SES attending a school with an SEC of 1.0 is 1.29*8.94 = 11.53 (probability = 0.92). The notion of the 95% range of plausible values can also be applied here to better gauge the magnitude of the SEC effect in the population of schools. SEC is an approximately normally distributed variable. Approximately 95 percent of the schools are expected to fall between ± 2 standard deviations from the mean on SEC. This factoid can be used to compute the expected range of graduation odds 95 percent of the schools are expected to fall between. Comparing schools ± 2 standard deviations from the mean, the graduation odds for schools 2 standard deviations below the mean on SEC are 5.33 (probability = 0.84) and 14.97 (probability = 0.94) for schools 2 standard deviations above the mean.[10] Approximately 95 percent of the schools will fall between those limits for the SEC effect. This indicates that for students with average SES, attending a high SEC school compared with a low SEC school is expected to increase their probability of graduation by 10%.[11] Comparisons of the SEC and SES effects is also helpful for gauging the magnitude of the SEC effect because SES is considered to be one of the most robust predictors of educational outcomes. A one standard deviation increase

[10] Note that the range is asymmetric in the probability metrics because the logistic curve is not linear. These computations were derived using the log-odds values for the coefficients, which are not shown, but can easily be computed for the odds.

[11] Note that this estimate is of the effect of SEC independent of SES. However, in reality it is not feasible to hold SES constant while changing SEC, because SEC is the aggregate of SES. Hence, the actual 95 percent range of plausible values (i.e., ±-2.0 SD on both SEC and SES) in the probability metric is 0.70 to 0.97).

in SES increases the odds of graduation by a factor of 1.52, holding SEC constant. This corresponds to an expected change in the probability of graduation for an average SES student compared with a student one standard deviation above average of 0.031 (from 0.900 to 0.931), which is 55 percent larger than the effect of a one standard deviation increase in SEC from average to one standard deviation above average (0.020, from 0.900 to 0.920). Note that the non-linear nature of the logistic curve dictates that the difference in the magnitude of the SES and SEC effects will diminish per successive standard unit as the probability of graduation approaches one.

SEC has a similar association with Enrollment and Persistence outcomes; however, some interesting patterns emerge. Similar to the Graduation outcome, the effects of SEC, while substantial, are consistently smaller than the effects of SES. Using the same method as above for the Graduation model, the SES effect on 2-year college enrollment is 23% greater than the SEC effect in the probability metric and 78% greater than the SEC effect on 4-year college enrollment. For the persistence outcome the SES effect is 30% and 44% greater than the SEC effect for the 2- and 4-year college persistence, respectively. Another trend is that the magnitude of the effect of SEC is consistently much larger at 4-year colleges as compared to 2-year colleges. This finding was expected because 4-year colleges tend to be more selective, more rigorous, and more expensive, all of which should amplify the effects of socioeconomic composition on enrollment and persistence. Note that the fit of each model to the data presented at the bottom of Table 2 is provided for comparison with subsequent models.

Student Model

Recall that this model is for the purpose of controlling for differences in the backgrounds of the students attending the schools. These student control variables are associated with the

outcomes and SEC, and therefore moderate the effect of SEC on the outcomes. Because the individual coefficients on the student control variables are not of substantive interest in the present study, they are not described here, but rather only displayed in Table 3.

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Table 3 About Here

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After the student background variables were added, the effect of SEC proved only marginally significant ($0.05 < p < 0.10$) for the graduation outcome and although its association with each of the other attainment outcomes remains statistically significant, the magnitude of its effect is reduced in each case. Interestingly, this moderation also reduced the magnitude of the SES effect in each outcome, so that the SES and SEC effects are comparable in magnitude across the outcomes. Note that this comparison is more appropriate than the Baseline Model comparison because both the SES and the SEC effects are overestimated in the Baseline model due to each "mopping up" the effects of other covariates that are not included in that model.

The likelihood ratio test (LRT) assesses whether the student variables as a group significantly improved the fit of the model to the data. For each attainment outcome, the fit of the model significantly improved over the Baseline model. The magnitudes of the LRTs are very large indicating the substantial importance of individual differences on educational attainment.

School Input Model

School inputs are characteristics of schools that are considered to be outside of the control of school site personnel, whereas school practices are within their control. The School Input model precedes the School Practice model in the model building sequence to account for the variation in the outcomes beyond the control of school personnel before modeling the

practices. Both the Input and Practice models also include the aforementioned student variables, but those results essentially do not change and thus are not presented again.

The School Input results shown in Table 4 indicate that inputs moderate the effects of SEC on enrollment and persistence at 4-year colleges. Controlling for individual differences among students, students who attended an urban high school compared with a suburban high school were more likely to enroll at a 4-college, but less likely to persist once there. Attending an extra large (more than 1800 students enrolled) high school compared with attending a medium size school (600-1200 students -- the reference category), tended to have a positive effect on attainment controlling for the other factors in the model, with highly significant positive effects on persistence at 4-year colleges. The LRT indicates that adding the school inputs statistically improved the fit of each model to the data.

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Table 4 About Here

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School Practice Model

The school practice model results are summarized in Table 5. Because school practices are the most easily alterable of the independent variable types considered in this study, the results of this model are of greatest policy interest. A number of school practices are associated with each sequential attainment outcome. Controlling for the effects of school practices substantially reduces the magnitude of the association between SEC and the outcomes. In fact, after controlling for school practices, SEC is significantly associated ($p < 0.05$) only with enrollment and persistence at 4-year colleges. It is also marginally associated ($0.05 < p < 0.10$) with enrollment at 2-year colleges.

Table 5 About Here

The school practice with the most consistent effect on educational attainment is Academic Press, which is a factors score capturing the degree to which the school emphasizes academics. It has a significant positive association with each outcome except high school graduation. Attending a high school where Teacher Morale is high has a significant positive effect on enrollment and persistence at 4-year colleges. These findings indicate that above all else a strong academic orientation and highly collegial, positive, and well-managed environment are most critical for promoting college-going behaviors. Time spent on homework and participation in sports during high school were significantly associated with graduation, but not with higher levels of attainment. The LRT test results indicate that school practice variables significantly improved the fit of the model for each of the attainment outcomes.

Discussion

This section begins by directly addressing the two research questions of this study. This is followed by a discussion on whether the results support theories that the effect of SEC is due to school effects or to peer effects. Finally, the implications of the findings to educational policy are considered.

Revisiting the Research Questions

Research Question 1: What is the magnitude and prevalence of the SEC effect?

In 1966 Coleman and his colleagues found that the SEC of the school one attends is more strongly associated with achievement than any other school factor. More recently, Rumberger and Palardy (2005) noted that the magnitude of the SEC effect on student learning in

high school is similar to the magnitude of family SES on learning. These findings demonstrate that there is a robust association between SEC and achievement and learning. The results of the present study indicate that SEC has a similarly robust association with attainment. After controlling for SES and an extensive number of student background variable, SEC is positively associated with each sequential attainment outcome. Moreover, the SEC effect is generally comparable in magnitude to the effect family SES, which is widely recognized to be one of the most potent predictors of educational outcomes.

Two noteworthy patterns emerged in the results. First, the SEC-attainment association tends to become progressively stronger at each successive level of attainment. This is the case even though low SES students drop out of the attainment pipeline at higher rates at each stage, leaving progressively more selective samples of students from low SEC schools.[12] Second, the magnitude of the SEC effect is larger for 4-year college enrollment and persistence than for 2-year college enrollment and persistence. These patterns were expected because the amount of commitment and academic preparation necessary for success tend to increase with each sequential level of attainment and are magnified at 4-year colleges as compared with 2-year colleges. These increases tend to benefit students who attended high SEC schools that typically provide greater academic preparation and more academically advantageous peer effects, cultural capital, and habitus.

Research Question 2: Do the three types of covariates moderate the effects of SEC? The results, summarized in Figure 3, show that student background, school inputs, and school practices each moderate the effect of SEC at least to some degree on some of the attainment outcomes. Student background is the most potent and consistent moderator of the three.

[12] If the same sample was used for each model and all students were retained for each successive analysis, the SEC effect would be even larger for enrollment and persistence.

Controlling for differences in student background across schools reduces the effect of SEC on the odds of graduation by 52 percent (from 1.29 to 1.14)[13] and the odds of enrolling in a 2-year college by 37 percent (from 1.16 to 1.10), suggesting that the Baseline Model SEC effect for graduation and 2-year college enrollment are partially due to differences in the backgrounds of the students attending high schools. That means if all schools took in students from similar backgrounds, the SEC effect on graduation and 2-year college enrollment would diminish substantially in magnitude. In comparison, student background moderates the effect of SEC on the other attainment outcomes to a lesser degree. Student background reduced the effect of SEC on the odds of 4-year college enrollment and persistence by 15 percent and 8 percent, respectively, while the odds effect of SEC on 2-year college persistence actually increased by 17 percent after controlling for student background.

Figure 3 About Here

An extensive number of school inputs were tested measuring aspects of the student composition, school resources, and school structures (see Appendix Table 1). Of these, only two were significantly associated with any attainment outcome—school size and urbanicity. As a result, the moderating effect of school inputs on SEC was largely inconsequential, the one exception being for 4-year college persistence. After controlling for school inputs, 4-year college persistence saw a reduction in the odds effect of SEC by 35 percent. This was due almost solely to the dummy variable indicating students who attended extra large schools had

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[13] A 1.0 coefficient indicates that variable does not change the odds of success on the outcome, whereas a coefficient greater than 1.0 indicates the variable has a positive association with success. Therefore, a coefficient of 1.0 is treated as having an effect of zero on the odds of success. In this example the SEC coefficient is reduced from 1.29 to 1.14, a reduction of 0.15 or 52% (0.15/0.29).

significantly higher 4-year persistence rates as compared to students attending medium size schools. These findings suggest that the typically more extensive college preparatory curriculum at extra large schools may offer significant advantages to college success. It is noteworthy that no compositional effects other than SEC and no resource variables were associated with any of the attainment outcomes. These findings indicate that after thoroughly controlling for student background, school inputs have little association with attainment and little bearing on the SEC-attainment association.

While several school practices were associated with attainment, the effect of SEC was moderated for only high school graduation and 2-year college persistence, which were reduced by 69 and 27 percent, respectively. After controlling for school practices, SEC was no longer statistically associated with high school graduation and 2-year college persistence. These findings suggest that school practices have a considerable effect on high school graduation rates and, to a lesser extent, community college persistence. Moreover, they suggest that SEC is essentially a school effect for those two attainment outcomes, a conclusion that is elaborated upon below.

Addressing Theory: Is the SEC-Attainment Association a School Effect or Peer Effect?

As discussed above, the two primary theories for the effect of school socioeconomic composition on educational outcomes are: 1) that SEC is essentially a school effect in that it is correlated with school context (i.e., other student compositional characteristics, school resources, and school structures) and practices that favor educational success; 2) Students at high SEC schools tend to have peers whose attributes enhance their educational success. The results of the present study suggest that both school effects and peer effects contribute to the SEC-attainment association, however, that it depends on the attainment outcome. For high school graduation and

2-year college persistence, SEC is almost fully moderated by school practices, suggesting SEC is mostly a school effect for those outcomes. For 4-year college enrollment, school effects (school input or practices) have almost no bearing on the SEC effect, which remains large in comparison to the other outcomes and highly significant. This suggests that SEC is mostly a peer effect for 4-year college enrollment. For 4-year college persistence, school inputs do moderate the SEC effect, but a highly significant effect still remains implying that both school effects and peer effects contribute. Finally, the SEC effect for 2-year college enrollment is very small after controlling for student inputs, suggesting that school SEC hardly matters to 2-year college enrollment.

It is important to recognize that while the results suggest that a relatively small set of school effects are associated with attainment, the mean values for the vast majority of the school variables differ significantly in low SEC schools compared with high SEC schools. For example, of the five school resource measures considered for the school input model[14], none were significant predictors of attainment; nonetheless, all were in significantly greater availability in high SEC schools than in low SEC schools. Hence, while the distribution of resource availability is indisputably inequitable on these and most other input and practice measures, it does not seem to impact attainment. Yet, it is possible that while individually these factors are not predictive of attainment, the cumulative effect creates a context that is inhospitable to the educational process, undermining learning and facilitating dropout and discouraging college going behaviors. Some recent research has supported this perspective,

[14] The five resource measures are student-to-teacher ratio, quality of the school facilities (e.g., science labs, library, and space availability), quality of school equipment (textbooks, computers, multi-media), percent of teachers who were fully certified, and average teacher salary.

although it is inherently difficult to statistically model such cumulative effects (Bryk, et al., 2010; Palardy, 2008).

Policy Implications

A central aspect of the Obama administration's educational policy is raising attainment, with the stated goal of the U.S. once again having the highest proportion of college graduates in the world (Obama, 2009). One element of that policy is reforming high schools to better prepare students for college. The results of the present study inform this effort. First and foremost, the results show that high school SEC is robustly associated with attainment and that students attending low SEC schools face additional challenges that tend to undermine their attainment. Indeed, students attending low SEC schools are typically doubly educationally disadvantaged in that they also likely come from low SES families. Even after statistically controlling for differences on an extensive number of student background characteristics, low SEC schools have lower graduation rates, college attendance rates, and college persistence rates. The SEC attainment disparity is greatest for 4-year college enrollment and persistence rates. It is important to reiterate that the actual SEC disparity in 4-year college enrollment and persistence is more pronounced than the results suggest because non-graduates are not included in that estimate nor are graduates who did not enroll in college, both of which are more likely to have attended a low SEC high school. Hence, efforts to increase the proportion of Americans with college degrees, particularly if equality of opportunity is also an objective, should focus on low SEC schools.

The results of this study show that the SEC effect on high school graduation is almost completely moderated by school practices including mean time spent on homework and mean interscholastic sport participation rate. These practices are proxy measures for academic and

social engagement at schools. A literature exists demonstrating that academic and social engagement raises student achievement and graduation rates (Bryk & Driscoll, 1988; Finn, 1989; Gamoran, 1996; Phillips, 1997; Rumberger, 1995; Wehlage, et al., 1989). It is assumed that students who spend more time on homework are more engaged in their coursework. Similarly, it is assumed that students who participate in school-sponsored varsity and junior varsity athletics are more socially engaged with their peers. School with higher means on these measures, controlling for student and school inputs, are promoting academic and social engagement, which has positive impacts of graduation rates. The findings of this study shows that those school practices also moderate the effect of SEC on graduation. Moreover, mean levels of academic and social engagement are far higher in high SEC schools than low SEC schools. Therefore, one general policy prescription is to develop interventions designed to raise academic and social engagement in low SEC school.

It is worth noting that not all types of social engagement at school have positive effects on graduation. For example, mean participation in a school-sponsored club was also tested and was not associated with graduation. What makes high school sports special may be the greater level commitment and intensity necessary for participation. The extra commitment and intensity are believed to result in a greater sense of belonging and accomplishment of participants, which is where the social benefits related to graduation are derived. High school activities that require less commitment may not provide the same engagement benefits.

Promoting college enrollment and persistence requires an emphasis on a different set of school practices than high school graduation. The single most important practice for enrollment and persist is school academic press. There is a literature on this construct mostly on its effect on high school achievement (see Lee & Smith, 1999). In the present study Academic Press is a

factor score of five Likert type principal reported items including, "teachers press students to achieve," "counselors/teachers encourage students to enroll in academic classes," and "classroom activities are highly structured." Emphasis of academic press is most valuable to college success in the most academic settings, which are 4-year colleges in the present study, although academic press did have a positive effect on 2-year college enrollment. A second practice associated with 4-year college success is Teacher Morale, which is also a factor score of three principal reported items including "teacher morale is high," "many teachers are negative about students," "there is often conflict between teachers and administrators." Teacher Morale is a school climate variable that is a proxy for relational trust between teachers and students and also between teachers and administrators. Relational trust has recently become one of the central tenets of the school improvement movement (Bryk et al., 2010; Bryk & Schneider, 2002; Tschannen-Moran & Hoy, 2000). Bryk and his colleagues refer to trust as a necessary condition, particularly in low SEC schools, without which other effective practices (e.g., academic press) cannot be effectively implemented. A second general policy prescription for reforming high schools to improve college participation is to implement intervention designed to improve academic press and teacher morale.

Shortcomings

As is the case with virtually all empirical research, the present study has some shortcomings. Perhaps the most relevant outcome measure to the Obama administration's policy agenda is college graduation, which is not yet available for ELS. Future research will address how high school SEC and other school effects impact college completion. This study focuses on the effect of SEC on attainment and concludes that the low SEC context represents a significant barrier to success at each of the attainment milestones considered. This study does not examine

which specific school practices are effective in the low SEC context (or the high SEC context), however. Because the effectiveness of school practices often depends on the context, specific analyses of, for example, low SEC schools, will provide more precise context-specific information that can more effective inform policy remedies (Palardy, 2008).

Conclusion

This study extends the literature on the effect of high school socioeconomic composition on attainment from high school graduation to college enrollment and persistence. The results indicate that SEC has a robust association with attainment even after statistically controlling for an extensive number of student input variables across schools. The SEC effect is comparable in magnitude to the effect of family SES. Attending a low SEC school reduces the probability of success at each attainment milestone with the magnitude of the effect being most pronounced for 4-year college enrollment and persistence.

In general, school inputs and practices, two major types of school effects, moderate the association between SEC and attainment, indicating that the SEC effect is partially due to differences in school inputs and practices. Altering school practices can reduce the negative effect of attending a low SEC school. The results show that the most important school practices for moderating the SEC effect and for raising attainment depends on the attainment outcome. High School Graduation is most responsive to practices that improve academic and social engagement as measured by mean time spent on homework and the proportion of the student body that participates in interscholastic sports. Academic press and teacher morale (a proxy measure for relational trust), are the most effective practices for improving 4-year college enrollment and persistence.

However, a significant SEC effect remains for enrollment and persistence at 4-year colleges even after statistically controlling for school inputs and practices. This indicates that while the SEC effect is partially due to differences in the quality and quantity of school inputs and practices, there is also an element of the SEC effect that will be resilient to school reform efforts focusing on school practices. This element is believed to be the result of peer effects. The background of one's classmates matters for a variety of reasons. Peers influence one another's educational trajectories by directly transfer of knowledge and skills through repeated interactions, through the exchange of cultural capital which becomes progressively valuable as one moves up the attainment ladder, and through influencing one another's educational tastes, perspective, and values (i.e., habitus), and aspirations (Bourdieu, 1977, 1986; Kahlenberg, 2001; McDonough, 1997). Addressing peer effects may require redistributing students in schools so that SEC is more equal across schools.

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Table 1: Sample Selection Criteria

Condition	Student N	School N
Unrestricted Sample	16,197	751
Public School (BYSCTRL=1)	12,765	581
Second Follow-up-Base Year Panel (F2BYWT > 0) [1]	10,936	581
Graduated on Time (F2HSSTAT = 1or 3) [2]	9,359	581
Enrolled Immediately (F2RTYPE = 1 or 3) [3]	6,305	578

[1] = Graduation Model sample; [2] = Enrollment Model sample; [3] = Persistence Model sample.

Table 2: Result of Baseline Model for Socioeconomic Composition

Variable Name	HS Graduation	College Enrollment		College Persistence	
		2 year	4 year	2 year	4 year
Fixed Effects					
Intercept	8.94**	1.37**	2.32**	2.33**	9.28**
SE Composition	1.29**	1.16**	1.53**	1.12*	1.25**
SES	1.52**	1.31**	2.06**	1.16**	1.41**
Model Fit					
N of parameters	4	6		9	
Log-Likelihood	-3629.77	-8655.09		-6002.82	

Coefficients are change in odds of success per unit increase in predictor. Values greater than 1 indicate an increase in the odds, while values less than 1 indicate a decrease in the odds.
Note for all statistical results: * = $p < 0.05$; ** = $p < 0.01$

Table 3: Result of Student Model

Variable Name	HS Graduation	College Enrollment 2 year	College Enrollment 4 year	College Persistence 2 year	College Persistence 4 year
Fixed Effects					
Intercept	47.56**	2.16**	2.17**	1.80**	3.14**
SE Composition	1.14†	1.10*	1.45**	1.14*	1.23**
Demographics and Family Background					
SES	1.05	1.23**	1.60**	1.15*	1.20**
Family Composition	1.05*	1.14*	1.19*	1.14	1.28*
Asian/Pacific Islander	1.71*	2.12**	2.37**	1.47*	2.79**
Black	1.38*	1.14	2.68**	0.88	1.22
Hispanic	0.86	1.14	1.07	1.00	1.79**
American Indian	1.10	0.92	1.64	0.67	0.93
Academics					
Cumulative Academic GPA (12th grade)	1.78**	1.24**	2.06**	1.43**	1.61**
Math/Reading Achievement (10th grade)	1.27**	1.19**	1.71**	1.00	1.06
Carnegie Units	3.90**	1.07	1.10	1.12	1.19†
Math Pipeline	1.48**	1.38**	2.83**	1.22*	1.43**
School and Family Engagement					
Participant Varsity Sports	1.28*	1.24**	1.94**	1.19†	1.34*
Parental Engagement	1.06	1.08*	1.15**	0.93	0.92
Friend dropped out	0.61**	0.84**	0.68**	0.85	0.79*
Transfer	0.29**	0.55**	0.74**	0.77†	0.94
Post-secondary Factors					
Financial Aid Offered	---	0.36**	1.19*	0.95	1.15
High Importance of College Expenses	---	1.10	0.50**	0.95	1.33
Moderate Importance of College Expenses	---	0.93	0.62**	0.82	0.99
High Importance of Financial Aid	---	1.75**	1.51**	1.04	0.46**
Moderate Importance of Financial Aid	---	1.05	0.93	1.13	0.91
Often Met Faculty about Academics	---	---	---	1.17	2.24**
Sometimes Met Faculty about Academics	---	---	---	1.24†	1.79**
Often Met Advisor about Academic Plan	---	---	---	2.85**	2.18**
Sometimes Met Advisor about Academic Plan	---	---	---	1.62**	1.18
Often Participate in Extracurricular Activities (other than sports)	---	---	---	0.85	1.74**
Sometimes Participate in Extracurricular Activities (other than sports)	---	---	---	1.04	1.19
Model Fit					
N of parameters	17	42		81	
Log-Likelihood	-1824.72	-6780.67		-4765.39	
LRT (compared with previous model)	3205.90**	3294.24**		2396.95**	

Coefficients are change in odds of success per unit increase in predictor. Values greater than 1 indicate an increase in the odds, while values less than 1 indicate a decrease in the odds. LRT = likelihood ratio test.
Note for all statistical results: † = $p < 0.10$; * = $p < 0.05$; ** = $p < 0.01$

Table 4: Result of School Input Model

Variable Name	HS	College Enrollment		College Persistence	
	Graduation	2 year	4 year	2 year	4 year
Fixed Effects					
Intercept	46.71**	1.93**	1.75**	1.57**	2.90**
SE Composition	1.13†	1.09†	1.46**	1.15l;*	1.15*
School Inputs					
Urban	0.99	0.89	1.64**	1.21	0.77†
Rural	0.89	1.09	1.22†	1.02	1.04
Small	1.10	1.08	0.96	1.06	0.82
Large	1.04	1.01	1.08	1.11	1.02
Extra Large	1.09	1.23†	1.20	1.12	1.65**
Model Fit					
N of parameters	22	52		93	
Log-Likelihood	-1824.06	-6739.41		-4732.49	
LRT	135.00**	51.99**		49.91**	

Coefficients are change in odds of success per unit increase in predictor. Values greater than 1 indicate an increase in the odds, while values less than 1 indicate a decrease in the odds. LRT = likelihood ratio test. Note for all statistical results: † = $p < 0.10$; * = $p < 0.05$; ** = $p < 0.01$

Table 5: Results School Practice Model

Variable Name	HS Graduation	College Enrollment 2 year	College Enrollment 4 year	College Persistence 2 year	College Persistence 4 year
Fixed Effects					
Intercept	45.60**	2.04**	1.73**	1.55**	3.15**
SE Composition	1.04	1.11†	1.43**	1.11	1.15*
School Inputs					
Urban	1.04	0.87	1.61**	1.22	0.80
Rural	0.88	1.11	1.18	0.97	1.05
Small	0.95	1.14	0.92	1.04	0.80
Large	1.11	0.96	1.09	1.14	1.01
Extra Large	1.22	1.08	1.21	1.16	1.61*
School Practices					
Academic Press	0.97	1.10*	1.16*	1.10†	1.19*
Teacher Morale	1.02	1.06	1.18**	1.01	1.28**
Homework Time	1.19*	1.03	1.02	0.96	0.92
Participate in Sports	1.14†	1.02	0.96	0.94	1.12
Safe School Environment	1.11	0.88**	1.06	1.09	0.92
Model Fit					
N of parameters	27	62		108	
Log-Likelihood	-1816.21	-6719.31		-4712.71	
LRT	15.28**	27.14**		32.33**	

Coefficients are change in odds of success per unit increase in predictor. Values greater than 1 indicate an increase in the odds, while values less than 1 indicate a decrease in the odds. LRT = likelihood ratio test.

Note for all statistical results: † = $p < 0.10$; * = $p < 0.05$; ** = $p < 0.01$

Appendix Table 1: Descriptive Statistics for Graduation, Enrollment, and Persistence Samples

Variable Name	Graduation		Enrollment		Persistence	
	Mean	SD	Mean	SD	Mean	SD
Student-level variables						
Demographics and Family Background						
SES	0.08	0.57	0.12	0.57	0.22	0.58
Non-traditional family structure	0.53	0.50	0.56	0.50	0.61	0.49
Asian/Pacific Islander	0.04	0.18	0.04	0.19	0.05	0.21
Black	0.14	0.34	0.13	0.34	0.12	0.32
Hispanic	0.15	0.35	0.13	0.34	0.11	0.31
American Indian	0.01	0.10	0.01	0.09	0.01	0.08
Academics						
Cumulative Academic GPA (12^{th} grade)	2.50	0.93	2.66	0.84	2.86	0.81
Math/Reading Achievement (10^{th} grade)	50.15	9.80	51.25	9.55	53.41	9.00
Carnegie Units	24.06	5.48	25.41	3.92	25.66	4.02
Math Pipeline	5.30	1.60	5.55	1.60	5.94	1.43
School and Family Engagement						
Participant Varsity Sports	0.50	0.47	0.53	0.47	0.58	0.47
Parental Engagement (FS)	0.00	0.76	0.02	0.76	0.05	0.75
Friend dropped out	0.52	0.50	0.47	0.50	0.41	0.49
Transfer	0.19	0.40	0.11	0.32	0.09	0.29
Misbehavior (FS)	0.01	0.83	-0.09	0.67	-0.16	0.55
Post-secondary Factors						
Financial Aid Offered			0.62	0.48	0.62	0.48
College Expenses High Importance			0.35	0.48	0.34	0.47
College Expenses Moderate Importance			0.50	0.50	0.50	0.50
Financial Aid High Importance			0.57	0.49	0.57	0.49
Financial Aid Moderate Importance			0.32	0.47	0.30	0.46
Met Faculty about Academics Often					0.23	0.42
Met Faculty about Academics Sometimes					0.24	0.43
Met Advisor about Academic Plan Often					0.25	0.44
Met Advisor about Academic Plan Sometimes					0.57	0.49
Participate in Extracurricular Activities (other than sports) Often					0.60	0.49
Participate in Extracurricular Activities (other than sports) Sometimes					0.32	0.47
School-level variables						
Student Composition						
Non-traditional family	0.53	0.15	0.53	0.15	0.53	0.15
Percent minority	27.74	31.42	27.74	31.42	27.50	31.25
Mean prior achievement	49.64	4.63	49.64	4.63	49.69	4.61
Extent of 2003 graduates attend 4-yr college	4.07	1.18	4.07	1.18	4.07	1.18
Extent of 2003 graduates attend 2-yr college	3.41	0.85	3.41	0.85	3.41	0.85
Mean SES (Socioeconomic Composition)	-0.01	0.25	-0.01	0.25	-0.01	0.25
School Resources						
Student/teacher ratio	15.53	4.52	15.53	4.52	15.55	5.10
Learning hindered by facilities (FS)	0.01	0.93	0.01	0.93	0.01	0.93
Learning hindered by equipment (FS)	0.05	0.89	0.05	0.89	0.05	0.89
Percent full teacher certification	90.20	16.65	90.20	16.65	90.69	15.42
Teacher salary	40165	7673	40165	7673	40018	7580
School Structures						
Urban	0.15	0.36	0.15	0.36	0.15	0.36
Rural	0.43	0.50	0.43	0.50	0.44	0.50

Small school	0.56	0.50	0.56	0.50	0.56	0.50
Large school	0.13	0.33	0.13	0.33	0.13	0.33
Extra large school	0.09	0.29	0.09	0.29	0.09	0.29
School Processes and Practices						
Academic Press (FS)	-0.21	1.00	-0.21	1.00	-0.19	0.94
Participate in Sports	0.55	0.21	0.55	0.21	0.55	0.20
Participate in Clubs	0.57	0.18	0.57	0.18	0.57	0.18
Homework Time	-0.06	0.38	-0.06	0.38	-0.05	0.38
Teacher Morale (FS)	-0.01	0.85	-0.01	0.85	-0.01	0.85
Learning Climate (FS)	-0.27	0.94	-0.27	0.94	-0.25	0.92
Mean Discipline Fair (FS)	0.02	0.40	0.02	0.40	0.02	0.40
Safe School Environment (FS)	0.12	0.53	0.12	0.53	0.12	0.53
Mean Misbehavior (FS)	0.02	0.30	0.02	0.30	0.02	0.29
Mean Classroom Disruption (FS)	-0.01	0.33	-0.01	0.33	-0.01	0.33
Mean Disorder (FS)	-0.18	0.85	-0.18	0.85	-0.19	0.85

Note: Student variables are weighted by F2BYWT and school variables are weighted by BYSCHWT. School-level Graduation and Enrollment samples are the same, while the Persistence sample contains 1 fewer school. FS means a factor score.

Figure 1: Conceptual Framework for Studying Individual and School Factors on Educational Attainment.

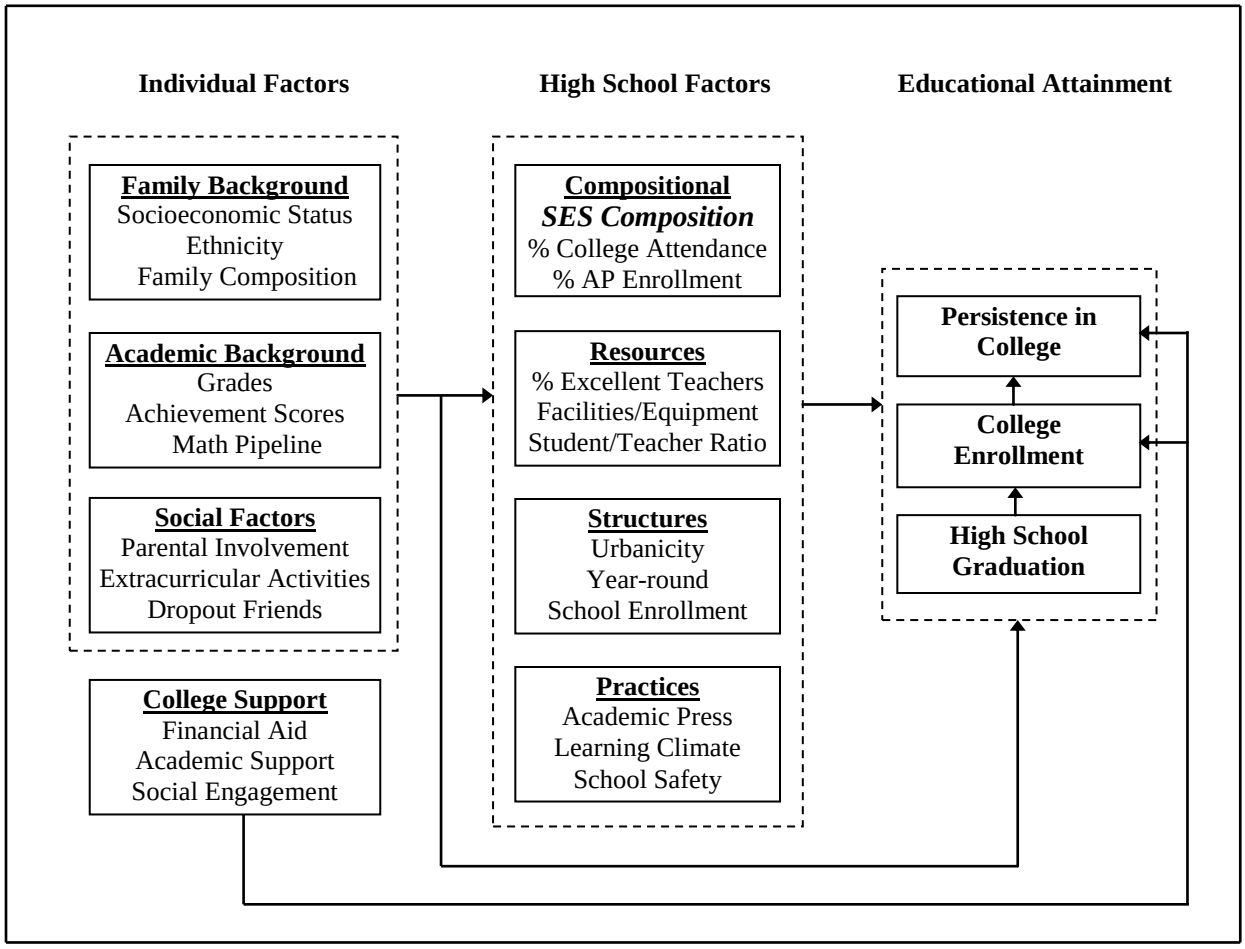
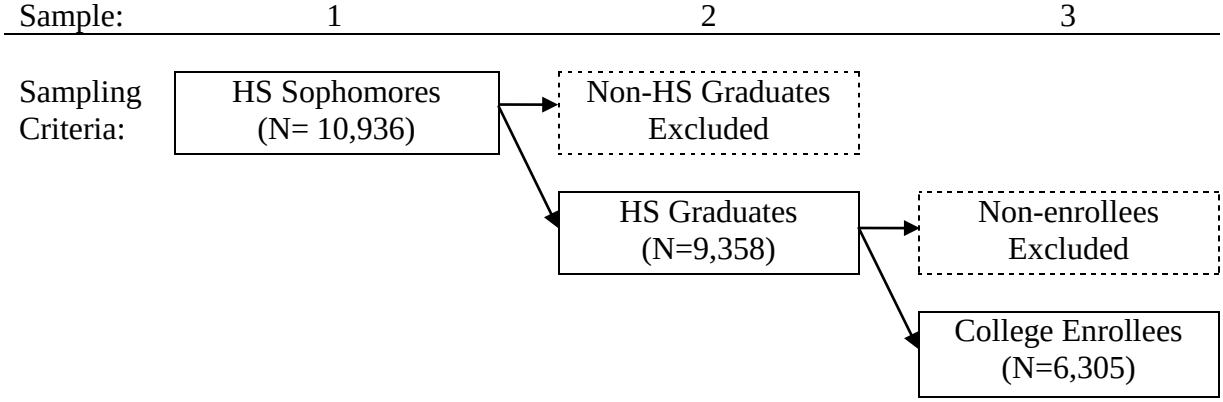


Figure 2: Sequential Sampling Design, Models and Attainment Outcomes

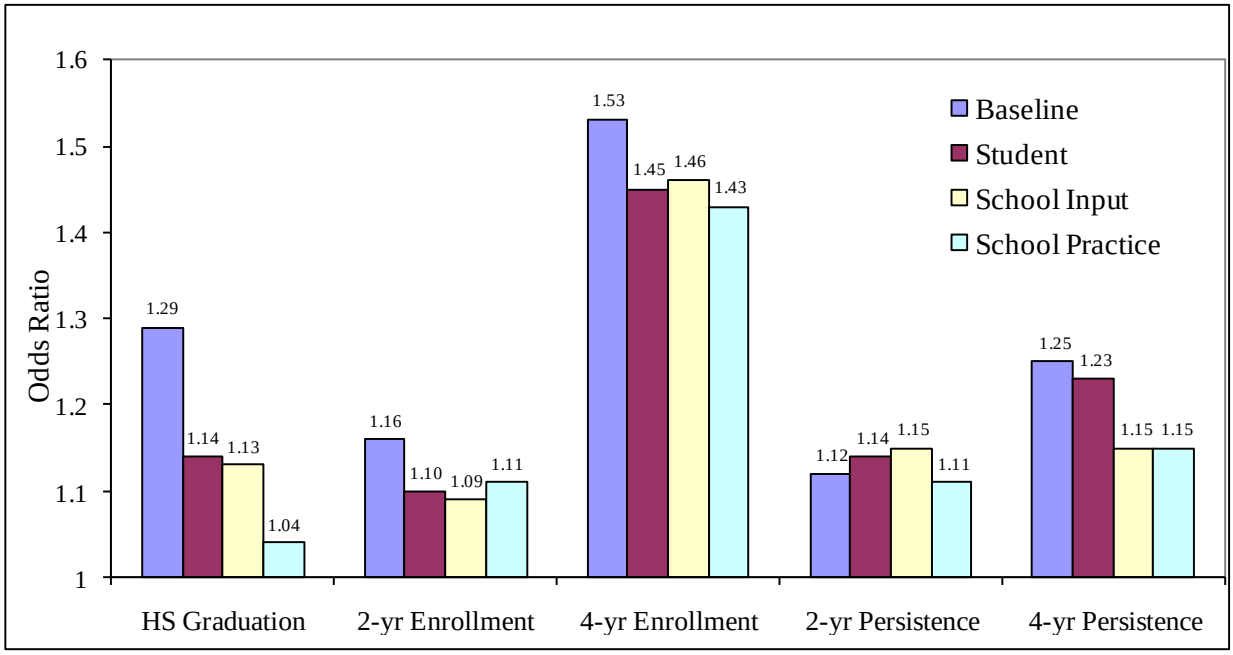


Model Outcome:‡	High school graduation	College enrollment	College persistence†
Coding Scheme:	1 = Graduated on time 0 = Otherwise	2 = Otherwise 1 = Enrolled 2-year 0 = Enrolled 4-year	3 = Persist 4-year 2 = Persist 2-year 1 = Depart 4-year 0 = Depart 2-year

† Note that the objective was to compare persisters and departers at 4-year and 2-year colleges, respectively. Because that requires two different reference categories, the model was run twice: first with 4-year persisters as the reference group and then with 2-year persister as the reference group.

‡ By convention, for binary outcomes the reference category is the lowest numbered group, typically coded zero, whereas for multinomial outcomes the reference category has the highest number.

Figure 3: Magnitude of the SEC effect on each attainment outcome in successive model.



Technical Appendix: Multilevel Nonlinear Models

This study uses two types of multilevel nonlinear models including multilevel logistic regression for the binary Graduation outcome and multilevel multinomial logistic regression for the Enrollment and Persistence outcomes, which have more than 2 categories. Multilevel models are used because students are nested in schools. Data nested in structure violates the assumption of statistical independence when analyzed using traditional statistical approaches. Multilevel models alleviate that concern because they are designed to model the dependencies. As is typically the case in applications of multilevel model, the substantive focus in the present application is on modeling the effects of the dependencies. Thus, the present study models between-school variance in the effects of social composition on Graduation, Enrollment, and Persistence rates.

The logistic regression uses a binary outcome and logit (log of the odds ratio or log-odds) link function to model association between a set of covariates and the probability of being in one category compared with the other. By convention the category with the lowest number (usually zero), is the reference category. Multilevel logistic regression extends logistic regression to include additional levels to accommodate nested data. In the present study there are two levels. The level-one model or student model uses a binary Graduation outcome (0 = graduated, 1 = otherwise) and can be represented by the following equation:

$$\eta_{ij} = \log\left(\frac{p_{ij}}{1-p_{ij}}\right) = \beta_{0j} + \sum_{p=1}^{P} \beta_{pj} X_{pij}$$

Where η_{ij} is the log-odds of graduating for individual i in school j, p_{ij} is the probability of graduating, β_{0j} is the expected log-odds of graduating in school j conditioned on student

covariates X_1 through X_p, and β_{pj} through β_{1j} represent the expected change in the log-odds of graduating from school j per unit change in covariates X_1 through X_p.

The level-two model or school-level model can be represented by the following set of equations:

$$\beta_{0j} = \gamma_{00} + \sum_{q=1}^{Q} \gamma_{q0} W_{qj} + u_{0j} \qquad u_{0j} \sim N(0, \tau_u)$$
$$\beta_{qj} = \gamma_{q0} .$$

Where γ_{00} is the grand mean of the conditional log-odds of graduation from school 1 through j, W_{1j} through W_{qj} are school-level covariates, γ_{10} through γ_{q0} are school-level slope coefficients that describe the expected change in the log-odds of graduation per unit change in the associated W variable, and u_{0j} is the random effect for school j, which describes the deviation in the expected graduate rate for that school given the set of control covariates in the model. The random effect is assumed to be distributed with a mean of 0 and a variance of τ_u. Note that this notation assumes that only the level one intercept coefficient randomly varies across schools, which is the case for each model estimated in the present study. All other coefficients are fixed.

The multilevel multinomial logistic regression models for the Enrollment and Persistence outcomes also use the logit link function and therefore the equations of those models are straightforward extensions of the multilevel logistic regression model equations described above and will not be presented here. Note that one critical difference is there will be an additional equation at level-1 and level-2 for each additional category in the outcome beyond 2. Therefore, there are 2 equations for the 3-category Enrollment model and 3 equations for the 4-category Persistence model. A second difference in the multilevel multinomial logistic regression model is that, by convention, the category of the outcome that is highest is the

reference group, which is compared with each of the remaining categories. For additional information about these models see Raudenbush and Bryk (2002, Chapter 10).