Tracing Racial Parity in Choice and Completion of Science, Math and Engineering Majors

by

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Abstract:

This paper investigates whether there is racial parity in choice and completion of science, math, and engineering (SME) majors using longitudinal data. Because these scientific and technical majors are associated with jobs that have high salaries and steady employment, completion of an SME major can yield substantial societal rewards. Past research has documented a racial gap in choice and completion of SME majors, with Blacks and Hispanics being less likely than Whites to do either. Surprisingly, these findings were not replicated in this study. I used weighted multivariate logistic regressions to measure racial differences in three related outcomes: (1) intention to major in an SME field in high school, given persistence to the senior year, (2) choice of an SME major, given entrance into college, and (3) completion of a bachelor's degree with an SME major, given college graduation. For all of these outcomes, underrepresented minorities were either equal to Whites or relatively advantaged, especially after controlling for prior academic achievement and preparation. I consider several potential explanations for this newfound racial parity, including the narrowing of racial gaps in academic performance and targeted recruitment and sponsorship of minorities at universities.

INTRODUCTION:

As college attendance expands, and more minorities matriculate into our nation's institutions of higher education, it is more pressing to understand factors that influence completion of majors associated with lucrative pay-offs. This study contributes to this endeavor by examining whether there is racial parity in completion of bachelors' degrees in science, math, and engineering (SME) majors using longitudinal data. Although many researchers frame college entrance and completion rates as the most relevant issue in achieving racial parity in higher education, focusing on these forms of vertical stratification alone gives us an incomplete picture. If we want to gain a more comprehensive understanding of how underrepresented minorities are faring in college, we must also pay attention to college majors as forms of horizontal stratification. After all, not all college majors carry equal weight in the labor market. College majors differ in terms of subsequent employment, salaries, and prestige (Clark, 1983; Hagstrom, 1971; Rumberger and Thomas, 1993). In order for minorities to reach economic parity with Whites, they must not only graduate from college, but also do so in majors that yield similar long-term rewards. Just as studying tracking and course sequences in high schools proved important in understanding the stratification processes associated with secondary schooling, so is studying entrance into and completion of college majors crucial in understanding stratification in college.

Studying a cluster of majors, such as the SME majors, provides a convenient case study to pursue this research agenda. These scientific and technical majors are associated with jobs that have high salaries and steady employment, especially in our increasingly skillbased society, (White, 1992)[1], making them noteworthy examples of paths to upward mobility. In addition, they are a route to a particular form of societal power: those who complete these majors frame the scientific and technical investigation and innovations in our world. Scientists, engineers, and technicians organize their research and design around problems that they view as important and, if racial minorities are disproportionately excluded from the opportunity to join the scientific ranks, this diminishes their ability to participate in this discourse.

While I am most interested in racial parity in completion of bachelor's degrees in SME fields, this thesis will also examine whether there are racial differences in intention to major in SME fields in high school and entrance to SME fields in college. These two outcomes are important precursors to completion of SME majors, and, thus, warrant attention. By documenting racial differences in high school SME intentions, choice of SME majors, and college graduation with SME majors, I will be able to track racial parity throughout the SME pipeline.

This metaphorical SME pipeline starts as early as elementary school and ends with entry into an SME career. Because I lack the longitudinal data to examine the SME pipeline from start to finish, I focus on the period in which the pipeline has the densest population.

[1] In 1992, when the respondents in data used for this thesis graduated from high school, the average unemployment rate for all workers was 6.7%, while the unemployment rate was 3.8% for engineers, 2.3% for natural scientists, and 2.6% for math and computer scientists (White, 1992). Furthermore, of all bachelors' recipients, graduates in engineering, physics, chemistry, math, and computer science commanded higher starting salaries than graduates in almost any other field. In mid-career, scientists and engineers earn substantially more than workers in other fields; only lawyers, doctors, and pharmacists make more, on average (White, 1992)

The population in the SME pipeline peaks in high school and then continues to decline as students transition to college, declare majors, and complete requirements for their bachelor's degree (Berryman, 1983). Students in high school often have high aspirations to enter into lucrative majors without having the practical knowledge or experience to understand what these majors require. After taking rigorous, lab-intensive math and science courses in the first two years of college, often referred to as "weed-out" classes by those in SME majors (Seymour and Hewitt, 1997), many of those students who intended to major in SME while in high school decide against it. And even after declaring SME majors, a large percentage of students do not persist to graduate in SME fields; in fact, more students switch out of SME majors than other types of majors (Green, 1989). Given that this leakage from the pipeline is continuous and concurrent with educational transitions, investigating whether there is racial parity at three different points along the SME pipeline will provide a more comprehensive understanding of how underrepresented minorities are faring relative to Whites.

Why do we need new research on racial equity in choice and completion of SME majors? Much of the research that uses nationally representative data to study racial parity in the SME pipeline is dated or methodologically suspect. According to research from the 1970s and early 1980s, Blacks and Hispanics were less likely than Whites to enter the SME pipeline in high school (Hilton and Lee, 1988), choose SME majors in college (Berryman, 1983; Hilton and Lee, 1988), or persist to graduation with an SME major (Hilton and Lee, 1988). However, since the early 1980s there have been significant societal shifts, including decreases in racial gaps in achievement, college attendance, and family socioeconomic status (Berends, Lucas, Sullivan, and Briggs, 2005; Alon and Tienda, 2005, 2007). Given that all of these societal shifts are associated with success on SME outcomes, previous findings on racial disparities in the SME pipeline may no longer apply.

Furthermore, more recent research on SME outcomes has not addressed racial differences in high school SME intentions and has not been able to definitively determine racial differences in choice and completion of an SME major. Studies on SME outcomes in the 1990s all suffer from one of these three limitations: (1) they are only applicable to specialized populations, such as students attending selective colleges or high ability students (Elliot et al., 1996; Smyth and McArdle, 2004),[2] (2) they rely on cross-sectional data to provide descriptive statistics by race but do not perform significance testing or use control variables (White, 1992; National Science Board, 1993), or (3) they confound educational persistence with persistence in the SME pipeline (Huang, Taddese, Walter, and Peng, 2000).

This third type of limitation is especially troubling because in these instances researchers used longitudinal data that was nationally representative but failed to provide decisive evidence of whether there were racial differences in SME outcomes. For example, one study used an analytic sample of 8th grade students to predict likelihood of entry into SME majors, finding a racial gap for underrepresented minorities (Huang, Taddese, Walter, and Peng, 2000). However, because this sample included eventual high school dropouts and students who never attended college, it is difficult to distinguish how much of the estimated racial differences in entry into SME majors are related to educational persistence and how

[2] Blacks and Hispanics are less likely to graduate in SME majors than Whites or Asians at selective colleges, though they choose SME majors at statistically equivalent rates (Elliot et al., 1996; Smyth and McArdle, 2004).

much they are related to persistence in the SME pipeline. Similarly, another analysis used a population of college students to predict graduation with an SME major, regardless of whether they had graduated from college. This study also noted a disadvantage for Blacks and Hispanics, relative to Whites, in completion of SME majors. However, because researchers confounded college graduation with completion of an SME major, we cannot parse out how much of this racial gap occurs because underrepresented minorities have unequal likelihood of graduating from college and how much occurs because they have unequal likelihood of completing SME majors.

I propose to address these methodological problems with measuring the racial gap in choice and completion of SME majors by using nationally representative, longitudinal data and by setting up my analytic samples so that my dependent variables do not confound educational persistence with persistence in the SME pipeline. I will track persistence in the SME pipeline by (1) measuring intention to major in SME fields, as expressed in high school, for a sample of high school seniors, (2) entry into SME majors, given entrance into college, and (3) completion of an SME major, given college graduation.

In addition to using a different methodological approach, this study will also further our understanding of factors related to successful completion of SME majors. As I will discuss in the literature review, there has been much research on the effects of family background, gender, and test scores on SME outcomes. I am interested, however, in building a more comprehensive model that incorporates ideas about how exposure to rigorous enrichment in science and math can make a difference, net of family background or academic achievement, in determining SME interest and persistence. As such, my models will include indicators of exposure to specific, advanced coursework, like calculus and physics, and enrichment activities, like science fair participation, discussion of science-related careers, and computer use.

LITERATURE REVIEW:

Research from the 1970s and 1980s showed that Blacks and Hispanics were less likely to choose and complete SME majors (Berryman, 1983; Hilton and Lee, 1988). However, given the narrowing of racial gaps in math and science achievement, family socioeconomic status, and college attendance, these racial disparities may no longer be present. This literature review will discuss possible explanations for both racial parity and disparity on SME outcomes.

Reasons to Suspect Racial Disparity on SME Outcomes:

Past studies suggest several possible mediating factors that may explain racial differences in SME outcomes. By far, academic preparation and achievement in science and math seem to play the biggest role in determining graduation with an SME major. However, prior research also indicates that lower frequency of exposure to math and science enrichment (both in the form of activities and interaction with SME professionals) lower parental income and education, gender gaps that differ by race, and lower rates of attendance at bachelor degree-granting institutions and selective colleges all contribute toward disparity in SME outcomes.

Academic Preparation and Achievement: Documented Effects on SME Outcomes

Differences in achievement and academic preparation are crucial in explaining racial disparities in choice and completion of SME majors. On average, Blacks and Hispanics score lower than Whites in math and science achievement tests (Peng, 1995) and receive lower grades in high school (Jaynes and Williams, 1989; Roscigno, 1998).[3] These achievement gaps arise because Blacks and Hispanics have less exposure to rigorous math and science curriculum throughout their educational trajectory, starting in elementary school and junior high (Persell, 1977; Rosenbaum, 1980; McKnight, Cross, White, Dossey, Kifer, Swafford, Travers, and Conley, 1987). Early disparities in coursework accumulate, so that by the end of the eighth grade, Blacks and Hispanics have lower achievement in math and science and lower preparation to tackle college-preparatory math and science courses (Muller, Stage, and Kinzie, 2001). As a result, in high school, Blacks and Hispanics are less likely than Whites to take rigorous math and science courses, even when they are college-bound (Rock, Braun, and Rosenbaum, 1985). While there are fewer racial differences in completion of biology and algebra, there are larger divergences in completion of more advanced math and science courses, most notably trigonometry, pre-calculus, calculus, and physics for the population of college-bound students (White, 1992).

[3] While these racial gaps are smaller for the population of college-bound students, they still exist (White, 1992). For example, at predominantly White colleges, there was a Black-White gap on the math SAT of nearly 100 points and a Hispanic-White gap of 50 points (Ramist, Lewis, and McCamley-Jenkins, 1994). In addition, while 11% of all incoming Black college students reported a high school GPA in the A range in 1990, 32% of Whites did (White, 1992).

In some cases, Blacks and Hispanics choose not to take advanced math and science courses, but, in many cases, they are not given the option, either because guidance counselors have placed them in lower level classes (Oakes, 1990; Page, 1987), [4] or because they attend a high-poverty school that lacks lab-intensive science and college-preparatory math courses due to a shortage of highly qualified teachers, a lack of instructional materials, and inadequate school facilities (Patillo-McCoy 1999; Kahle, Matyas, and Cho 1985).[5] Since Blacks and Hispanics are more likely to attend high-poverty schools than Whites (KewalRamani, Gilbertson, Fox, Provasnik., 2007),[6] these disparities in schooling conditions have disproportionate effects on underrepresented minorities' achievement and growth in math and science. Many Blacks and Hispanics leave high school under-prepared but overconfident, since they were excellent students at sub par schools (Seymour and Hewitt, 1997).

This inequity in coursetaking drives the achievement gap in math and science. The quantity of completed high school units in science is strongly related to individual growth for all races and achievement levels (Muller, Stage, and Kinzie, 2001; Jones, 1984; Jones,

[4] In addition, Blacks and Hispanics are less likely to have parents or school officials advocate for them to take academic courses to prepare them for college entry and success in college majors (Useem, 1992; Baker and Stevensen, 1986; Betz, 1990; Erickson, 1975).

[5] High poverty schools have a hard time attracting and retaining highly qualified teachers, resulting in a higher proportion of teaching vacancies (NCES, 1985; Ingersoll, 2001). This is especially true in subjects like math and science, fields in which there are national teacher shortages (Johnston and Aldridge, 1984). In these schools, it is not uncommon to have cancelled courses, long-term substitutes, and large class sizes in math and science (Oakes, 1990).

[6] In 2005, Blacks and Hispanics were more likely than Whites to attend high-poverty schools, or schools where the majority of students qualified for federal free or reduced lunch, while Asians were not (Huang, Taddese, Walter, and Peng, 2000). Furthermore, the majority of Blacks and Hispanics attended schools with 75% or more minority enrollment; the same does not hold true for Asians (KewalRamani et al., 2007).

Davenport, Bryson, Behhuis, and Zwixk, 1986). By the end of high school, Blacks and Hispanics consistently perform below the levels of Whites in math and science (Dossey et al., 1988; Mullis and Jenkins, 1988). Furthermore, they show disproportionately less science achievement gain from middle school to the end of high school, relative to Whites (Scott, Rock, Pollack, Ingels, and Quinn, 1995).

Most importantly for this thesis, these disparities in coursetaking also constrain minority students' educational paths in college, as well as their future careers. Curricular momentum in math and science starts in high school, and students who do not take the appropriate math and science courses find the lack of preparation to be an obstacle to success in SME majors (Adelman, 1998). Blacks and Hispanics are more likely than Whites to cite inadequate high school preparation and conceptual difficulty with one or more subject matter among their reasons for leaving SME fields (Seymour and Hewitt, 1997).

Thus far, in research on SME outcomes, measured ability in math and overall academic competence have been the most consistence predictors of choice and persistence in SME majors (Davies and Guppy, 1997; Astin and Astin, 1993; Ramist et al., 1994). In fact, after controlling for achievement, the racial gaps in these outcomes dissipate (Ware and Lee, 1985; Huang, Taddese, Walter, and Peng, 2000; Elliot et al., 1996; Smyth and McArdle, 2006). While researchers tend to use test scores to indicate prior achievement, some also include high school grades, which are proxy measures for work habits and content mastery (Farkas, Sheehan, Grobe, and Shaun, 1990; Roscigno and Ainsworth-Darnell, 1999). High school grades are important predictors of choice of a science major for Blacks (Thomas, 1985), though they may not be predictive of SME graduation (Smyth and McArdle, 2004).

Unfortunately, much of the research on racial differences in SME outcomes has excluded measures of coursework as indicators of academic preparation and achievement, despite the sentiment that, "…secondary school curriculum…more than any identifiable factor…provides momentum, and in [SME] fields, curricular momentum is worth far more than a grade point average or test score"(Adelman, 1998, p.4). While some have employed the number of math and science courses or credits as predictors (Strenta et al. 1994; Thomas, 1985; Elliot et al. 1996; Maple and Stage, 1991; Huang, Taddese, Walter, and Peng, 2000), researchers have yet to use completion of specific math and science courses. These qualitative indicators of coursework should have more predictive power than quantitative measures (the number of math and science courses or credits) because they contain more information about whether the class is academically rigorous.

Enrichment Activities in Math and Science:

Another noted racial disparity which may affect choice and completion of SME majors is exposure to enrichment activities in math and science. Technical and scientific careers tend to attract students who have steady occupational goals starting in high school (Adelman, 1998), but for students who have little information about these careers, it may be more difficult to develop early, consistent, and well-informed educational plans. Blacks and Hispanics are less likely than Whites to have access to extracurricular science and math experiences, including school clubs, computer use, visits to science and technology themed museums, or access to educational resources within the home (Ekstom et al., 1988; McNeal, 1998). Furthermore, racial minorities are less likely to have role models who work in science or technical careers. This is unfortunate because having a parent in science and engineering has positive, statistically significant effects on choice of SME majors for Hispanic and Black males (Leslie, McClure, and Oaxaca, 1998).

Surprisingly, exposure to enrichment activities in math and science has not been widely used as a predictor of SME outcomes. One study showed that students at selective colleges did not regard trips to museums and participation in the science fair as important in their decision to major in science (Strenta et al., 1994), but this finding is only applicable to the advantaged few who attend elite colleges and does not speak to racial differences in SME outcomes. Because this exposure seems pertinent to explaining racial differences in SME outcomes and yet underutilized in SME research, I plan to include indicators of enrichment in models predicting high school SME intentions and choice of SME majors in college. This will inform our understanding of whether participation in the science fair, discussion of science careers, computer use, and hands-on experiments predict choice and completion of SME majors, net of academic and family background.

Family Socioeconomic Status: Documented Effects on SME Outcomes

On average, Blacks and Hispanics both have lower educational attainment and family income than Whites or Asians (U.S. Census Bureau, 1990; KewalRamani et al., 2007; Fronczek, 2005). This racial disparity affects SME outcomes because parental education and family income have indirect and direct effects on choice of college major and persistence in

SME pipeline (Berryman, 1983; Seymour and Hewitt, 1997). Previous research indicates that parental education influences student academic behavior, which has direct effects on choice and completion of SME majors. However, after controlling for student academic ability and preparation, parental education is not associated with SME outcomes (Huang, Taddese, Walter, and Peng, 2000; Grandy, 1998). One study did find that parental education had a statistically significant association with completion of SME majors, but it did not control for previous academic achievement (Huang, Taddese, Walter, and Peng, 2000).

Unlike the indirect effect of parental education on SME persistence, parental income has a direct impact on choice and completion of SME majors and a role in explaining racial disparity in choice and completion of SME majors. For example, Blacks' rates of choosing science majors increase as family income increases (Berryman, 1983). Furthermore, receiving dependable financial support has a statistically significant and practically meaningful effect on completing an SME major, confirmed both in quantitative and ethnographic research (Huang, Taddese, Walter, and Peng, 2000; Seymour and Hewitt, 1997).

Gender

Overall, females are less likely to choose or persist in SME majors (Berryman, 1983; Strenta et al., 1994; Chipman and Thomas, 1987; Smyth and McArdle, 2004; Huang, Taddese, Walter, and Peng, 2000). Female disadvantage may take root early, as males express more interest in scientific childhood hobbies, more affinity for coursework in science, more confidence in their mathematical ability, and stronger math and science achievement than females by eighth grade (Thomas, 1985; Catsambis, 1994; Muller, Stage and Kinzie 2001). This gender difference matters for this analysis of racial differences in SME outcomes for two main reasons. First, the gender gap in choice of SME majors is larger for Whites than underrepresented minorities (Huang, Taddese, Walter, and Peng, 2000; National Science Board, 1993). Second, gender gaps in completion of college also differ by race. Since the early 1980s, women have matriculated and graduated from college at higher rates than men (Buchmann and DiPrete, 2006), and this trend is especially prominent among Blacks and Hispanics (KewalRamani et al., 2007).[7] If more Black and Hispanic females are finishing college, but fewer are choosing or completing SME majors, this might affect racial parity in SME graduation.

College Academic Performance and Institutional Type:

Up to this point, this literature review has discussed how factors that take root prior to college are related to choice and completion of SME majors. Obviously, academic performance in college affects the likelihood of SME graduation as well. For example, grades during the first two years of college affect SME persistence at selective colleges (Strenta et al, 1994). Although there is no evidence about whether grades are associated with SME success at the broader spectrum of colleges, given that grades are a proxy for work habits and content mastery, we would expect that they do.

[7] Black females account for 64% of the total enrollment of black undergraduates, while Hispanic females account for 59% of the total enrollment of Hispanic undergraduates. Meanwhile, about 55% of Asian and White undergraduates are female (KewalRamani et al., 2007).

Besides academic performance, college type is also an important determinant of racial differences in SME success. More minorities than Whites attend two-year colleges, and, of the minorities who attend four-year institutions, fewer attend colleges than universities (NCES, 1988). These attendance patterns matter for SME outcomes because research and comprehensive universities award the largest proportions of baccalaureates in SME fields and are more likely to have high-quality science facilities than two- or four-year colleges (National Science Board, 1993). In addition, students are two to three times more likely to complete a bachelor's degree if they start at four-year institutions rather than two-year institutions (Astin, 1982).

Also, minorities who choose to major in science, engineering, and math seem to have different outcomes depending on the selectivity and sector of their college. At this point, it is hard to determine from the research whether the outcomes associated with attending a certain type of institution are due to the institution or to some unobserved characteristics of the types of minorities who attend them. Nevertheless, descriptive statistics indicate that the gap in achievement between Whites and non-Asian minorities is even higher at selective schools, leaving minorities at an even greater competitive disadvantage compared to their White and Asian peers (Elliot et al., 1996). Science courses are even more likely to be impersonal, fast-paced, and competitive at selective institutions, meaning that students who enter these schools without adequate academic preparation may suffer more at selective rather than less competitive schools (Hewitt and Seymour, 1991; Manis et al., 1989; Tobias, 1990). At selective institutions, Blacks suffer the highest attrition rates from these majors (Elliot et al., 1996). While some researchers suggest that if underrepresented minorities in math, science, and engineering had attended less competitive colleges, where their SAT scores would have been average, they would be more likely to graduate (Elliot et al., 1996), others disconfirm this hypothesis (Smyth and McArdle 2000).

Reasons to Suspect Racial Parity on SME Outcomes

In the previous section, I discussed several factors that might lead to racial disparity on SME outcomes, including gaps in math and science achievement, family income and parental education, gendered behaviors, and college attendance at four-year universities. While previous research offers strong evidence of racial disparity on SME outcomes, there are two important reasons to suspect that Blacks and Hispanics may have reached racial parity on choice and completion of SME majors since the early 1980s. First, when Blacks and Hispanics are equal to Whites in academic achievement and preparation in math and science, they choose and complete SME majors at higher rates (Berryman, 1983; Hilton, Hsia, Solorzano, and Benton, 1989). Since there is evidence that the achievement gaps in math narrowed between the 1980s and mid-1990s, we might expect that Blacks and Hispanics would be equal to Whites (and perhaps even advantaged) in their likelihood of choosing and completing SME majors.

Second, though minorities have lower achievement and academic preparation than Whites, on average, they appear to have higher interest in math and science and more self-confidence in their abilities in these subjects. As early as elementary school, Black students are often as interested as Whites in math and science, and have shown the most positive attitude toward science and math of any racial group (Carpenter et al., 1983; Mullis and

Jenkins, 1988). Minorities' positive attitude toward math and science seems to linger through high school. Blacks, Hispanics, and Asians are all more likely than Whites to believe that they are good at math during their tenth grade year, and the Black-White difference in self-assessment on math ability is larger than the Asian-White or Hispanic-White difference (Correll, 2001).[8] This strong self-confidence in math has a statistically significant, positive association with choosing a quantitative major in college, controlling for parental education, prior achievement, and other relevant factors (Maple and Stage, 1991; Correll, 2001).

RESEARCH QUESTIONS AND HYPOTHESES

Given that Blacks and Hispanics may have reached parity on SME outcomes, it is worthwhile to use more current data and an improved methodology to update our understanding of persistence in the SME pipeline.

My research questions for this analysis are as follows:

(1) Are Blacks and Hispanics disadvantaged, relative to Whites, in their likelihood of expressing SME intentions in high school, choice of an SME major in college, and completion of SME majors?

(2) Can we explain racial differences in SME outcomes, should they exist, by accounting for disparities in academic achievement and preparation, family socioeconomic background, exposure to math and science enrichment, and college attendance patterns and academic performance?

[8] This finding corresponds with previous research that has shown that Blacks tend to have more positive attitudes toward education than Whites (Portes and Wilson, 1976; Catsambis, 1994; MacLeod, 1987).

I hypothesize that there will not be any racial disparity in SME outcomes in my models for all of the reasons discussed above. In addition, although Blacks and Hispanics have lower rates of college attendance and graduation, this will not affect their likelihood of success in SME outcomes because, unlike previous studies, my outcomes do not confound educational persistence with persistence in the SME pipeline. Furthermore, I also hypothesize that, (1) given equal academic preparation and achievement, Blacks and Hispanics will be advantaged over Whites in their likelihood of choosing and completing SME majors, while Asians will be equal to Whites, and (2) exposure to coursework and enrichment in math and science will have a positive, significant association with choice and completion of SME majors, net of test scores and grades.

DATA & METHODS

Data:

This thesis uses data from the National Education Longitudinal Study (NELS: 88), which is ideal for tracing persistence in the SME pipeline through high school and into college. NELS tracks students from eighth grade until they are 26 years old, providing a comprehensive, longitudinal source of data. In addition, NELS also provides transcript data, both from high school and college, allowing me to investigate whether high school course sequence may affect SME intentions. Furthermore, NELS does not measure college graduation until eight years after high school graduation, which is beneficial because over one-third of undergraduates take time off from their studies, and thus take more than four years to complete a degree (Goldrick-Rab, 2006).

Since the current analysis traces racial parity at the end of high school, after entrance to college, and at college graduation, it is necessary to use data from all five waves of NELS. Students were first surveyed in eighth grade in 1988, and then surveyed again in 1990, 1992, 1994, and 2000, when most were in tenth grade, twelfth grade, 20 years of age and 26 years of age. In the base year, 1988, researchers used a two-stage probability design, first selecting schools stratified by school type, region, and whether the school was in an urban, rural, or suburban location, then selecting an average of 23 students within each school to participate (NCES, 2002). This resulted in a final sample of 1,052 schools and 24,599 students. Researchers oversampled private schools, as well as Asian and Hispanic students. In the tenth and twelfth grade, researchers freshened the samples to account for attrition. I weighted each of the three sets of models in order to correct for non-response, as well as unequal probabilities of being sampled. In addition, the weights allowed me to project findings to a population of students who were in the same age cohort during that year nationwide.

Multiple Imputation

Many of the variables for these analyses had missing values (see Table 1). I used multiple imputation to predict missing values for independent and control variables, so that I could use more of the available cases for the analysis. I did not impute missing values on the dependent variables. Multiple imputation is a widely utilized and trusted procedure in the social sciences because, unlike some other imputation techniques, it "… produces estimates that are consistent, asymptotically efficient, and asymptotically normal when the data are MAR [missing at random]" (Allison, 2002).

I employed multiple imputation to predict values for missing data using the ICE command in STATA. ICE predicts multiple values for missing variables using switching regression and stores them in different datasets. I imputed a total of five datasets, and then used combined estimates for coefficients and standard errors using formulas derived by Rubin (1987). [9]According to Rubin's formula, the estimated coefficient from the logistic regression is simply the average estimate across M replications,

$$\bar{r} = \frac{1}{M}\sum_{k=1}^{M} r_k$$

where r_k represents the estimated coefficient in the *kth* replication and *M* equals the number of replications (in this case M=5). In order to estimate the standard error, I averaged the within-imputation variance,

$$\overline{U} = \frac{1}{M}\sum_{k=1}^{M} s_k^2$$

and the between-imputations variance,

$$B = \left(\frac{1}{M-1}\right)\sum_{k=1}^{M}(r_k - \bar{r})^2$$

[9] I used these formulas to combine estimates in a spreadsheet because STATA does not support the simultaneous use of 'svy' commands (which I will explain below) and 'micombine'.

where s_k equals the standard error in the *kth* replication. The overall standard error is the square root of the total variance,

$$S.E.(\bar{r}) = \sqrt{\overline{U} + \left(1 + \frac{1}{M}\right)B}$$

Analytic Strategy

Tracing Persistence in the Education and SME Pipelines: Descriptive Statistics

Completion of bachelor's degrees in SME fields is the product of two related selection processes: (1) student retention in the education pipeline, and (2) student persistence in the science and math pipeline. In order to earn a bachelor's degree in an SME field, a student must persist to high school graduation, apply and be accepted to a college, matriculate at this college and persist until graduation, while simultaneously maintaining interest in science and math. Blacks and Hispanics are less likely than Whites and Asians to succeed in several of these educational transitions, which affects their access to and persistence in SME majors.

In order to document these two processes, I trace persistence in both the education and SME pipelines using NELS data. The percentages come from weighted data, and findings project to the population of students nationwide who were in eighth grade in the spring of 1988. All together, there were 2,979,140 students in this population. Of this number, 3.6% were Asian, 10.4% Hispanic, 13.2% Black, and 71.4% White. To test whether one racial group was statistically different from the rest on a specific outcome, I performed Pearson Chi-Square tests.

Predicting Likelihood of Participation in the SME Pipeline: Modeling Strategy for Logistic Regressions

I use multivariate weighted logistic regressions to predict the likelihood of (1) high school SME intention, (2) choice of an SME major, given college attendance, and (3) completion of an SME major, given completion of a bachelor's degree. The models take the following form:

$$\text{Logit}(\pi_i) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \ldots \beta_Z X_Z$$

As the model states, the log odds of completing a bachelor's degree with an SME major is a function of Z unique predictors.

I add predictors in blocks for each of the analyses, starting with a model that just accounts for race using dummy variables to represent Asians, Hispanics, and Blacks.[10] Whites are the reference category, so this first model allows me to estimate average racial differences between Whites and other groups. Subsequently, I add blocks of control variables to remove bias from the estimated racial differences. Because these predictors differ for each

[10] American Indians were excluded from these analyses because there were too few in the data to provide adequate statistical power. I could not place them in an "other race" category, as is common practice, because there were only five racial groups in the original variable (Asian, Hispanic, Black, White, and American Indian) and the other four racial groups were utilized in the analysis.

of the three analyses, I will describe them separately for each outcome. A complete list of variables, along with their definitions and ranges, is available in Appendix 1.

Models Predicting High School SME Intention

The first set of analyses predicts the likelihood of expressing high school SME intention using data from the 1988, 1990 and 1992 surveys. This analysis has a sample size of 10,875; when weighted, these analyses project to a nationwide population of 1,786,700 students who were in eighth grade during the spring of 1988. The dependent variable, high school intention to major in an SME field, as expressed in senior year, comes from a survey question asking each student to select the field s/he would study if s/he were to continue her/his studies after high school. I code the responses so that engineering, math, computer science, agriculture, biology, and physical sciences equal 1 and all other fields equal 0, including majors in health occupations. I include agriculture in the SME category because subsequent measures of college major in NELS are more specific and include options such as, agricultural science, botany, and zoology. I exclude health related majors from the SME category for this or any subsequent outcomes for two reasons: first, I want the outcome measure to be comparable to that used by past researchers (for example, Elliot et al., 1996; Maple and Stage, 1991), and (2) many of these majors are vocational in nature and do not yield the same lucrative pay-off in steady employment and high pay as majors in SME fields.

To remove bias from the estimation of average Asian-White, Hispanic-White, and Black-White differences in the likelihood of expressing SME intentions, I add control variables in the following sequence. First, I control for relevant demographic characteristics, including fathers' and mother's education (dummy variables, coded 1 if the parent had a completed college degree), logged family income, and gender (a dummy variable, coded 1 for females). Controlling for these demographic factors in the second block of variables allows me to discern the effects of family background and gender, both before and after accounting for academic factors.

Third, I control for two social psychological variables that measure affinity towards math, so that I can estimate their effects both before and after including indicators of academic background. One variable comes from a base year survey question asking students whether they usually look forward to math class (coded so that students who agreed and strongly agreed with this statement received a value of 1). I also included a measure of math confidence from the 1990 wave of the survey, when most respondents were in tenth grade. This measure comes from a question asking students whether they have always done well at math (I recoded this as a dummy variable, so that students who answered that this statement was true or mostly true received a value of 1).

The fourth model adds measures of coursework, grades, and achievement in math and science, which I hypothesize will have large direct effects on SME intentions. Academic predictors include: (1) dummy variables indicating whether the student was in accelerated math in eighth grade (coded 1 if true) and the college preparatory track in tenth grade, [11](2) math and science grades from junior high and tenth grade (dummy variables, coded 1 if the

[11] This is a relevant control measure because students who are in accelerated math in eighth grade are more likely to take a rigorous math course sequence in high school (Schneider, Swanson, and Riegle-Crumb, 1998).

student had received mostly A's), and (3) standardized measures of student achievement in math and science, as measured by NCES achievement tests in eighth and tenth grade.

In the fifth and final model, I control for enrichment activities. I add these last to see whether they will have a net effect after controlling for academic factors. These variables include dummy indicators of science fair participation in eighth and tenth grade, whether the student's teachers had discussed careers in science during tenth grade (coded 1 if this discussion happened once a month or more), and whether the respondent used personal computers (coded 0 if rarely or never).

Models Predicting Choice of an SME Major

The second set of analyses predicts the likelihood of choosing an SME major, given college entrance, using data from the 1992 and 1994 surveys, as well as High School Transcript Study data. This weighted analysis has a sample size of 7,085 students who had entered college by 1994, participated in the 1992 and 1994 surveys, and had high school transcript data; it projects to a population of 1,632,290 students. The dependent variable, choice of an SME major, was measured in the 1994 survey, when most students were two years beyond high school graduation. By 1994, 53.7% percent of the senior class had entered college.[12] This dependent variable comes from a survey question asking students to indicate their major field of study at the postsecondary institution with the earliest enrollment date. Researchers at the National Center for Education Statistics validated responses, including

[12] Ideally, I would have used a measure of college major at any point in time, but this type of variable was not available.

only those that referenced valid postsecondary institutions. Majors in computer/information science, computer programming, engineering, mathematics, statistics, zoology, botany, biochemistry/biophysics, biology, chemistry, earth sciences, agriculture science, physics, and other physical sciences are coded as 1.

The modeling strategy for predicting the likelihood of choosing an SME major, given entrance to college, is almost identical to that used to model high school SME intention. First, I measure racial differences without adding any other control variables. Second, in contrast to the previous analysis, I control for high school SME intentions and student expectations to finish college to see whether there are racial differences net of these factors. Third, I control for demographic characteristics, including parental education, logged family income, and gender. These variables come from the 1992 survey and are coded the same as the demographic variables described above. Fourth, I control for academic preparation and achievement, using: (1) dummy variables measuring whether the respondent took upper-level math and science courses (algebra II, pre-calculus, trigonometry, calculus, chemistry and physics) in high school, (2) high school grade point average (NCES recoded this variable, bringing all values into a standard 4-point range), and (3) standardized measures of content mastery in math and science, as measured by math and science tests administered by NCES in the senior year of high school. Finally, in the fifth model, I control for enrichment activities in math and science, adding dummy variables indicating whether the student had performed experiments alone or in a group in science class (coded 1 if one to time a week or more), whether the student had a science teacher who discussed careers in science (coded 1 if one to two times a month or more), and whether the student used personal computers at least once a week.

Models Predicting Graduation with an SME Major

The third set of analyses predicts the likelihood of college graduation with an SME major. These analyses utilize data from the 1992 and 2000 wave, including High School Transcript Study data and data from the Postsecondary Education Transcript Study (PETS). This analysis has a sample size of 3,571 who had complete high school and postsecondary transcript data and participated in the 1992 and 2000 waves of the survey and projects to a population of 944,651 students. The dependent variable (completion of an SME major, given completion of a bachelor's degree) comes from a Postsecondary Education Transcript Study (PETS) variable indicating the detailed field for the student's bachelor degree.[13] Therefore, unlike the previous dependent variables, this outcome is not self-reported. This dependent variable is binary, coded 1 for students who completed a major in biology, biochemistry, chemistry, computer programming, computer science, electrical/communication engineering, chemical engineering, physics, mathematics, statistics, agriculture/animal and plant sciences, or other physical sciences. All other majors are coded as 0, including majors in health-related fields and majors that are technical/vocational, such as those in data management, computer technology, and communication technology.

The modeling strategy for predicting completion of SME majors is nearly identical to that used to model choice of an SME major with two important differences. In the second

[13] I also account for double majors, though doing so did not change the coding scheme.

model, I control for choice of an SME major, as measured in 1994, and in the fifth model I control for factors relevant to college experience. These measures of college experience include grade point average from classes taken in the first calendar year of college attendance, and dummy indicators of whether the respondent started college at a two-year public community college or another institution (including private for-profit institutions, private not-for-profits colleges that require less than four years to earn a degree, and public institutions that require less than two years to earn a degree). The reference category is public and private four-year colleges and universities. Lastly, I include a measure of whether a student attended a selective four-year institution. This is coded 1 if the student started at a highly selective or selective college.[14] I add these variables last to see whether they have an effect on racial differences in SME major completion, net of all other factors.

Correcting for Survey Design:

As described above, data collection for NELS involved a complex, two-stage probability design, which included stratification by region and school type, clustering in schools, and oversampling of certain student populations. It is important to take these survey elements into consideration in my analysis, because not doing so would produce downwardly biased estimates of variance and standard errors. This downward bias occurs because measurement error is not independent in clustered and stratified samples. Not correcting for this bias can lead to inflated t-values, which might, in turn, lead to incorrect conclusions

[14] NELS coded colleges as selective according to a coding system set forth by the Cooperative Institutional Research Project.

about the statistical significance of coefficients. In order to prevent this bias due to survey design in my analyses, I utilize STATA's 'svy' commands. These commands, specifically designed by STATA for use with complex survey designs, allowed me to simultaneously correct for stratification, clustering and the oversampling, thus providing more accurate estimates of standard errors.

RESULTS

Tracking Persistence in the Education and SME Pipelines: Descriptive Statistics

Most of the leakage from the education pipeline from eighth grade to a bachelor's degree occurs between (1) eighth grade and high school graduation, and (2) entrance to college and completion of a bachelor's degree (see Table 2). Only 78.1% of the eighth graders graduate from high school on time. Almost all of the eighth graders who graduate from high school on time attend some form of post-secondary education by the time they are 26 years old (76.5%). However, only 65.9% of the eighth grade population attends a college or university where they can earn a bachelor's degree by age 26. Even after passing the hurdle of being admitted to and matriculating in a four-year institution, only 38.8% of students earn a bachelor's degree by age 26.

Relative to Whites and Asians, Hispanics and Blacks are disadvantaged in terms of high school graduation, attendance at bachelor-degree granting institutions, and college graduation. Both Hispanics and Blacks are significantly more likely than other races to drop out of high school ($p<0.001$ and $p<0.001$ respectively). Compared to 12% of Asians and 18% of Whites, 33% of Hispanics and 35% of Blacks do not finish high school on time. In

Table 2: Tracing Persistence in the Education Pipeline by Race[15]

Points Along Education Pipeline	Percentage of Eighth Graders Who Persist to this Point	Percentage by Race Who Persist to this Point[16]			
Eighth Grade	100% (N=24,370)	Eighth Graders[17]			
		A	100%		
		H	100%		
		B	100%		
		W	100%		
High School Graduation (on time)	78.1% (N=13,811)[18]	High School Graduates		High School Dropouts	
		A	**88%**	A	**12%**
		H	**67%**	H	**33%**
		B	**65%**	B	**35%**
		W	**82%**	W	**18%**
Attend Two-Year or Four-Year College (by age 26)	76.5% (N=12,125)	Any College		No College	
		A	**91%**	A	**9%**
		H	**70%**	H	**30%**
		B	76%	B	24%
		W	77%	W	23%
Attend Four-Year College (by age 26)	65.9% (N=9,525)	Attend		Never Attend	
		A	73%	A	27%
		H	**47%**	H	**53%**
		B	**56%**	B	**44%**
		W	**70%**	W	**30%**
Graduate With Bachelor's Degree (by age 26)	38.8% (N=9,490)	Graduate		Never Grad.	
		A	**49%**	A	**51%**
		H	**20%**	H	**80%**
		B	**23%**	B	**77%**
		W	**44%**	W	**56%**

[15] *Statistics project to the population of students who were in eighth grade in the spring of 1988, N=2,979,140*

[16] *A=Asian, H=Hispanic, B=Black, W=White*

[17] *Because the longitudinal survey begins in eighth grade, it appears as though 100% of each race has persisted to this point. This is a statistical artifact, rather than a reflection of true persistence patterns.*

[18] *The sample size is lower because of planned attrition between the eighth and tenth grade waves in NELS.*

addition to being overrepresented among high school dropouts, Hispanics are less likely to attend any type of college, and Blacks and Hispanics are each less likely to attend bachelor-degree granting institutions. Only 70% of Hispanics attend any college by the age of 26, compared to76% of Blacks, 77% of Whites, and 91% of Asians; [19] this difference is statistically significant ($p<0.05$). Furthermore, Hispanics and Blacks are significantly less likely to attend four-year college than Whites or Asians ($p<0.001$ and $p<0.05$); while 47% of Hispanics and 56% of Blacks do so, compared to 73% of Asians and 70% of Whites. Finally, Blacks and Hispanics are each significantly less likely to earn a bachelor's degree, relative to other races ($p<0.001$); while 49% of Asians and 44% of Whites earn a bachelor's degree by the age of 26, only 20% of Hispanics and 23% of Blacks do so. In contrast, Whites and Asians are both significantly more likely to graduate compared to other races ($p<0.001$ and $p<0.05$).

Loss from the SME Pipeline by Race (see Table 3)

Imagine an SME pipeline forming in high school, continuing to declaration of an SME major in college, and ending with receipt of a bachelor's degree in an SME field. The leakage across educational transitions described above greatly contributes to leakage from the SME pipeline, since we can only measure the SME interest for students who remain in the educational pipeline. As shown in Table 3, the greatest leakage from the SME pipeline

[19] These percentages are greater than the percentages of high school graduates because the measures of high school graduation reflect whether respondents had graduated on time. It appears that some students who graduate late or earn GEDs still go on to attend community college or four-year colleges.

comes between the senior year in high school and declaration of an SME major; this is due, in large part, to the fact that so many students do not matriculate in college.

However, when calculating the proportion of students who are in the SME pipeline, if we restrict the denominator to students who persist to a certain point in the educational pipeline (rather than using the eighth grade population), we can see that leakage from the pipeline is not as massive. For example, of those students who graduate from high school, 19% express interest in majoring in an SME field. Asians are statistically more likely than the average to express interest in SME fields, as compared to members of other races ($p<0.01$). Compared to 18% of Hispanics, 20% of Blacks, and 19% of Whites, 24% of Asians have intention to pursue SME majors in their senior year of high school. The next step in the SME pipeline is entering into an SME major in college. About 13.2% of students who begin college at either a two-year or four-year school choose SME majors at their first institution. At four-year institutions, this percent is higher (15.6%). Asians and Blacks are more likely than members of other races to choose SME majors at four-year colleges, (($p<0.01$) for Asians and ($p<0.05$) for Blacks), whereas Whites are less likely than other races to do so ($p<0.01$). This pattern holds when considering choice of major at any post-secondary institution and just at four-year colleges. While Asians have long been advantaged in their rates of entry into SME majors, these findings regarding Whites' disadvantage and Blacks' advantage contradict past research.

Table 3: Tracing Persistence in the SME Pipeline by Race

Points Along SME Pipeline	Percentage of Eighth Graders Who Persist in the Educational AND SME Pipeline	Of the Students Who Persist, the Percentage that Remain in the SME Pipeline[20]	Percentage by Race Who Persist to this Point and Remain in SME Pipeline[21], [22]			
High School Senior's SME Intentions	**14.0%** of eighth graders express high school SME intention (N=15,487)	**19.0%** of high school seniors have SME intention (N=8,177)	High School Seniors: SME Intentions		None	
			A	**24%**	A	**76%**
			H	18%	H	82%
			B	20%	B	80%
			W	19%	W	81%
Choice of SME Major at Two-Year or Four-Year College	**8.5%** of eighth graders choose SME majors at any college (N=13,822)	**13.2%** of students at any college have SME intentions (N=7,722)	College Attendees: SME Major		None	
			A	**18%**	A	**82%**
			H	11%	H	89%
			B	**21%**	B	**79%**
			W	**12%**	W	**88%**
Choice of SME Major at Four-Year College	**5.4%** of eighth graders choose SME majors at four-year colleges (N=13,822)	**15.6%** of students at four-year colleges have SME intentions (N=5,825)	Four-Year College Attendees: SME Major		None	
			A	**21%**	A	**79%**
			H	14%	H	86%
			B	**23%**	B	**77%**
			W	**14%**	W	**86%**
Bachelor's Degree in SME Field	**4.9%** of eighth graders graduate with SME majors (N=12,144)	**16.8%** of bachelor degree recipients complete SME majors (N=3,723)	B.A. Recipients: Majored in SME		Other Major	
			A	**28%**	A	**72%**
			H	18%	H	82%
			B	22%	B	78%
			W	**16%**	W	**84%**

[20] *Because we can only measure SME intentions if a student remains in the education pipeline, these statistics are only representative of eighth graders still in school at the time of the measure. In other words, students who are high school seniors, have entered any college, have entered four-year college, or have received a bachelor's degree respectively.*

[21] *Statistically significant differences ($p<0.05$) are in bold; Chi-Square tests compared the average of each race to the combined average of the other three races.*

[22] *A=Asian; H=Hispanic; B=Black; W=White*

The final step in the SME pipeline is graduation with a bachelor's degree in an SME field. Of those students who earn a bachelor's degree, 16.8% do so in an SME field. [23] Of these B.A. recipients, Asians are more likely than other races to be in the pool of SME majors ($p<0.00$), while Whites are less likely ($p<0.05$). Compared to 16% of Whites, 18% of Hispanics, and 22% of Blacks, 28% of Asians graduate in an SME field. Neither Blacks nor Hispanics are statically different from other races on this measure. This finding differs from past research which has indicated a disadvantage on this outcome for underrepresented minorities, relative to Whites and Asians.

Results from Weighted Multivariate Logistic Regressions

Next, I will present a series of three weighted multivariate logistic regression models in order to measure the racial gap and explain racial differences on three sequential SME outcomes: (1) intentions to major in SME, as expressed in the senior year of high school, (2) choice of an SME major, given entry into college, and (3) receipt of a bachelor's degree with an SME major, given college graduation. The means and standard deviations for all of the variables included in models can be found in Table 1.

Table 4 shows five weighted logistic regressions predicting intention to major in SME, as expressed in high school. I present both the logit coefficients, (abbreviated as 'coef.') and the odds ratios (abbreviated as 'OR'). The standard errors are below the

[23] This percentage is larger than that representing students who choose SME majors at four-year institutions. Apparently, among those who persist to graduate with a bachelor's degree, the proportion of students in the SME pipeline is higher. This is not surprising, given that students interested in SME fields are more likely to be high achievers.

coefficients in parentheses, and coefficients that are statistically significant ($p < 0.05$ level) are in bold. The first model just controls for race, with Whites as the reference category. This model shows that while Blacks and Hispanics are similar to Whites on this outcome, Asians are 29.5% more likely to express interest in SME fields as seniors in high school. The second model controls for family background characteristics, including mother and father's education and family income, as well as gender. Adding these demographic controls to the logistic regression model does not change the pattern for the estimated racial differences. Females are 69.3% less likely to express interest in SME majors than males, but none of the family SES variables are significant predictors.

Model 3 adds controls for affinity for math, as measured in eighth grade, and confidence in math, as measured in tenth grade. Controlling for math affinity and confidence, Asians are no longer statistically different from Whites in their intentions to major in SME fields, while Blacks and Hispanics are still equivalent to Whites. Students who look forward to math class in eighth grade are 19.6% more likely to express SME intentions as high school seniors, while students who feel that they are good at math as tenth graders are 126.3% more likely to express SME intentions. The coefficient for female does not change much from the previous model, indicating that math affinity and confidence do not explain the gender gap.

The next model, Model 4, accounts for students' academic performance in eighth and tenth grade by adding measures of tracking, grades, and standardized test scores. Controlling for family SES, gender, math affinity and confidence, and these academic factors, Blacks are 63.1% more likely to express interest in SME majors as high school seniors than Whites, but neither Hispanics nor Asians have an advantage over Whites. In addition, students who are in accelerated math in eighth grade are 23.4% more likely to express SME intentions, while students who receive mostly A's in tenth grade science are 22.7% more likely to express SME intentions. Furthermore, for every standard deviation increase in the science test score in eighth grade, the odds of expressing SME intentions increase by 12.7%, while for standard deviation increase on the tenth grade science test, the odds increase by 21.8%. While controlling for academic achievement in math and science does not account for the gender gap in high school SME intention, it does make affinity for math in eighth grade insignificant. In addition, though math confidence in tenth grade is still statistically significant net of academic factors, the magnitude of the coefficient has shrunk.

The last model for this outcome, Model 5, adds controls for exposure to science and math enrichment. As in the last model, Blacks are significantly more likely than Whites to express SME intentions, on average. However, this racial difference is slightly lower than that in the last model; now Blacks are only 58.1% more likely than Whites to express intentions. Again, neither Asians nor Hispanics are statistically different from Whites on this outcome. Of the new predictors, participation in the science fair in tenth grade increases the odds that a student will express interest in SME fields by 30.4% on average, while having the opportunity to use computers every few weeks increases the odds by 17.6%, on average. Net of controls for family socioeconomic status, academic background, and exposure to enrichment, statistically significant predictors include: gender, math confidence in tenth grade, being in accelerated math in eighth grade, and science test scores for eighth and tenth grade.

Table 5 presents multivariate logistic regression models predicting choice of an SME major, given college attendance. As in Table 4, the first model just controls for race. Conditional on college attendance, Asians are 80% more likely to enter SME majors than Whites, on average, while Blacks are 121.3% more likely than Whites, on average, to do so. Hispanics are statistically equivalent to Whites on this outcome measure, conditional on college attendance. The second model controls for high school intentions to major in SME and student expectations to finish a bachelor's degree. In this model, again, Asians and Blacks are more likely than Whites, on average, to enter SME majors; while Asians are slightly less likely than Whites to enter SME majors, controlling for intentions and expectations (68.7% more than Whites), Blacks are slightly more likely (125.1%). Again, Hispanics are statistically equivalent to Whites under this model. SME intentions in high school and expectation to finish college, as we might expect, are both highly predictive of entry into an SME major.

Model 3 adds controls for family SES and gender. Holding these factors constant does not alter the pattern of significance for racial groups seen in the previous model. Asians are 64.3% more likely than Whites to enter SME majors, on average, while Blacks are 154.7% more likely than Whites to do so. High school SME intentions and educational expectations are still statistically significant predictors, though the magnitudes of each coefficient have decreased slightly after controlling for family SES and gender. Females are 32.3% less likely than males, on average, to enter into SME majors, controlling for high school SME intentions, race, family background, and expectations to finish college.

The next model, Model 4, adds controls for academic preparation and achievement in high school, including coursework in math and science, high school GPA, and math and science standardized test scores. Under this model, Hispanics are 71.7% more likely than Whites to enter into these majors, while Blacks are 252% more likely than Whites to do so. After controlling for academic factors, Asians are statistically equivalent to Whites on entrance to SME majors, indicating that their prior advantage was due to coursework and achievement. In this model, females are 36.8% less likely than males to enter into SME majors; since the magnitude of this effect has not changed much, we can infer that academic preparation and achievement do not cause the gender gap. Of all the academic factors included in this model, only three appear to be statistically significant predictors of entry into SME fields: taking trigonometry, pre-calculus, and calculus. Students who take trigonometry in high school are 35.5% more likely to enter into SME majors, while those who take pre-calculus are 56.7% more likely than those who do not to do so. Finally, students who take calculus in high school are 65.5% more likely to enter into SME majors. Interestingly, though science was a statistically significant predictor of declaring SME intentions in high school, science test scores in twelfth grade are not predictive of entry into an SME major.

In the final model for this outcome, I add controls for math and science enrichment activities, including having the opportunity to perform experiments in science class, discussion of careers in science with teachers, and use of personal computers. None of these enrichment predictors is statistically significant, though discussing careers in science is marginally significant with a t-statistic of 1.94. Under this model, the estimated odds for Blacks and Hispanics are almost identical to those in the previous model, and the pattern of statistical significance is unchanged. Asians are still equivalent to Whites on choice of an SME major.

Table 6 presents the multivariate logistic regression results for the last outcome measure, receipt of a bachelor's degree with an SME major. This outcome is conditional on college graduation, or receipt of a bachelor's degree. The first model provides an estimation of average racial differences on this outcome, relative to Whites. Conditional on college graduation, Asians and Hispanics are more likely than Whites to graduate in an SME field, on average. While Asians are about 190% more likely than Whites to do so, Hispanics are about 90% more likely to do so. Even though Blacks are more likely than Whites to enter into SME fields, conditional on college entrance, they are statistically equivalent to Whites on SME graduation.

The second model controls for whether students have entered into an SME field by 1994, or two years after high school graduation. Since both Asians and Blacks are advantaged on this outcome, as shown in Table 5, I hold this measure constant to see whether Asians still have a net advantage. The coefficient for Hispanics is no longer statistically significant, meaning that Hispanics are not different from Whites on SME graduation, after taking entry into SME fields into account. Meanwhile, Asians are 229% more likely than Whites to graduate in SME fields, and Blacks are still statistically equivalent to Whites on this outcome.

The third model added controls for family SES and gender. These coefficients do not add much precision to the measurement of racial differences. Controlling for family SES, gender, and entry into an SME major, Asians are 202% more likely than Whites to graduate with an SME major, on average, while Hispanics are 81.2% more likely to do so, on average. Father's education is also a statistically significant predictor in this model; if the respondent's father has a college degree, the estimated odds of graduating with an SME field, conditional on college graduation, are 63.5% higher. Females do not appear to be statistically different from males in this model, on average, but this is most likely because the model already controls for entry into SME majors (where males hold an advantage) and college graduation (where females hold an advantage).

Model 4 introduces controls for academic preparation and achievement. These controls improve the precision in measurement for the Asian-White difference in SME graduation; controlling for high school achievement and coursework, in addition to family background, gender and entry into an SME major, Asians are 157% more likely to graduate in an SME field. In this model, Hispanics are 93.6% more likely than Whites to graduate in an SME field, on average. In this model, exposure to trigonometry and calculus, as well as high school GPA were statistically significant predictors. Having taken trigonometry increases the estimated odds of graduating in an SME major, conditional on college graduation, by 73.7%, while taking calculus increases the estimated odds by 79.1%. Meanwhile, for every point increase in high school grade point average, the estimated odds of completing a bachelor's with an SME major increases by 74.5%.

The final model, Model 5, adds controls for the type of institution where the student started college (two-year or other relative to four-year institution), selectivity of first college attended, and first year college GPA. Adding these controls improves the precision of the measurement of Asian-White and Black-White differences in SME graduation, as shown in the decrease of the standard error, but doing so adds more statistical imprecision in the measurement of the Hispanic-White difference. In this model, as in the previous three, both Asians and Hispanics are more likely than Whites to graduate in SME majors, conditional on college graduation. Asians are 166.8% more likely than Whites to do so, on average, while Hispanics are 103.2% more likely to do so. In this model, being female is a statistically significant and negative predictor of SME graduation. In addition, exposure to trigonometry and exposure to calculus in high school are statistically significant predictors. For every point increase in high school grade point average, the expected odds of SME graduation increased by 54.7%. This coefficient is lower in magnitude than in the previous model, most likely because before it was carrying some of the effect of first year college GPA, which is statistically significant in this model (every point increase in college GPA, increased the odds of SME graduation by 50.1%).

SUMMARY OF FINDINGS

These results help us answer the main questions for this thesis: (1) Are Blacks and Hispanics disadvantaged, relative to Whites, in their likelihood of expressing SME intentions in high school, choice of an SME major in college, and completion of SME majors? (2) Can we explain racial differences in SME by accounting for disparities in academic achievement and preparation, family socioeconomic background, exposure to math and science enrichment, and college attendance patterns and academic performance?

My findings indicate that Asians are more likely than Whites to express SME intentions in high school, enter into SME majors once in college, and graduate from college with SME degrees. Since many prior studies have documented that Asians have an advantage in entry into and completion of SME majors, this finding is not surprising. By contrast, the finding that Hispanics and Blacks are no longer at a disadvantage, relative to Whites, on any of these three SME outcomes is surprising since the majority of prior research has documented a racial gap. These findings are illustrated in Figure 1, which graphs the probabilities of success on SME outcome for different races in models without any controls.

How do these racial differences change after accounting for family background, math confidence, academic preparation and achievement, college type, and opportunities for enrichment? The Asian-White, Hispanic-White, and Black-White differences in probabilities of success on SME outcomes, as estimated with a full set of controls, are available in Figure 2. This figure illustrates that after controlling for relevant factors, all races are advantaged, relative to Whites, on all three outcomes, and, furthermore, the Black-White gaps in probability of having high school SME intention and choosing an SME major are between three and five times the Asian-White gaps or Hispanic-White gaps. As for my specific hypotheses regarding how these factors would affect SME outcomes, both were confirmed.

My first hypothesis was that, given equal academic preparation and achievement, Blacks and Hispanics would be advantaged over Whites on choice and completion of SME majors. As hypothesized, academic factors do account for racial differences. Holding coursework, grades, and test scores constant, the Asian-White gap becomes statistically insignificant in models predicting high school SME intentions and choice of an SME major, though not in the model predicting college graduation. This finding indicates that Asians hold

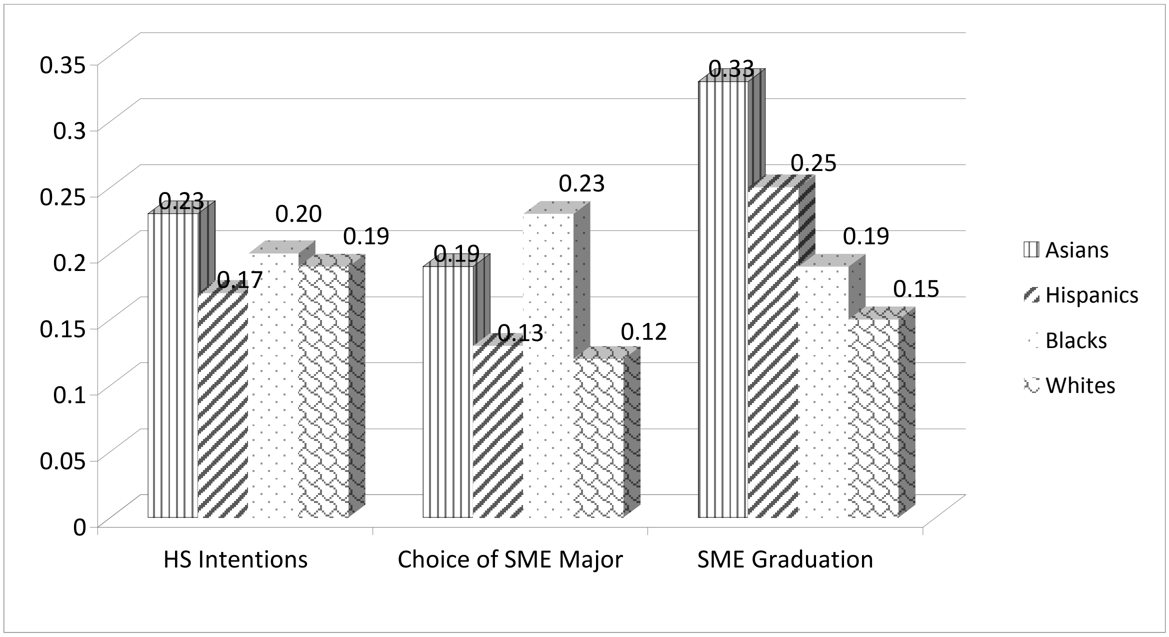

Figure 1: Probabilities for Different Races on SME Outcomes in Models without Controls

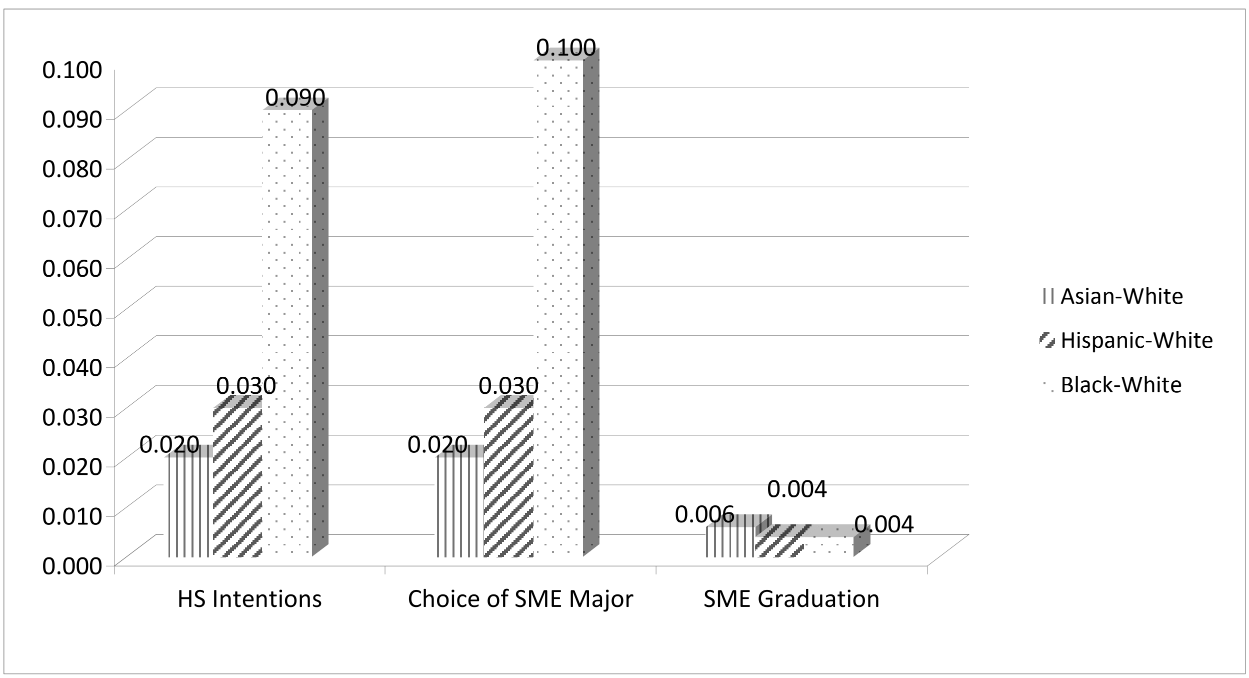

Figure 2: Asian-White, Hispanic-White, and Black-White Differences in Probabilities of Being in SME Pipeline, Controlling for Family Background, Gender, Academic Preparation, Prior SME Interest, and Math and Science Enrichment (From Model 5 of Each Respective Table)

an advantage over Whites because Asians have higher academic achievement and preparation, on average, than Whites. While controlling for academic preparation and achievement decreases Asian's advantage over Whites on SME outcomes, it makes Blacks and Hispanics more likely to choose and complete SME majors. From this finding, we can infer that the gaps in preparation and achievement still affect Blacks and Hispanics' success on SME outcomes.

My second hypothesis was that exposure to coursework and enrichment in math and science would be a statistically meaningful factor in predicting persistence in the SME pipeline, even after controlling for math and science test scores and grades. As hypothesized, taking rigorous math and science is associated with entry and persistence in the SME pipeline. In the model predicting high school SME intentions, being in accelerated math in 8th grade is a statistically significant predictor. Furthermore, taking trigonometry, pre-calculus, and calculus prove to be the only academic factors to be significant predictors of entry into an SME major. Finally, in the model predicting college graduation with an SME major, trigonometry and calculus are both statistically significant predictors. These findings indicate that taking rigorous math and science courses is associated with persistence in the SME pipeline.

As for exposure to enrichment in math and science, although participation in science fair and computer use are significantly, positively associated with high school intention to major in SME fields net of academic and family background, controlling for these factors does not dramatically change the estimated racial differences on the outcome. In addition, predictors of enrichment are not even statistically significant in the model predicting choice of a college major.

DISCUSSION OF FINDINGS

By far, the most important finding from this study is that Blacks and Hispanics are not disadvantaged on any SME outcomes, given college attendance and graduation. This finding differs from research done with data from the 1970s and 1980s, possibly marking a significant societal shift in the participation of Blacks and Hispanics in science, math, and engineering. While more recent studies on SME outcomes have continued to document racial disparity, my findings differ because of two important methodological innovations. First, unlike previous studies using nationally representative data from the nineties, I avoid confounding educational and SME persistence. Because race is associated with educational persistence, any confounding of educational and SME persistence may bias the estimation of racial differences in choice and completion of an SME major. Second, because NELS allows students eight years after high school graduation to finish a college degree, as compared to four or five years, I am able to use a more all-encompassing sample for my measurement of major completion. In so far as taking a non-traditional path through college is associated with race, we might expect that measuring SME graduation after only four or five years would bias estimates of racial difference on this outcome. Given these methodological innovations, it is not surprising that I find different results.

Beyond methodological innovations in measurement of SME outcomes, several societal factors may have helped minorities reach racial parity in choice and completion of

SME majors. First, institutional support for minorities in SME majors increased during this time period. Since the early 1980s, the National Science Foundation has founded or funded several programs to recruit minorities into SME fields and provide mentoring and tutoring while they are in college (National Science Foundation, 1997, 1996a). Also, many colleges and universities took a more active approach to ensuring that minorities feel welcomed and academically supported in these majors (Huang, Taddese, Walter, and Peng, 2000; Elliot et al., 1996).

Second, in addition to targeted sponsorship for minorities in SME fields, racial gaps in academic preparation and persistence have narrowed, making minorities better equipped to succeed in SME majors (Berends, Lucas, Sullivan, and Briggs, 2005). As this thesis has illustrated, academic factors are strong predictors of SME outcomes, and, given equal academic achievement and preparation, Blacks and Hispanics are more likely than Whites to choose and complete SME majors. Therefore, in so far as achievement gaps in math and science have closed, we would expect shifts toward racial parity in SME majors. Furthermore, the percentage of Blacks and Hispanics attending and graduating from college has increased substantially from the early 1980s to the mid-1990s (Alon and Tienda, 2007, 2005).[24] Since measurement of SME outcomes is contingent on educational persistence,

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[24] While 52.8% of Blacks attended any college in the 1982 cohort of High School and Beyond, 68.3% did in the 1992 cohort of NELS. Meanwhile, the college attendance rate for Hispanics increased 20 percentage points from 49% to 69% during this same time period (Alon and Tienda, 2007). As for college completion, while 26.4% of Blacks graduated from college at non-selective institutions in the early 1980s, this graduation rate had increased by 20 percentage points by the mid-nineties (Alon and Tienda, 2005). The same pattern holds at selective colleges as well. While 51.6% of Blacks graduated from selective institutions in 1982, 71.7% graduated at selective institutions in the nineties. The graduation rate of Hispanics also increased, though not as dramatically. In the early 1980s, 25.7% of Hispanics graduated from non-selective institutions, but by the mid-

greater persistence of minorities may have resulted in a higher percentage choosing and graduating in SME fields. In sum, this racial parity in choice and completion of SME majors arose in a context of swelling support for minority participation in SME fields. Several concurrent societal shifts, including the narrowing of racial gaps in academic performance and persistence, helped enhance the chances for minority success in science, math, and engineering fields.

CONCLUSION:

This thesis has demonstrated that, given educational persistence, the disadvantage for underrepresented minorities in choice and completion of science, math, and engineering majors is not present. Because we can only measure SME intentions if a student remains in the education pipeline, these statistics are only representative of students who were still in school at the time of the measure. In addition, this thesis has shown that coursework helps account for racial differences in SME outcomes, though exposure to enrichment activities does not seem to make much of a difference.

However, there are important limitations to this study that deserve consideration: (1) potential endogeneity bias in models, (2) measurement of SME major choice in college, and (3) unidentified mechanisms. I will discuss each of these in turn. Endogeneity bias arises when dependent variables affect independent variables in the model. This may be relevant to

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nineties 40.5% did. At selective colleges in the early 1980s, 62.1% of Hispanics graduated, while 69.0% graduated from selective colleges in the nineties. Meanwhile the change for Whites in graduation rates has been less dramatic; while Whites had a ten percentage point gain in graduation rate from non-selective colleges (53.4% to 62.5%) during this time period, the graduation rate at selective colleges remained about the same (82% to 81.2%) (Alon and Tienda, 2005).

this thesis, in so far as intention to major in SME fields shapes students' exposure to curriculum, high school achievement, and involvement with math and science enrichment activities. Using longitudinal data so that independent variables occur before dependent variables helps protect against endogeneity bias. However, because intention to pursue an SME field could have taken root long before the senior year in high school, it could have influenced the choice of high school curriculum or participation in enrichment activities. This hypothesis is difficult to test. However, I can test whether SME intentions affect educational persistence, which would be another form of endogeneity bias.

To see whether intention to pursue SME fields was associated with educational persistence, I tested for statistically significant associations between SME intentions and high school graduation, college entrance, and college graduation using Chi-Square tests. Results indicate that high school SME intentions are not related to high school graduation, or starting college. However, choosing an SME major by 1994 does have a statistically significant association with college graduation ($p<0.001$); a higher percentage of students who selected SME majors persist to graduation than students who did not (44% compared to 31%). This statistically significant relationship holds for all racial groups except Blacks and is especially notable for Asians. While 41% of Asian non-SME majors graduated from college, 75% of Asian students who had selected SME majors did ($p<0.001$). By contrast, Hispanic and White students who major in SME fields have much less of an advantage in college graduation, as compared to their counterparts who choose other fields. While 13% of Hispanics who chose other fields graduated from college, 23% of Hispanics who chose SME fields did ($p<0.05$). And while 36% of White non-SME majors graduated from college, 49% of SME majors did ($p>0.05$).

In sum, SME intentions appear to be related to starting college at a four-year institution and college graduation. These associations may have influenced my results because students who were SME majors were more likely than non-SME majors to graduate from college. In other words, students who chose SME majors were more likely to be in the sample of college graduates used to perform the analysis on graduation with an SME major. Ideally, in order to avoid this non-random selection into the sample of college graduates, I would have been able to measure college graduation with an SME major using a sample of students who had selected into SME majors early on in college. In fact, I did run this model (see Appendix 2), but because the sample size was only 651, there was not enough statistical power to determine whether predictors had statistically significant associations with the outcome.

The second limitation concerns bias in the measurement of choice of major. Ideally, I would have been able to measure the first college major, irrespective of date of college entry. However, given data limitations, I could only measure choice of college major if the respondent had entered college by 1994 and had chosen a college major. Thus, these findings are only applicable to students who did not delay their college entrance more than two years after graduating high school and who had declared a major by 1994.

The third limitation to this thesis is that I have not fully identified mechanisms that explain why there are racial differences on these outcomes. While curriculum appears to be an important factor in accounting for racial differences, I have not established why Whites are at a disadvantage when respondents of all races have equal academic preparation and achievement. Furthermore, in the literature review, I had hypothesized that math interest and confidence would explain Black and Hispanic advantage, but controlling for these factors did not make this advantage dissipate.

Future Research

There is need for more research in this area. First, given the huge gender gap on all of three SME outcomes, it would be meaningful to estimate models for males and females separately. I would predict that there is less differentiation between races for females, given that fewer females express interest in SME fields. Second, future research in this area should address the methodological complication induced by endogeneity bias. As I have discussed above, there is reason to believe that there is some reverse causation, with SME intentions causing educational persistence. One way to address this bias would be by using non-recursive structural equation models that allow SME outcomes and outcomes associated with educational persistence to affect each other. Third, and finally, future research should investigate mechanisms that lead to racial differences in choice and completion of SME majors after controlling for differences in academic preparation, family background, enrichment, and attitudes toward math and science, such as parental involvement or family values.

Implications

Although this thesis demonstrates that Hispanics and Blacks are no longer at a disadvantage on choice and completion of SME majors, these findings only apply to students who have persisted to and through college. As I have shown, Hispanics and Blacks are less likely than members of other races to graduate from high school or to attend or graduate from bachelor degree-granting institutions. Although my results indicate that there is racial parity in SME fields, if we were to account for all of the Hispanics and Blacks who drop out of the educational pipeline before they have a chance to choose or complete an SME major, this parity would not hold. Therefore, in order to bring about more equal SME outcomes across racial groups, policy makers should focus on educational persistence of Blacks and Hispanics.

I recommend three specific strategies to accomplish this goal. First, given that faculty-student mentoring improves SME retention at the college level (National Science Foundation, 1996b), it may be effective for retention of junior high and high school students. Early exposure to one-on-one mentoring from SME professionals or academics might help high school students understand how to prepare for an SME major by taking an appropriate high school course sequence, seek financial aid specific to SME fields, or apply to colleges with minority support systems in place. Second, students need rigorous academic preparation in math and science because this will help them succeed in SME majors once they get to college. Blacks and Hispanics often lack access to academically rigorous math and science courses because they attend high-poverty schools that have shortages of highly qualified teachers or instructional materials. Policy makers should focus on creating a level-playing field for minorities interested in math and science by ensuring that their high schools are well-equipped with the resources and human capital necessary to maintain college preparatory math and lab-intensive science courses. Third, since underrepresented minorities are more likely to start at community colleges, there should be more support for transfer to bachelor-degree-granting institution. For example, the Community College Summer Research Program at Occidental College provides community college students with the opportunity to experience research at a four-year college, thereby easing their transition (Halleck, 1990). With strategies like these, I believe that Blacks and Hispanics will be more likely to persist to and through college, while reaching their full potential in science, math, and engineering fields.

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Table 1. Descriptive Statistics for the Three Analytic Samples

	High School Seniors			College Attendees			College Graduates		
	N=10,875			N=7,085			N=3,571		
	Mean	SD	% Missing	Mean	SD	% Missing	Mean	SD	% Missing
OUTCOME VARIABLES									
SME Intentions '92	0.19	0.39	28.2	--	--	--	--	--	--
SME Intentions '94	--	--	--	0.14	0.32	35.38	--	--	--
SME Major	--	--	--	--	--	--	0.17	0.35	0.06
PREDICTORS									
Asian	0.05	0.20	0.74	0.04	0.20	0.28	0.06	0.20	0.08
Hispanic	0.09	0.28	0.74	0.09	0.27	0.28	0.05	0.18	0.08
Black	0.11	0.31	0.74	0.11	0.30	0.28	0.08	0.22	0.08
White	0.75		0.74	0.76	0.41	0.28	0.81	0.32	0.08
SME Intentions '92	--	--	--	0.18	0.36	36.12	--	--	--
SME Intentions '94	--	--	--	--	--	--	0.18	0.32	32.39
Expectations	--	--	--	0.80	0.39	20.62	--	--	--
Family Income	10.42	0.99	19.10	10.55	1.03	18.00	10.84	0.61	15.96
Father's Educ.	0.38	0.47	23.32	0.36	0.46	17.75	0.53	0.41	16.29
Mother's Educ.	0.30	0.45	20.56	0.29	0.44	14.08	0.40	0.40	13.04
Female	0.53	0.49	0.00	0.54	0.48	0.00	0.57	0.41	0.00
Like Math '88	0.57	0.49	13.68	--	--	--	--	--	--
Math Confidence '90	0.49	0.49	12.44	--	--	--	--	--	--
Accel. Math '88	0.45	0.49	16.58	--	--	--	--	--	--
College prep	0.47	0.49	17.52	--	--	--	--	--	--
Math Grades '88	0.40	0.48	12.55	--	--	--	--	--	--
Science Grades '88	0.40	0.48	13.14	--	--	--	--	--	--
Math Grades '90	0.42	0.49	9.28	--	--	--	--	--	--
Science Grades '90	0.45	0.49	11.55	--	--	--	--	--	--
Math Test '88	0.00	1.00	13.60	--	--	--	--	--	--
Science Test '88	0.00	1.00	13.71	--	--	--	--	--	--
Math Test '90	0.00	1.00	36.17	--	--	--	--	--	--
Science Test '90	0.00	1.00	36.57	--	--	--	--	--	--
Science Fair '88	0.30	0.45	16.82	--	--	--	--	--	--
Science Fair '90	0.11	0.31	14.65	--	--	--	--	--	--
Discussion '90	0.38	0.48	12.75	--	--	--	--	--	--
Computer '90	0.35	0.47	10.17	--	--	--	--	--	--
Algebra 2	--	--	--	0.62	0.47	11.93	0.76	0.36	14.85
Trigonometry	--	--	--	0.25	0.42	11.96	0.39	0.41	14.90
Pre-Calculus	--	--	--	0.19	0.38	11.92	0.33	0.39	14.85
Calculus	--	--	--	0.13	0.32	11.94	0.22	0.35	14.86

Table 1 (Continued)

	High School Seniors			College Attendees			College Graduates		
	N=10,875			N=7085			N=3571		
	Mean	SD	% Missing	Mean	SD	% Missing	Mean	SD	% Missing
Chemistry	--	--	--	0.66	0.46	11.95	0.84	0.30	14.88
Physics	--	--	--	0.31	0.45	12.00	0.47	0.42	14.94
High School GPA	--	--	--	2.85	0.67	47.06	3.20	0.49	34.60
Math Test	--	--	--	0.00	1.00	39.00	0.00	1.00	24.62
Science Test	--	--	--	0.00	1.00	39.33	0.00	1.00	25.04
Experiments '92	--	--	--	0.61	0.47	28.73	--	--	--
Discussion '92	--	--	--	0.44	0.48	28.75	--	--	--
Computer '92	--	--	--	0.24	0.41	19.14	--	--	--
1st Year GPA	--	--	--	--	--	--	2.89	0.50	34.18
2-Year	--	--	--	--	--	--	0.16	0.31	35.81
4-Year	--	--	--	--	--	--	0.83	0.36	35.81
Other PSE Institution	--	--	--	--	--	--	0.01	0.09	35.81
Selective	--	--	--	--	--	--	0.27	0.37	39.24

Table 4. Predicting HS Intentions for SME Major Using a Sample of High School Graduates (N=10,875)

	Model 1		Model 2		Model 3		Model 4		Model 5	
	coef	*OR*	*coef*	*OR*	*coef*	*OR*	*coef*	*OR*	*coef*	*OR*
Asian	**0.258**	1.2947	**0.229**	1.257	0.136	1.146	0.094	1.099	0.087	1.091
	(0.113)		(0.115)		(0.120)		(0.121)		(0.121)	
Hispanic	-0.128	0.880	-0.069	0.934	-0.055	0.946	0.141	1.152	0.149	1.161
	(0.111)		(0.116)		(0.120)		(0.130)		(0.129)	
Black	0.058	1.060	0.145	1.156	0.128	1.137	**0.489**	1.631	**0.458**	1.581
	(0.139)		(0.152)		(0.151)		(0.149)		(0.146)	
Father's Educ.			0.124	1.132	0.091	1.095	-0.073	0.930	-0.086	0.918
			(0.099)		(0.098)		(0.096)		(0.097)	
Mother's Educ.			0.062	1.064	0.023	1.024	-0.079	0.924	-0.091	0.913
			(0.099)		(0.097)		(0.098)		(0.097)	
Family Income			-0.004	0.996	0.007	1.007	-0.057	0.945	-0.066	0.937
			(0.041)		(0.041)		(0.039)		(0.039)	
Female			**-1.181**	0.307	**-1.134**	0.322	**-1.128**	0.324	**-1.096**	0.334
			(0.073)		(0.073)		(0.072)		(0.073)	
Like Math '88					**0.179**	1.196	0.138	1.148	0.117	1.124
					(0.074)		(0.074)		(0.075)	
Math Confidence '90					**0.817**	2.263	**0.442**	1.556	**0.435**	1.545
					(0.071)		(0.083)		(0.084)	
Accel. Math '88							**0.210**	1.234	**0.198**	1.219
							(0.082)		(0.083)	
College prep							0.004	1.004	-0.017	0.983
							(0.077)		(0.077)	
Math Grades '88							0.120	1.127	0.123	1.131
							(0.085)		(0.086)	
Science Grades '88							0.130	1.139	0.114	1.121
							(0.083)		(0.082)	
Math Grades '90							0.148	1.159	0.142	1.153
							(0.094)		(0.095)	
Science Grades '90							**0.204**	1.227	0.181	1.199
							(0.093)		(0.094)	
Math Test '88							-0.005	0.995	-0.002	0.998
							(0.073)		(0.073)	
Science Test '88							**0.119**	1.127	**0.115**	1.122
							(0.056)		(0.056)	
Math Test '90							0.075	1.078	0.077	1.080
							(0.084)		(0.084)	
Science Test '90							**0.198**	1.218	**0.190**	1.209
							(0.061)		(0.062)	
Science Fair '88									0.092	1.096
									(0.087)	
Science Fair '90									**0.265**	1.304
									(0.116)	
Discussion '90									0.051	1.052
									(0.075)	
Computer '90									**0.162**	1.176
									(0.075)	
Constant	**-1.456**	0.2332	**-0.984**	0.374	**-1.652**	0.192	**-1.156**	0.315	**-1.156**	0.315
	(0.039)		(0.417)		(0.427)		(0.406)		(0.410)	

Table 5. Predicting Entry into SME Major Using a Sample of College Attendees (N=7,085)

	Model 1		Model 2		Model 3		Model 4		Model 5	
	coef	*OR*	*coef*	*OR*	*coef*	*OR*	*coef*	*OR*	*coef*	*OR*
Asian	**0.588**	1.800	**0.523**	1.687	**0.497**	1.643	0.347	1.415	0.347	1.415
	(0.168)		(0.178)		(0.180)		(0.186)		(0.187)	
Hispanic	0.146	1.157	0.274	1.315	0.358	1.430	**0.540**	1.717	**0.523**	1.687
	(0.203)		(0.219)		(0.223)		(0.237)		(0.242)	
Black	**0.794**	2.213	**0.811**	2.251	**0.935**	2.547	**1.260**	3.524	**1.259**	3.521
	(0.198)		(0.230)		(0.236)		(0.247)		(0.239)	
SME Intentions '92			**2.217**	9.181	**2.127**	8.387	**1.859**	6.416	**1.846**	6.335
			(0.135)		(0.143)		(0.143)		(0.143)	
Expectations			**0.852**	2.345	**0.779**	2.178	0.311	1.364	0.283	1.327
			(0.208)		(0.218)		(0.236)		(0.235)	
log income					0.021	1.021	-0.036	0.964	-0.037	0.964
					(0.063)		(0.055)		(0.055)	
Father's Educ.					0.196	1.216	0.015	1.015	0.011	1.011
					(0.187)		(0.195)		(0.196)	
Mother's Educ.					0.169	1.184	0.077	1.08	0.087	1.091
					(0.179)		(0.181)		(0.180)	
Female					**-0.390**	0.677	**-0.459**	0.632	**-0.412**	0.662
					(0.139)		(0.137)		(0.137)	
Algebra 2							-0.058	0.944	-0.062	0.940
							(0.148)		(0.147)	
Trigonometry							**0.304**	1.355	**0.302**	1.352
							(0.134)		(0.136)	
Pre-Calculus							**0.449**	1.567	**0.449**	1.567
							(0.163)		(0.162)	
Calculus							**0.504**	1.655	**0.508**	1.661
							(0.168)		(0.168)	
Chemistry							-0.142	0.867	-0.143	0.867
							(0.193)		(0.192)	
Physics							0.312	1.367	0.307	1.359
							(0.169)		(0.169)	
High School GPA							0.094	1.098	0.085	1.089
							(0.141)		(0.139)	
Math Test '92							0.198	1.219	0.210	1.233
							(0.148)		(0.148)	
Science Test '92							0.017	1.017	0.002	1.002
							(0.145)		(0.141)	
Experiments '92									-0.039	0.962
									(0.149)	
Discussion '92									0.256	1.291
									(0.132)	
Computer '92									0.206	1.228
									(0.142)	
Constant	**-2.011**	0.134	**-3.426**	0.033	**-3.532**	0.029	**-2.979**	0.051	**-3.092**	0.045
	(0.062)		(0.199)		(0.681)		(0.718)		(0.711)	

Table 6. Predicting Graduation with SME Major Using a Sample of College Graduates (N=3,571)

	Model 1		Model 2		Model 3		Model 4		Model 5	
	coef	*OR*	*coef*	*OR*	*coef*	*OR*	*coef*	*OR*	*coef*	*OR*
Asian	**1.066**	2.904	**1.191**	3.289	**1.104**	3.017	**0.944**	2.570	**0.981**	2.668
	(0.236)		(0.429)		(0.427)		(0.371)		(0.360)	
Hispanic	**0.641**	1.899	0.485	1.624	**0.594**	1.812	**0.661**	1.936	**0.709**	2.032
	(0.287)		(0.273)		(0.291)		(0.299)		(0.309)	
Black	0.325	1.383	0.149	1.161	0.346	1.413	0.608	1.836	0.694	2.001
	(0.399)		(0.527)		(0.522)		(0.563)		(0.557)	
SME Intentions '94			**3.623**	37.44	**3.643**	38.21	**3.357**	28.71	**3.415**	30.41
			(0.169)		(0.173)		(0.172)		(0.171)	
log income					-0.036	0.964	-0.118	0.888	-0.100	0.905
					(0.144)		(0.141)		(0.145)	
Father's Educ.					**0.492**	1.635	0.338	1.402	0.323	1.381
					(0.187)		(0.185)		(0.188)	
Mother's Educ.					0.242	1.274	0.114	1.121	0.128	1.136
					(0.203)		(0.218)		(0.215)	
Female					-0.206	0.814	-0.295	0.745	**-0.344**	0.709
					(0.184)		(0.170)		(0.171)	
Algebra 2							0.043	1.044	0.029	1.029
							(0.221)		(0.221)	
Trigonometry							**0.552**	1.737	**0.534**	1.706
							(0.184)		(0.185)	
Pre-Calculus							0.162	1.176	0.156	1.168
							(0.196)		(0.191)	
Calculus							**0.583**	1.791	**0.551**	1.734
							(0.235)		(0.233)	
Chemistry							0.253	1.288	0.276	1.317
							(0.293)		(0.293)	
Physics							0.345	1.412	0.378	1.459
							(0.238)		(0.229)	
High School GPA							**0.557**	1.745	**0.436**	1.547
							(0.198)		(0.209)	
Math Test							-0.007	0.993	-0.012	0.988
							(0.180)		(0.176)	
Science Test							0.115	1.122	0.101	1.106
							(0.133)		(0.133)	
1st Year GPA									**0.406**	1.501
									(0.184)	
2-Year									0.008	1.008
									(0.292)	
Other PSE Institution									0.508	1.661
									(0.671)	
Selective									-0.155	0.857
									(0.220)	
Constant	**-1.755**	0.173	**-2.954**	0.052	-2.858	0.057	**-4.531**	0.011	**-5.499**	0.004
	(0.079)		(0.105)		(1.564)		(1.766)		(1.844)	

Appendix 1. Descriptions of Variables

Variable	Description	Range
HS SME Intentions	1 if expressed intention to major in SME field as senior in high school, 0 if other field	0-1
Started SME MAJOR	1 if major at first PSE institution was in an SME field, 0 if other major	0-1
Grad with SME Major	1 if completed B.A. in SME major, 0 if completed B.A. with another major	0-1
Asian	1 if Asian or Pacific Islander	0-1
Hispanic	1 if Hispanic	0-1
Black	1 if Black	0-1
White	1 if White	0-1
Expectations	1 if expected to finish a bachelor's degree	0-1
Family Income '88	Logged family income, as reported by parents in 1988	0--12.77
Family Income '92	Logged family income, as reported by parent	0--12.77
Father's Educ.	1 if father completed college	0-1
Mother's Educ.	1 if mother completed college	0-1
Female	1 if female	0-1
Like Math '88	1 if student looked forward to eighth grade math class	0-1
Math Confidence '90	1 if student thought s/he was good at math in tenth grade	0-1
Accel. Math '88	1 if student was in accelerated math in eight grade	0-1
College prep	1 if student in college preparatory track in tenth grade	0-1
Math Grades '88	1 if student earned mostly A's, 0 if other grades	0-1
Science Grades '88	1 if student earned mostly A's, 0 if other grades	0-1
Math Grades '90	1 if student earned mostly A's, 0 if other grades	0-1
Science Grades '90	1 if student earned mostly A's, 0 if other grades	0-1
Math Test '88	Score on standardized math test administered by NCES in 8th grade	-3.73--3.35
Science Test '88	Score on standardized math test administered by NCES in 8th grade	-4.11--3.91
Math Test '90	Score on standardized math test administered by NCES in 10th grade	-3.76--3.63
Science Test '90	Score on standardized math test administered by NCES in 10th grade	-4.26--3.56
Science Fair '88	1 participated in science fair in eighth grade	0-1

Appendix 1 (Continued).

Variable	Description	Range
Science Fair '90	1 if participated in science fair in tenth grade	0-1
Discussion '90	1 if at least once a month, 0 if less than this	0-1
Computer '90	1 if used computer at least once every few weeks, 0 if rarely or never	0-1
Algebra 2	1 if took Algebra 2 in high school	0-1
Trigonometry	1 if took Trigonometry in high school	0-1
Pre-Calculus	1 if took Pre-Calculus in high school	0-1
Calculus	1 if took Calculus in high school	0-1
Chemistry	1 if took Chemistry in high school	0-1
Physics	1 if took Physics in high school	0-1
High School GPA	High School Grade Point Average	0.14--4.00
Math Test	Score on standardized math test administered by NCES in 12th grade	-3.47--4.67
Science Test	Score on standardized science test administered by NCES in 12th grade	-4.42--4.17
Experiments '92	1 if conducted experiments 1-2 times a week or more in science class, 0 if less than 1-2 times	0-1
Discussion '92	1 if discussed careers in science in science class at least 1-2 times a month, 0 if never discussed	0-1
Computer '92	1 if used computer more than once a week, 0 if less than once a week	0-1
1st Year GPA	Grade Point Average from 1st calendar year of college	0.21--4.00
2-Year	1 if began college at a 2-year college	0-1
4-Year	1 if began college at a 4-year college	0-1
Other PSE Institution	1 if began college at a less than 2-year or for-profit institution	0-1
Selective	1 if began college at a selective college	0-1

Appendix 2. Predicting Graduation with an SME Major Using a Sample of Declared SME Majors (N=651)

	Model 1		Model 2		Model 3		Model 4		Model 5	
	logit	*OR*	*logit*	*OR*	*logit*	*OR*	*logit*	*OR*	*logit*	*OR*
Asian	0.673	1.959	0.665	1.945	0.412	1.509	0.420	1.522	0.514	1.672
	(0.360)		(0.394)		(0.379)		(0.373)		(0.390)	
Hispanic	0.337	1.401	0.460	1.584	0.408	1.505	0.459	1.582	0.636	1.889
	(0.530)		(0.531)		(0.497)		(0.485)		(0.513)	
Black	0.008	1.008	0.259	1.296	0.329	1.389	0.221	1.247	0.301	1.351
	(0.611)		(0.611)		(0.678)		(0.680)		(0.734)	
log income			0.068	1.070	-0.026	0.975	0.000	1.000	0.047	1.048
			(0.198)		(0.184)		(0.180)		(0.188)	
Father's Educ.			0.557	1.745	0.369	1.446	0.357	1.430	0.230	1.259
			(0.314)		(0.322)		(0.325)		(0.312)	
Mother's Educ.			0.190	1.209	-0.043	0.958	-0.031	0.969	0.019	1.019
			(0.330)		(0.352)		(0.355)		(0.340)	
Female			0.054	1.055	-0.031	0.969	0.035	1.036	-0.089	0.915
			(0.258)		(0.246)		(0.251)		(0.250)	
Algebra 2					-0.029	0.971	0.006	1.006	0.039	1.040
					(0.329)		(0.328)		(0.335)	
Trigonometry					**0.718**	2.051	**0.703**	2.020	**0.689**	1.991
					(0.255)		(0.258)		(0.259)	
Pre-Calculus					-0.211	0.810	-0.197	0.821	-0.153	0.858
					(0.274)		(0.274)		(0.277)	
Calculus					0.383	1.467	0.309	1.362	0.197	1.218
					(0.299)		(0.301)		(0.316)	
Chemistry					-0.111	0.895	-0.086	0.918	-0.157	0.855
					(0.523)		(0.505)		(0.495)	
Physics					0.126	1.134	0.055	1.057	0.135	1.145
					(0.324)		(0.337)		(0.341)	
High School GPA					**0.888**	2.429	**0.884**	2.420	0.622	1.863
					(0.335)		(0.325)		(0.350)	
Math Test					0.158	1.171	0.175	1.191	0.065	1.067
					(0.245)		(0.243)		(0.246)	
Science Test					0.226	1.254	0.201	1.222	0.195	1.215
					(0.231)		(0.239)		(0.227)	
intend92							0.432	1.540	**0.575**	1.777
							(0.268)		(0.269)	
1st Year GPA									**0.790**	2.204
									(0.278)	
2-Year									-0.778	0.460
									(0.399)	
Selective									-0.133	0.875
									(0.267)	
Constant	**0.744**	2.104	-0.404	0.667	-2.430	0.088	-2.945	0.053	**-4.770**	0.008
	(0.145)		(2.122)		(2.097)		(2.052)		(2.131)	