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ABSTRACT

The Effect of Georgia's HOPE Scholarship on College Major: A Focus on STEM

There is growing concern in the U.S. that the nation is producing too few college graduates in science, technology, engineering, and mathematics (STEM) fields and there is a desire to understand how various policies affect college major decisions. This paper first uses student administrative records from the University System of Georgia to examine whether Georgia's HOPE Scholarship has affected students' college major decisions, with a focus on STEM majors. We find consistent evidence that HOPE reduced the likelihood that a USG student earned a degree with a major in a STEM field. The paper explores alternative reasons why HOPE reduced the likelihood of earning a STEM major.

JEL Classification: I23, J24

Keywords: merit aid, HOPE Scholarship, college major, STEM

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1. Introduction

There is a substantial literature spanning several disciplines that attempts to explain students' choice of and persistence in a college major. More recently, this literature has focused on majors in science, technology, engineering, and math (STEM). The literature from education focuses on factors such as role models (including parents, teachers, and peers), exposure to math and science courses, and math self-efficacy beliefs; Delaney (2007), Crisp, Nora, and Taggart (2009) and Wang (2012) provide surveys of the education literature.

Economists have also explored this issue. In a life-cycle utility maximization framework a student's choice of major depends on the student's preferences, the cost of completing various majors, the student's ability, that is, the probability of successfully completing the course of study for various majors, and the expected earnings after graduation (Berger 1988). Montmarquet, Cannings, and Mahseredjian (2002) extend the model to include uncertainty regarding the successful completing of each major. While the cost of college has been shown to affect the probability of attending college, it has also been found to affect the choice of major; see for example, Stater (2011), Denning and Turley (2013), and Stange (2013). See Arcidiacono (2004), Kinsler and Pavan (2013), Griffith (2010), Beffy, Fougere, and Maurel (2011), Arcidiacono, Hotz, and Kang (2012), and Wiswall and Zafar (2011) for other economic studies of the choice of college major.

We consider how Georgia's merit-based financial aid program, i.e., the HOPE Scholarship, affects student decisions to major in STEM fields. State merit aid programs have grown substantially since the early 1990s, with Georgia's HOPE Scholarship program adopted in 1993 being among the largest and most notable.[1] A large research literature has emerged that

[1] HOPE (Helping Outstanding Pupils Educationally) is a universal merit-based post-secondary scholarship and grant program for Georgia students enrolled in college or a technical school. To be eligible a student must be a U.S.

examines the effects of these merit aid programs on college outcomes such as enrollment, persistence, completion, and post-college retention in the state.[2] One outcome receiving limited attention thus far is the effect of merit aid on college major decisions.

We identified three studies that examine the effects of state merit aid programs on college majors. Cornwell, Lee, and Mustard (2008) investigate the effect of Georgia's HOPE Scholarship on the college major choices of freshmen enrolled at the University of Georgia. They find that HOPE significantly increased the probability of majoring in education but find no significant effect of HOPE on other majors. The current paper differs substantively from theirs in two major ways. First, our administrative data includes all 35 public colleges and universities in Georgia, not just one university as with Cornwell, Lee, and Mustard (2008). Furthermore, we consider not just freshman major but also the major upon graduation.

Zhang (2011) examines the effects of merit aid programs in Florida and Georgia on annual statewide STEM degree conferrals computed from the Integrated Postsecondary Education Data System's (IPEDS) Completion Survey. He generally finds statistically insignificant effects of merit aid on the percentage of STEM graduates in each state, with the one exception being a 1.6 percentage point increase for Florida private institutions. However, merit aid programs likely affect where students attend college and have been shown to increase the average academic ability of students in the state. STEM fields require greater academic ability,

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citizen or eligible non-citizen, a Georgia resident, enrolled in an eligible institution (either full or part time), and have a 3.0 GPA in high school, and maintain a GPA of 3.0 in college. For more details see Sjoquist and Walker (2010). As Sjoquist and Walker note, the motivation for HOPE was Governor Miller's desire to elevate the importance of education to Georgians. As best we can determine, there were no other policies adopted at that time that might have affected student choice of major.

[2] Sjoquist and Winters (2012, 2015) find small and insignificant average effects of merit aid on college attendance and completion rates. Welch (2014) finds minimal effects of merit aid on persistence and degree completion for students at community colleges. Sjoquist and Winters (2014) find that on average merit aid does increase the percentage of college attendees residing in their native state post-college, but there are meaningful differences in the effects across states.

especially in math, so merit-induced increases in average student quality need to be accounted for, but using aggregate data prevents Zhang from doing so.

Sjoquist and Winters (forthcoming) use American Community Survey (ACS) microdata to examine the average effects of merit aid programs across 25 states adopting them since 1991. Their analysis focuses on nine states with relatively large and generous merit aid programs and uses a difference-in-differences (DD) approach, comparing states with and without merit aid programs pre- and post-merit aid adoption. They find that the merit programs in these states substantially reduced the likelihood that an individual earned a degree in a STEM field. Their baseline estimate suggests that strong merit programs reduce the likelihood of earning a STEM degree by 1.3 percentage points (which corresponds to a 6.5 percent decrease in the number of STEM graduates), but alternative specifications suggest that the magnitude could be larger.

In this paper we use administrative records from the University System of Georgia (USG) to first examine the effect of Georgia's HOPE Scholarship on students' college major choices, focusing on STEM majors. We use a pre- and post-policy time difference identification strategy to estimate the model. Our analysis complements that of Sjoquist and Winters (forthcoming), but the current paper differs from Sjoquist and Winters in several fundamental ways. Examining USG administrative data allows us to explore possible mechanisms that might explain the effect of merit aid on STEM majors, something that cannot be explored as well with the ACS data used by Sjoquist and Winters. Thus, we consider the roles played by factors such as student ability, student performance in college, the transition between initial major and major at graduation, and how the effect on major differs by type of college. Using USG administrative data also offers a more precise measure of treatment than with the ACS, which requires defining treatment based on being born in a state with a merit-aid program at the time the student should have graduated from high school. Finally, Georgia's HOPE Scholarship is one of the largest and most generous merit aid programs in the nation and it could have stronger effects than the average effect of the nine strong merit aid programs estimated by Sjoquist and Winters (forthcoming). This paper provides evidence for and against some specific potential mechanisms through which HOPE could affect the likelihood of being a STEM major that Sjoquist and Winters (forthcoming) could not.

To preview our results, we find consistent evidence that Georgia's HOPE Scholarship reduced the probability that a young person would complete a bachelor's degree with a major in a STEM field. Our baseline specification yields an estimate of a 12.6 percent decrease in the number of STEM graduates, with the effects being larger for males than females. This estimate is larger than that found by Sjoquist and Winters (forthcoming) for their baseline specification, possibly because HOPE is an especially large merit program. The USG data include detailed student information that allows us to take a closer look at which students are shifting away from STEM. We estimated the effect by ability and found that the relative effects were most pronounced for students with good but unexceptional math skills. Our data do not allow us to precisely identify the exact mechanisms driving the negative results, but we do offer some evidence for or against specific mechanisms. The decrease in STEM degree probabilities in Georgia appears to be driven largely by the decreased likelihood that initial STEM majors actually go on to earn a STEM degree; HOPE did not significantly affect the likelihood that a USG student chooses STEM as their initial major.

There are several possible mechanisms through which HOPE could reduce the probability of earning a STEM degree; we discuss these mechanisms more fully in section 5, where we summarize the evidence for and against specific mechanisms. First, financial aid reduces the cost of tuition but not the other costs. To the extent that other costs differ across majors, financial aid changes the relative prices of majors, which could affect a student's choice of major.[3] Second, financial aid reduces the need for a student to take out loans. The magnitude of a student's loans might affect the student's major if the student plans to choose an occupation that would allow him to pay off the debt quickly. Third, the mechanism that is perhaps most intuitive are student actions to maintain eligibility for HOPE, and in particular students might select or switch to a major for which it is easier to maintain a 3.0 GPA required to maintain HOPE.[4] Fourth, the high school GPA requirements for merit aid eligibility may create incentives for students to enroll in less challenging courses in high school, which might make them less prepared for more difficult majors in college. Fifth, HOPE has been shown to alter the type of in-state institution students attend and to increase the likelihood that students stay in-state to attend college. As we discuss in section 5, this could affect the college major opportunities that are available and alter the relative attractiveness of specific majors. While we are unable to fully explain the exact mechanisms driving the results, we do provide evidence in support of some potential mechanisms over others.

2. Data and Empirical Framework

[3] Other researchers have found that relatively small changes in the total cost of college can significantly affect the choice of major. Denning and Turley (2013) explore the effects of the SMART Grant program on choice of major. The SMART program provided financial aid to college juniors and seniors majoring in STEM and foreign languages. They find that the SMART Grant program induced students to major and take courses in incentivized fields; a roughly 3 percentage point increase in Texas and a 10 percentage point increase at BYU. Stange (2013) studies the effects on the choice of major resulting from differential tuition across undergraduate majors, and finds that differential tuition altered the allocation of students across majors.

[4] Dee and Jackson (1999) report that students majoring in science, engineering, and computing are significantly more likely to lose the Georgia HOPE scholarship than those in other majors, but do not examine how this might affect students college major choices.

We explore the effects of the Georgia HOPE Scholarship on college major using administrative data for the University System of Georgia (USG). The USG is a statewide system that at the time consisted of 35 public higher education institutions including two- and four-year colleges and universities in Georgia. From the USG Board of Regents we obtained data on four cohorts of entering students to the USG. The four cohorts include all students who graduated from a Georgia high school during the years 1990, 1991, 1995 and 1996 and enrolled in a USG institution in the same year (i.e., students who enrolled in the summer or fall terms immediately after graduating high school). Data were obtained for the 1995 and 1996 cohorts instead of the 1993 and 1994 cohorts because these first two post-HOPE cohorts were initially subject to an income cap for eligibility. The 1992 cohort of students was avoided out of concern that some of these students might have anticipated the passage of HOPE and altered their behavior in response. The 1990-1991 cohorts are therefore the pre-HOPE control group and the 1995-1996 cohorts are the post-HOPE treatment group. [5]

The USG sample is also restricted to Georgia residents who graduated high school in Georgia because non-residents and graduates of schools outside of Georgia were not eligible for HOPE. Of particular importance, we know the major declared as a freshman and the earned major upon graduation. Our main sample is restricted to students who eventually earn a bachelor's degree from the USG. We first consider the effect of HOPE on majoring in a STEM field, and then consider the effects on other broad majors. Descriptive statistics by sex and pre- and post-HOPE are presented in Table 1.

We estimate a linear probability model as follows:

$$P(Y_{it} = 1) = \beta X_{it} + \theta PostHOPE_t + \varepsilon_{it},$$

[5] Appendix Table A shows how the composition of the student body changed pre- and post-HOPE.

where Y is an indicator variable equal to one if the individual's major is in a STEM field[6], X includes dummy variables for sex, race, Hispanic origin, high school attended, SAT score, and high school GPA, and $PostHOPE$ is a dummy equal to one for the 1995-96 cohorts and zero for the 1990-91 cohorts.[7] We used a set of GPA and SAT dummy variables since we did not want to assume that their effects are linear.[8] Therefore, θ measures the effect of the HOPE program on the probability of being a STEM major holding student quality and demographics constant. We consider both the major at time of matriculation (initial major) and the final major (earned major). Sjoquist and Winters (2015) use the same preferred specification and confirm that there was no significant effect on degree completion in the USG dataset.

A concern with the use of these data is that HOPE could have affected the composition of the student body post-HOPE, resulting in a possible endogeneity problem. Dynarski (2000) and Cornwell, Mustard, and Sridhar (2006), for example, find that the HOPE program enticed students who would have gone to college out-of-state in the absence of HOPE to go to college in-state. Denote these students by H_O and HOPE students who would have gone to college in-state without HOPE by H_I. (Obviously, we cannot identify which students are H_O students.) If

[6] We follow Sjoquist and Winters (forthcoming) definition of STEM majors based on the Immigration and Customs Enforcement list; see table A.1 in Sjoquist and Winters (forthcoming).
[7] Note that the $PostHOPE$ dummy equals one for all students in the post-HOPE cohort and not just students who received the HOPE Scholarship. We do not have the HOPE GPA needed to determine if pre-HOPE students would have qualified for HOPE had it existed. The high school GPA calculated to determine HOPE eligibility is not the same GPA that USG schools use to determine whether to admit a student; we have the admission GPA for the pre-HOPE period and cannot calculate the HOPE GPA. However, 86 percent of our post-HOPE sample of graduates received HOPE as freshmen as did 92 percent of post-HOPE graduates with initial STEM majors, so the post-HOPE dummy is a reasonably good approximation for HOPE receipt. We also considered an event-style analysis by replacing the post-hope dummy with three dummies for matriculation year. Results, reported in Appendix Table B, are qualitatively similar to using the simple post-HOPE dummy.
[8] Specifically, we define 13 groups for both math and verbal SAT scores and define a dummy variable for each (excluding the lowest as the base group). The groups are 200-340, 350-390, 400-430, 440-460, 470-490, 500-520, 530-550, 560-580, 590-610, 620-650, 660-690, 700-750, and 760-800. We control for math and verbal scores separately because they are expected to have differing effects on the probability of being a STEM major. We also define 26 high school GPA groups; students with GPA below 1.5 are the base group. We then round GPAs to the nearest tenth and include a dummy for each tenth, e.g., dummies for 1.6, 1.7, 1.8, …, 3.9, and 4.0.

the H_O students are equivalent to the H_I students, then endogeneity should not be a problem. However, if H_O students are less inclined to major in a STEM field, then our estimate of the effect of HOPE on STEM majors will be overstated. We control for the quality of students, which should reduce the importance of the endogeneity, although there may be unmeasured differences. On the other hand, if H_O are more likely to be STEM majors than H_I students, then we will underestimate the effect of HOPE on STEM majors. While we don't know which of these three alternatives is correct, we believe that H_O students are not less likely to major in STEM than H_I since the students who in the absence of HOPE would have gone to college out-of-state are likely to be higher quality students, and thus more likely to be STEM majors.[9]

There is some indirect support for this supposition. First, there is some evidence that the probability of being a STEM major is positively related to family income. For example, Moore (2014) finds that students from higher income families are more likely to major in STEM than low-income.[10] Additionally, Jaquette, Curs, and Posselt (2014) suggest that the probability that a student will attend an out-of-state school increases with family income.[11] Sjoquist and Winters (2013) report that average SAT scores in the USG increased post-HOPE, and we find that STEM majors have higher average SAT scores. If the increase in SAT scores is due to higher-SAT students staying in-state for college as a result of HOPE, the implication is that these students are more likely to major in STEM. We also partially address this issue empirically below by examining the differential effects of HOPE on initial and earned STEM majors. If H_O students

[9] To explore the effect of the possible change in the student body due to HOPE we considered students from high schools for which the number of students attending USG schools changed by less than 5 percent pre- and post-HOPE and that did not change at all. The results for both groups are similar to our main results (Table 2), but because of the small sample size the coefficients are noisier.

[10] However, Stater (2011) finds that higher family income reduces the probability of being a science major.

[11] In addition, Kinsler and Pavan (2011) find that the probability that a student attends a high-quality college increases with family income. Fuller, Manski, and Wise (1982) find that high income households are less sensitive to the cost of college.

have unobservables that less incline them toward STEM, the post-HOPE dummy should reduce both initial and earned STEM majors.

We are essentially estimating a time-differenced model. This raises identification concerns that the observed differences over time that we attribute to the effects of HOPE may be affected by other factors that vary over time and affect the probability of being a STEM major. As noted below, we address these concerns in several ways. We use ACS data that do not suffer problems from changes in student body composition to check the robustness of our basic results. We also use ACS data to confirm that other states did not experience a decrease in STEM during this time period that could confound our USG results. Finally, we explore using non-resident students in the USG as a control group. None of these alternatives suggest that HOPE did not cause a reduction in the likelihood that a student majors in STEM. These results are discussed in more detail below.

3. The Effects of HOPE on Majoring in STEM

In this section we present estimates of the effects of HOPE on the probability of being a STEM major. The USG data, unlike the ACS data used in Sjoquist and Winters (forthcoming), allow us to consider the effect of merit aid on both initial majors and earned majors, and to control for student quality. Note that the sample sizes for the main results are equivalent to those in Table 2. However, for several of the tables we consider various subsamples and there are multiple samples sizes, but we do not report these sample sizes.[12]

[12] Reporting sample sizes for each subsample would clutter the tables. The sizes of the various subsamples almost always exceed 1000; the exception is for Table 7 (results by SAT) for initial STEM majors in which there are only 356 female initial STEM majors with SAT math scores in the 700-800 range and only 839 male initial STEM majors with SAT math<400.

3.1. *Initial STEM Major*

Columns 1-4 of Table 2 present the results for the USG analysis in which the dependent variable is whether a student initially declared a STEM major as a freshman. The first column includes dummies for sex, race, Hispanic origin, and high school attended, but not SAT, high school GPA, or institution. The second column adds SAT dummies, the third adds high school GPA dummies, and the fourth adds dummies for initial USG institution attended. There are important caveats for the last two columns. There is evidence of high school grade inflation for post-HOPE cohorts in Georgia. Appendix Table C, which presents regressions of high school GPA for college graduates against a post-HOPE dummy using various controls, shows that high school GPA increased post-HOPE by 0.15 points for all majors and 0.11 points for STEM majors.[13] Inflated high school GPAs for post-HOPE students mean that one should be cautious interpreting results that control for high school GPA because looking at students with the same GPA compares lower quality post-HOPE students to higher quality pre-HOPE students.[14] Since student quality is positively correlated with the probability of majoring in a STEM field, grade inflation will create a negative bias in θ when controlling for high school GPA. Furthermore, HOPE likely changed which institution students attend and this may affect their majors.[15] Our primary interest is in the overall effects of HOPE, but controlling for HOPE-induced changes in institution may partial out some of the effect. Our preferred estimates, therefore, do not control

[13] Sjoquist and Winters (2013) also find evidence of high school grade inflation for the full population of students enrolled in the USG, i.e., the result is not unique to the sample of graduates. The increase in high school GPAs over time could also be partially attributable to factors other than HOPE. However, regardless of the source, grade inflation over time makes high school GPA a problematic control variable for our analysis.

[14] Castleman (2012) also finds that students in Florida take strategic actions to help ensure that their high school GPAs and SAT/ACT scores are above the cutoffs.

[15] If applicants perceive that admissions at selective institutions are becoming more competitive post-HOPE, they may report more challenging intended majors in order to bolster their chances of admission. However, the period that we consider is early in the life of the HOPE program, and it was not until later that admissions to some of the colleges became much more difficult. So, we do not believe that perceived admission standards would have induced applicants to alter their reported major.

for high school GPA or institution, but we also report results that do. SAT score increases are likely to represent actual increases in student quality and should be controlled for, so our preferred specification is the second column that includes all of the controls except for high school GPA and institution.[16]

The results in the first column of Table 2 suggest that the HOPE Scholarship program increased the probability of declaring a STEM major as a freshman. The second column in which we control for student quality by adding the SAT score dummies results in a very small negative coefficient that is statistically insignificant. When we add the high school GPA dummies in the third column, the coefficient estimates increase in magnitude (i.e., become larger negatively) and become statistically significant. Adding institution dummies (column 4) turns the coefficient positive, and though relatively small it is statistically significant. However, we cluster by cohort, but there are only 4 cohorts and we have only one state so the clustered standard errors should be interpreted with some caution.[17] The results for our preferred specification in column 2 suggest that controlling for changes in student quality using SAT scores HOPE had no meaningful effect on the likelihood that freshmen declared a STEM major.[18]

3.2. *Earned STEM Major*

[16] Note that the SAT is not part of the HOPE eligibility condition and thus not subject to merit-induced strategic manipulation.

[17] In results not shown, we also experimented with several alternative procedures for estimating standard errors for our baseline results including individual OLS, individual bootstrapped, clustering by origin county, the Donald and Lang (2007) mean residual by cluster OLS standard error procedure, and a cluster-bootstrap procedure. Inferences are qualitatively consistent across the various standard error estimates.

[18] One limitation of the analysis using the initial major is that a very large percentage of students, almost 40 percent, do not have a declared major. This is much larger than the 19.9 percent reported by Stater (2011) for the three universities in Colorado, Indiana, and Oregon (1994-1996) and 29.5 percent reported by Carruthers and Özek (2012) for 4-year schools in Tennessee. In results not shown, we examined using a dummy for "ever held a STEM major" as an outcome variable; results were similar to those using the initial STEM major dummy.

Columns 5-8 of Table 2 report the effects of HOPE on the probability of earning a bachelor's degree in a STEM field. The coefficient on the post-HOPE dummy is statistically insignificant in column 5, but the effect is significantly negative for all regressions in columns 6-8. For our preferred regression in column 6, the coefficient of -0.0253 implies that HOPE reduced the number of STEM graduates by 12.6 percent. Controlling for high school GPA again decreases the size of the coefficient. Controlling for institution again makes the coefficient smaller (i.e., less negative). If HOPE causes some students to go to college in state rather than out-of-state and if these students are more likely to major in STEM than other students, then the reported decrease in earned STEM majors is smaller than what would occur if there was no change in the composition of students.

Comparing columns 1 and 2 and 5 and 6 in Table 2 shows that including SAT makes the effect of HOPE on the probability of being a STEM major substantially more negative, both as a freshman and upon graduation. If HOPE resulted in higher-SAT students staying in-state, controlling for SAT reduces some of the potential bias from the changing composition of the student body due to HOPE. Given the effect of SAT on the HOPE coefficient, more casual analysis that does not control for SAT will find that HOPE had no effect on the probability of earning a STEM degree and not find a reduction in this probability due to HOPE because of the influx of high-ability students into the USG that was also due to HOPE.

Grades in STEM courses are lower than in other majors, which might reduce the likelihood that initial STEM majors eventually graduate relative to equal ability students not initially majoring in a STEM field. But that may not be the case for HOPE recipients. Furthermore, it is possible that HOPE could have altered the composition of college graduates by initial college major. Thus, we consider the effect of HOPE on degree completion for students with an initial STEM major (Table 3).[19] The regressions suggest that HOPE had either no or a negative effect on graduation of initial STEM majors. For our preferred specification (column 2) the coefficients are negative but not statistically significant.

The pattern of coefficients by sex is also of interest. The coefficient for males is considerably larger than that for females and the difference is statistically significant in columns 6-8. In column 6 the coefficient for males is -0.0416, while the coefficient for females is only -0.0121. The larger decrease for men is partially attributable to their higher prevalence in STEM fields, but the relative magnitude for men is even greater than would be expected based on relative means. We also explored the effect of HOPE on subfields within STEM and found that the results reported above are not being driven by a particular subfield.

A possible concern with our results is that there may have been other policies that affected the choice of college major. We have surveyed policy changes that were adopted around the same time as HOPE and did not identify any policy that would be expected to change the choice of college major. Another important concern with attributing the pre- and post-HOPE differences to the merit program is that the economy could have experienced broader shifts over time that altered the relative desirability of STEM and non-STEM majors. Unfortunately, our administrative dataset includes only Georgia, and so we cannot estimate a difference-in-differences (DD) model to account for time differences in comparable states. We do, however, explore several alternatives.

We first used data from IPEDS on college major and do not observe any pre-HOPE downward trend in STEM majors in Georgia. We then explored separately including a linear

[19] Appendix Table D presents results corresponding to the specifications in Table 2 that include the full sample of USG enrollees unconditional on eventual degree completion. Results are qualitatively similar to those in Table 2.

time trend and the state unemployment rate in the regression model[20]; doing so actually makes the negative coefficient on earning a STEM degree larger in magnitude, but including such variables is somewhat problematic with only four cohort years, so our preferred results exclude them. In addition, given that the size of the student body changed pre- and post-HOPE, we re-estimated the regression in column 6 of Table 2 using weights so that the pre- and post-HOPE periods are weighted equally. The results, which are not reported here, are qualitatively similar to those reported in Table 2.

One possible control group for a DD estimator is non-resident USG students. Unfortunately, non-residents are an imperfect control group since HOPE could have created a variety of spillover effects onto non-residents, including changes in the composition of such students. Furthermore, among USG institutions, non-residents only enroll in large numbers at Georgia Institute of Technology (Georgia Tech) and the University of Georgia. Therefore, we cautiously explore the effects of HOPE on earning a STEM degree for students initially enrolling at these two institutions using both the residents-only time-differenced approach and a DD approach using non-residents as a control group; results are provided in Appendix Table E. We further consider differences by initial institution type in a sub-section below. The results in Table E show large negative effects of HOPE on earning a STEM degree using both approaches. The DD estimates are smaller and somewhat noisier, but possible spillover effects may render non-residents an inaccurate counterfactual.

We also examined American Community Survey (ACS) microdata to help assess whether earned college majors changed significantly over this time period in other states. The ACS

[20] Over the period 1983 to 2000, the unemployment rate in Georgia decreased almost uniformly (1992 was the exception); the correlation between the unemployment rate and a time trend over this period is -0.84. This strongly suggests that the unemployment rate did not have an effect separate from the time trend.

reports earned college majors for bachelor's degree recipients, but it does not report initial college majors or majors for non-graduates. We use the 2009-13 ACS to construct a sample of college graduates who were age 18 in 1990, 1991, 1995, or 1996 and born outside of Georgia. Persons age 18 in 1990-91 and in 1995-96 likely finished high school at the same time as our pre- and post-HOPE USG cohorts, respectively. Thus, these ACS cohorts likely attended college and faced similar macroeconomic conditions as our USG cohorts, and their major decisions should have been affected similarly by any significant changes over this period. We then compute differences in the percentage of STEM graduates for the 1990-91 and 1995-96 ACS cohorts. In contrast to what we find in the USG, the percentage of STEM graduates for the ACS comparison group actually increased slightly over time for the rest of the U.S. and for Southern non-merit aid states. Additional details are available from the authors. These results support our contention that HOPE caused the observed negative effect on the probability of earning a STEM degree for Georgia resident USG graduates.

Sjoquist and Winters (forthcoming) use the 2009-11 ACS to estimate average treatment effects for the 9 states with strong merit programs. We also experimented with computing a difference-in-difference estimate for the specific effect of Georgia' HOPE Scholarship using the 2009-2013 ACS. Results are reported in Appendix Table F.[21] Unfortunately, examining ACS

[21] Persons are assigned to the HOPE treatment group if they were born in Georgia and were age 18 in 1993 or later. Regression controls include dummies for year age 18, survey year, age, birth state, sex, race, and ethnicity. The control group includes persons born in states not adopting a merit aid program prior to 1998. We estimate the effects for 4-year, 5-year, and 6-year policy windows; an X-Year Window means that cohorts included were age 18 X years before or after the policy was adopted. Including cohorts that are very far from the policy adoption weakens the identification since DD assumes a break right at policy adoption; using a 7- or 8-year window produces results similar to the 6-year window. However, examining a less than 4-year window is problematic because it yields few observations and focuses on treated observations in the very first post-HOPE cohorts. The 1993 and 1994 cohorts of entering freshmen were subject to an income cap for eligibility which reduced the percentage of Georgia students in these first cohorts who were affected by HOPE. Furthermore, focusing very close to the policy adoption exacerbates measurement error issues resulting from some students finishing high school at an age other than 18. Standard errors are clustered by year age 18, but significance levels are unchanged under several reasonable alternative inference procedures.

data for only one merit-adopting state produces noisy estimates, and the results are not statistically significant at the ten percent level. However, the coefficient estimates are negative and of similar magnitude to the estimates in Sjoquist and Winters (forthcoming), and not very different from our preferred estimates using the USG data in column 6 of Table 2.

4. Additional Issues

The USG data allows us to explore several additional questions or issues that are not possible to consider with the ACS. In this section we consider these issues.

4.1. *Changing Majors*

Our preferred specification in Table 2 suggests that the HOPE Scholarship did not affect the initial choice of a STEM major, but did negatively affect the probability of earning a STEM degree. We explore the relationship between the initial major and the earned major, considering just two categories of majors, STEM and non-STEM. The upper panel of Table 4 is a simple crosstab between initial major and earned major, while the second panel shows for each of the two initial majors the fraction of students with earned degrees with STEM and non-STEM majors. (Table 4 considers only students who earned a college degree but uses students from all 4 cohorts.) Note that 13.7 percent of students with an undeclared initial major earned a STEM degree, while only 8.4 percent of students who declared a non-STEM major as a freshman earned a degree with a STEM major. In other words, students who do not initially declare a STEM major have a relatively low probability of eventually earning a STEM degree. On the other hand, 57.4 percent of students with an initial STEM major actually earned a STEM degree, so that 42.6 percent of freshmen STEM majors switched to another major before they graduated.[22]

Given this pattern it is of interest to consider the effect of the HOPE Scholarship on the student's earned major given the student's initial major (Table 5). Column 1 of Table 5 reproduces column 6 from Table 2, and is presented for convenience. Column 2 considers students who declared a STEM major as a freshman. The results imply, as we would expect, that the HOPE Scholarship caused a reduction in the percentage of initial STEM majors who earned a degree in a STEM field. The coefficients are statistically significant for the entire sample as well as for females and males. The magnitude of the effect of the HOPE Scholarship is larger for initial STEM majors than for the entire sample (column 1), and is larger for males than females.

Columns 3 and 4 examine the effects of HOPE on earning a STEM degree for students with an initial non-STEM major and with an initial undeclared major. For these two groups, the coefficient estimates are negative for the total population as well as for females and males separately, but the coefficients are much smaller in magnitude than for initial STEM majors and they are not statistically significant. Thus, the negative effect of HOPE on STEM degree production is primarily driven by initial STEM majors deciding not to complete degrees in STEM fields. HOPE is somehow causing additional initial STEM majors to switch away from STEM at some point before they graduate.

4.2. ***Type of College***

[22] See Stinebrickner and Stinebrickner (2014) for an analysis of the attrition of STEM majors. They focus on the effect of changes in students' beliefs about their likely grade point average as STEM majors as the students take STEM courses.

The University System of Georgia consists of both 2-year and 4-year schools. One might expect that the effect of merit aid would differ between 2-year and 4-year institutions, perhaps because of differences in the type of students who enroll in the two types of schools, so we consider 2-year and 4-year colleges separately. Similarly, there are three large research universities, Georgia Institute of Technology, Georgia State University, and the University of Georgia. Given that the culture and other characteristics of large research universities might differ from smaller 4-year colleges, we explore whether there are differences in the effect of HOPE on STEM majors between 4-year non-research colleges and the three research universities. In addition, the Georgia Institute of Technology is the primary engineering school in the University System of Georgia; Georgia Tech accounted for 32.6 percent of STEM degrees in the sample. Given the difference in the environment in an engineering college, we consider the effect of HOPE on STEM majors at Georgia Tech. We assign the student to the school at which they initially enrolled and use the control variables in our preferred specification.

Table 6 considers the effect of HOPE on the probability of earning a STEM degree by type of school. The results for all schools and for just 4-year schools are very similar, and in particular the effect of HOPE is negative. For 4-year non-research schools, the three research universities, and for Georgia Tech, the coefficients for HOPE for all students and for males are negative and statistically significant, but the magnitude of the effect is much larger for Georgia Tech and somewhat larger for the research universities than for the 4-year non-research schools. The coefficient for females is statistically insignificant in column 3, but negative and statistically significant in columns 4 and 5. It thus appears that the effect of HOPE on the probability of being a STEM major is greater at research universities, and GA Tech in particular.[23] In results

[23] This is consistent with arguments that the state's research universities have tougher grading standards than other institutions and may have increased grading standards in STEM fields post-HOPE. In results not shown available

not shown, we also estimated the effect of the post-HOPE dummy on earning a STEM degree for students initially enrolling at two-year schools. The coefficient was positive but small and noisily estimated and potentially affected by student re-sorting across institution types post-HOPE.

4.3. *STEM Persistence by SAT*

There is a substantial literature that attempts to explain the choice of a STEM major and the lack of persistence in earning a degree with a STEM major. The research reports that students with stronger academic ability as measured, for example, by SAT scores are more likely to initially major in a STEM field and to persist (Ost, 2010; Rask, 2010; Griffith, 2010). Here we consider the effect of HOPE on earned STEM degrees for initial STEM majors by SAT math score using our preferred specification.

Table 7 presents the results by SAT math score[24]; for each panel, the first row is the coefficient on the post-HOPE dummy, the second row in parentheses is the standard error, the third row in braces is the implied percentage change in STEM degrees, that is, the coefficient divided by the sample mean for the SAT group.[25] The coefficients on the post-HOPE dummy are generally negative and are statistically significant for higher SAT math scores. HOPE reduced the probability that an initial STEM major would have an earned STEM degree, and the percentage of initial STEM major students who fail to get a STEM degree due to HOPE is

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from the authors by request, we also examined the effect of initial institution and initial major on the probability of keeping HOPE for four years for the sample of students who received HOPE as freshmen, controlling for students quality and individual characteristics. As one might expect, students starting at more selective institutions were less likely to keep HOPE for four years than comparable students starting at less selective institutions. Similarly, initial STEM majors were less likely to keep HOPE than comparable non-STEM majors.

[24] A few individuals do not have SAT scores. Examination of their GPAs shows that they are on average low performing students, so we include them in the lowest SAT group.

[25] Though not the focus of our study, the simple means are consistent with previous literature suggesting that STEM persistence rates increase with student ability and are generally lower for women than men.

smaller for higher SAT score students. This is not unexpected given existing research that finds that students with higher SAT scores are more likely to initially major in STEM and are more likely to persist and earn a STEM degree. Thus, we expect these students to be less influenced by HOPE. However, while we observe the same pattern for males, for females the relationship is reversed, with the larger percentage change being for females with high SAT math scores.[26] It should be of concern for policymakers that HOPE appears to reduce the probability of earning a STEM degree even for students with high SAT math scores.[27]

4.4. *Non-STEM Majors*

Table 8 considers the effects of the post-HOPE dummy on initial non-STEM majors. The only statistically significant coefficients are for health (positive coefficients) and social sciences (negative coefficients). It is unclear *a priori* why HOPE would affect these initial majors in this way. To some extent, the growth in health majors may reflect new programs created to meet the growing demand for healthcare.

Table 9 considers the effects of the post-HOPE dummy on earned non-STEM majors; the upper panel considers all students while the lower panel considers just initial STEM majors. For the full sample, the post-HOPE period exhibits an increase in the probability of majoring in

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[26] The large magnitude for females with high SAT math scores was not expected. One possible explanation is that this effect could be caused by an increase in female students at Georgia Tech, which as Table 4 shows had a larger effect on STEM majors. However, the increase in the percentage of female students at Georgia Tech pre- and post-HOPE was no larger than that experienced in the rest of the USG. Furthermore, the number of females with 700 or better SAT-Math scores is relatively small, so the coefficient is not precisely estimated.

[27] In results not shown, we also examined heterogeneous effects by SAT score of the post-HOPE dummy on the probability of an earned STEM major unconditional on initial major. The results are qualitatively similar to the results for initial STEM majors except that the coefficient for students with SAT math below 400 goes from insignificantly negative to insignificantly positive. The small sample size, low rates of STEM majors, and inclusion of persons with missing SAT among this group of low ability students leads to considerable noise in the estimation.

business and in health and a decrease in education and social science majors.[28] The coefficient on the post-HOPE dummy for liberal arts majors is positive but statistically insignificant. There are differences in the pattern by gender.

The bottom panel of Table 9 contains results using just those students who declared a STEM major as a freshman. These results suggests that initial STEM majors who changed major likely shifted into business and liberal arts, although there are differences in the patterns by gender.

Cornwell, Lee and Mustard (2008), using data from the University of Georgia, find that HOPE led to an increase in the probability of an initial education major. We also find a positive but statistically insignificant effect on initial education major (Table 8). This leads to an expectation that merit-aid programs would also increase the probability of an earned major in education, but we find that merit aid reduces the probability of an earned major in education. To explore this a bit further, we redid our analysis using just data for the University of Georgia and find that HOPE had no effect on the probability of an earned major in education. When we consider the initial education major for University of Georgia students, we obtain a positive, but statistically insignificant, coefficient on HOPE that is similar in magnitude to that found by Cornwell, Lee, and Mustard. Thus, there may have been a slight positive effect of HOPE on initial education majors for students at the University of Georgia, but there appears to be no effect of HOPE on education degrees conferred.

[28] We also considered specific majors within business to explore the premise that the post-HOPE increase in business majors might be STEM majors shifting to the more mathematically oriented business majors. In results not presented we find statistically significant positive effects on MIS and finance majors, which is supportive of the shift from STEM to more technical business majors. However, we find negative effects for economics and accounting and especially large positive effects on marketing and management (probably the least technical business majors), which is contrary to the premise.

5. Mechanisms

There are a number of possible mechanisms through which HOPE could reduce the probability of earning a STEM degree. We are unable to say conclusively which mechanisms are driving the results, but we do offer some evidence and insights.

5.1. Costs and Benefits of a Major

The first two mechanisms relate to the effect of merit aid on the relative costs and benefits of a major. First, Stater (2011) argues that an increase in financial aid lowers the price of majors that offer current consumption benefits and encourages student substitution toward such majors, and finds that merit aid affects the choice of the student's first-year major.[29]

Second, Rothstein and Rouse (2011) suggest that student loan debt might affect a student's choice of college major and future occupation due to debt aversion and credit constraints. Students who are debt averse may choose high earning majors and occupations to pay off debt quickly after graduation. Post-graduation credit constraints may make it difficult to finance large purchases like cars and houses, and individuals may pursue high earning majors and occupations to make these more attainable. Financial aid should decrease student loan debt and may reduce the importance of future earnings in college major decisions.

The mechanisms suggested by Stater (2011) and Rothstein and Rouse (2011) predict that financial aid will encourage students to shift away from high paying majors such as STEM fields, but the expected magnitudes are uncertain. Our findings for earned STEM majors are

[29] Similarly, financial aid could be viewed as a transitory income shock that could lead to more current consumption oriented majors. Riegle-Crumb, King, Grodsky, and Muller (2012), using the NELS and HS&B, find that an additional $10,000 of real family income reduces the probability that a student will declare a physical science/engineering major by 0.2 to 0.5 percentage points. However, $10,000 of permanent family income might have very different effects than transitory income from student financial aid.

consistent with this mechanism. However, business majors also earn relatively high salaries, but we do not observe a shift away from business majors; we actually see a strong shift toward business. The large shift toward business is seemingly inconsistent with the mechanisms suggested by Stater (2011) and Rothstein and Rouse (2011). Additionally, their mechanisms would suggest a decrease in initial STEM majors, but we observe no such decrease in our preferred specification. So while we cannot rule out the Stater (2011) and Rothstein and Rouse (2011) mechanisms, they seem unlikely to be a significant explanation for the relatively large decrease in STEM degrees that we find.

5.2. Required 3.0 GPA

Student actions to maintain a 3.0 GPA in order to retain their HOPE Scholarship is a third possible mechanism. Cornwell, Lee, and Mustard (2005, 2008) suggest that the requirement that students maintain a 3.0 GPA causes students to engage in strategic behavior such as taking lighter course loads, easier courses, and changing majors if the student is close to a 3.0 GPA. This suggests that students might avoid majors for which maintaining a 3.0 GPA is harder, like STEM, when they first enter college. However, we see little effect of HOPE on choice of freshman major, which is inconsistent with this mechanism.

To examine this mechanism further we explore how the effect of HOPE differs by first-year GPA (for initial STEM majors), that is, after 45 quarter credit hours.[30] The results are presented in Table 10. The coefficients on the HOPE variable are negative, with one exception, but less than half are statistically significant. There is no consistent pattern in the size of the coefficients on HOPE or the percentage change in the number of students who fail to earn a

[30] As with high school GPA, there is concern that there has been a general upward trend in college GPA's.

STEM degree because of HOPE. The results suggest that the HOPE Scholarship reduced the probability of an earned STEM major regardless of first-year GPA, and that in general the magnitude of the effect does not depend on the first-year GPA. We do not find a larger effect of HOPE for students with a first-year GPA near 3.0, but some students may have already changed majors and others may have padded their first year schedule with easier courses. As Ost (2010) reports, grades both push students away from a major and pull them towards a major, and since first year grades are not necessarily in STEM courses, the effect by grade may reflect the pull of grades into non-STEM fields.

A further difficulty with using first year GPAs is that it appears that HOPE led to an increase in grades, which is consistent with students taking actions to improve their grades, and that the increase was larger for non-STEM majors than for STEM majors. Table 11 explores how the post-HOPE dummy affected students' first year GPAs, by category of majors. In general, the results imply that the HOPE Scholarship program increased students' GPAs, but the effects for initial STEM majors who earn STEM degrees are smaller than the effects for initial STEM majors earning degrees in other fields. This suggests that many of the latter group may have already begun taking a non-STEM curriculum. These results are consistent with the suggestion that students take actions to improve their grades in an attempt to meet HOPE's 3.0 GPA renewal requirement, although we cannot precisely assess the relative contribution of these student actions to the overall decrease in STEM.[31] Although Table 10 parallels the format of Table 7, because college GPA is subject to various forms of manipulation, GPA cannot be

[31] The observed increase in college GPAs could also be partially attributable to other factors besides HOPE driving an upward trend over time.

viewed as an exogenous measure of student ability for our analysis as is the SAT score used in Table 7.[32]

This mechanism is also consistent with our findings that HOPE did not have a negative effect on STEM majors of students who enrolled in two-year schools. Since grading standards at two-year schools are lower, students should have less concern with how a STEM major will affect their GPA.

5.3. Behavioral Economics

If students are lifetime utility maximizers, one might wonder why so many would leave STEM majors to keep HOPE, when the lifetime gains from earning a STEM degree are so large compared to the value of the Scholarship for a few additional years. This mechanism is not inconsistent with the life-cycle utility maximization framework if the financial gains of STEM relative to the next best alternative are not especially great. It appears that HOPE induces many students to switch to business fields, which offer the second highest national average salaries among broad major groups behind STEM (Sjoquist and Winters, forthcoming). To the extent that business programs provide greater flexibility for keeping HOPE, switching from STEM to business may be rational for marginal USG students. Furthermore, Arcidiacono (2004) suggests that students in STEM fields are differentially selected, implying that the private return to majoring in STEM for marginal students may not be very large, especially compared to majoring in business.

While the life-cycle utility maximization framework is useful for framing the effects of merit aid on college major, behavioral economics suggests alternative explanations. Efforts to

[32] We also explored the effects of controlling for USG institution in Tables 8 and 9; the results are qualitatively similar to the reported results and are available from the authors by request.

maintain a 3.0 GPA may be consistent with behavioral mechanisms such as loss aversion, hyperbolic discounting, and rules of thumb. According to the theory of loss aversion, people weigh potential losses much more heavily than potential gains when making choices under uncertainty. If students view higher future earnings from a STEM degree as a gain and are especially averse to losing HOPE, their college major decisions will be much more affected than would be predicted by the lifetime utility model. Hyperbolic discounting suggests that some people make time-inconsistent choices because of preferences that heavily discount the future relative to the present. Hyperbolic discounting may affect students' college major decisions because losing HOPE has a present cost while the costs of switching to a lower earning major are born further in the future. The HOPE Scholarship 3.0 GPA renewal requirement may also provide a rule of thumb for student major choices; a student who loses HOPE may interpret it to suggest that they are not a good enough student for their current major and that they should switch to a less challenging major. While behavioral economics provides possible explanations for the observed decrease in STEM majors, we can offer no empirical evidence.

5.4. High School Courses

High school GPA requirements for merit aid eligibility may create incentives for students to enroll in less challenging courses in high school, which might make them less prepared for more difficult majors in college; alternatively, if merit programs increase student effort in high school, they could cause students to be better prepared for college, which is consistent with the findings of Henry and Rubenstein (2002). We have no evidence on high school course taking, but the high school grade inflation we observe is consistent with students taking easier courses in high school.

5.5. Change in Enrollment Patterns

It is likely that the probability that a student earns a major in a STEM field differs across colleges. For example, Griffin (2010) finds that persistence of STEM majors varies inversely with the importance of research at the school. Webber (2012) reports that college completion is affected by a college's expenditures on student services and instruction, while Price (2010) finds that black students are more likely to persist in STEM majors if they have a course taught by a black professor.

In addition to these empirical findings, there are other possible reasons why the probability of earning a STEM major might differ across colleges. The strength of STEM fields can differ across colleges, making them more or less desirable majors. Grading standards in STEM fields likely differ across colleges so that maintaining the HOPE required 3.0 GPA could be easier at some colleges, thus affecting the likelihood that a student of a given quality majors in a STEM field or the likelihood that students shift to other majors. Colleges and departments can differ in the intensity of the advising and mentoring that students are provided, which can possibly influence a student's field of study and might affect the attachment to the field for initial STEM majors, so that fewer students switch major as a result of HOPE.

Thus, to the extent that HOPE affected the pattern of enrollment across colleges, the percent of students who earn a STEM major could have changed as a result. In fact, previous researchers (Dynarski, 2000; Cornwell, Mustard, and Sridhar, 2006) have found that merit aid increases the likelihood that students stay in-state to attend college and alters the type of in-state institution students attend.

Suppose as Dynarski (2000) finds that HOPE did increase the proportion of high ability students who stay in-state, and that these students enroll in the state's more selective universities.[33] If supply at these institutions is relatively inelastic, HOPE could make it more difficult for moderate ability students to gain admission to these universities. The alternative colleges and universities attended by moderate ability students do not in general have engineering programs and may have weaker math and science programs. Many of these students who may have been likely to major in STEM at a selective university may decide not to major in STEM when pushed into the less selective alternative colleges with less desirable STEM options.[34] As indirect and weak evidence, we find (in results not shown) that math SAT scores for earned STEM majors did not change at 4-year non-research schools but did increase by about 16 points at the research universities, although that increase was similar to other majors.

While our preferred results in Table 2 do not control for institution (or high school GPA), adding institution dummies to our regressions in Table 2 makes the effect of HOPE more positive for both initial and earned STEM major outcomes. This change in the coefficients suggests that there are differences across colleges in the effect of HOPE on STEM majors. These results further suggest that some of the negative effect of HOPE on earned STEM degrees for our preferred specification is due to changes in the institutions that students attend. Specifically, it appears that HOPE induced students of a given academic ability to enroll in institutions that make them less likely to earn a STEM degree. This may have resulted in part

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[33] Cornwell and Mustard (2006) note that over the period 1990 to 2003 average SAT scores for Georgia college freshmen increase significantly more than the average for either U.S. or Georgia high school seniors. Average SAT math scores for in-state students increased between our pre and post-HOPE periods by 24 points at Georgia Tech and by 29 points at the University of Georgia, but by only 5 points for all other schools. The share of USG students with high SAT math scores that enrolled at Georgia Tech decreased over the period; 29.3 percent of students with SAT math scores between 600 and 800 attended Georgia Tech in the pre-HOPE period, but only 22.2 percent in the post-HOPE period.

[34] However, these alternative colleges may have stronger student advising and support programs that increase retention in STEM fields, or have weaker academic standards that make earning a 3.0 GPA easier.

from merit-induced increases in average student quality at top universities like Georgia Tech, which may have caused more moderate ability students to enroll elsewhere, as implied by the increased SAT scores at USG research universities. However, the movement toward institutions with weaker STEM programs could also be consistent with students enrolling at less competitive institutions to increase their chances of keeping a 3.0 GPA to retain HOPE.

Additionally, to the extent that students are graded relative to their peers, the merit-induced influx of high ability students may cause more moderate ability students to receive lower grades in challenging majors and cause them to shift toward less challenging majors. Furthermore, colleges and universities experiencing merit-induced increased enrollment pressure may respond by raising academic standards in particular fields, e.g. STEM, thereby shifting lower quality students into other majors that require less student effort. We do not have data on student grades for particular courses and are unable to provide evidence regarding these particular mechanisms. However, Luppino and Sander (2012) and Arcidiacono, Aucejo, and Hotz (2013) provide evidence of peer competition effects in the University of California system; they find that attending a more competitive campus makes a student of a given quality less likely to earn a degree in the sciences.

5.6. Summary

While we are unable to identify the exact mechanisms driving our results, the above discussion does provide evidence in support of some potential mechanisms over others. Specifically, we find evidence consistent with two mechanisms: students taking actions to increase their GPAs to retain HOPE and students enrolling at less competitive institutions that make them less likely to major in STEM. The policy implications differ somewhat depending on how important each of these mechanisms are. If student actions are the primary mechanism, policymakers should consider reducing the incentives to take such actions, perhaps by allowing the renewal GPA to differ by major and even institution. To the extent that the effect is driven by inelastic supply at selective universities, states with or considering adopting merit aid programs should be aware that the potential benefits may not be realized if their program crowds some students into less selective institutions with weaker STEM programs.

6. Summary and Conclusions

State merit aid programs have grown significantly since the early 1990s, but these programs could have unintended effects that harm the economic interests of the state and the nation. In particular, merit programs may inadvertently cause students to choose different college majors than they would have in the absence of merit aid. The U.S. has experienced increasing concern that the nation is producing too few graduates with degrees in science, technology, engineering, and mathematics (STEM) fields. STEM graduates play an important role in creating new technologies that lead to new production processes and increased productivity (Winters, 2014a, b). Producing too few STEM graduates could have very harmful economic effects for the nation and individual states.

This paper uses student records from the University System of Georgia (USG) to examine whether Georgia's HOPE Scholarship program altered students' college major decisions. We focus on the effects on STEM fields but also examine the effects on other majors. We find significant evidence that HOPE reduced the likelihood that a young person earned a degree in a STEM field. Our baseline specification gives a coefficient of -0.025, which corresponds to a 12.6 percent decrease in the number of STEM graduates. The effect of HOPE is in contrast to evidence from ACS data that the likelihood of an individual being a STEM major increased over the period in states without merit aid programs. We also find that although Georgia's HOPE Scholarship reduced STEM degree completion, it did not affect the likelihood that a student chose STEM as their initial major. Instead, HOPE appears to have resulted in some students to change majors out of STEM fields at some point in their college career. Furthermore, the decrease in STEM degrees was driven largely by the decrease in initial STEM majors actually earning a STEM degree (not by fewer students switching into a STEM field) and by the decrease in earned STEM degrees by students enrolled at the state's research universities. The decrease in STEM degrees also occurred throughout the ability distribution, but the relative effects were most pronounced for students with good but unexceptional math skills. Our finding that merit aid programs such as Georgia's HOPE Scholarship reduce the likelihood that students earn degrees in STEM fields has important policy implications for both states and the nation and should be considered in debates on the merits of merit programs.

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Table 1: Summary Statistics for USG Data

	All Graduates		Females		Males		Pre-HOPE		Post-HOPE		Difference
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Pre/Post
Initial STEM Major	0.197	0.398	0.148	0.355	0.262	0.440	0.184	0.387	0.208	0.406	0.025***
Earned STEM Major	0.197	0.398	0.128	0.334	0.289	0.453	0.201	0.400	0.193	0.395	-0.007*
Initial Business Major	0.107	0.309	0.094	0.292	0.125	0.331	0.107	0.310	0.107	0.309	0.000
Initial Education Major	0.044	0.206	0.066	0.248	0.016	0.125	0.042	0.200	0.047	0.211	0.005**
Initial Health Major	0.028	0.166	0.045	0.208	0.006	0.077	0.021	0.145	0.034	0.182	0.013***
Initial Liberal Arts Major	0.185	0.388	0.183	0.387	0.188	0.391	0.191	0.393	0.180	0.385	-0.010***
Initial Social Science Major	0.060	0.237	0.069	0.254	0.047	0.212	0.063	0.243	0.057	0.231	-0.006***
Initial Undeclared Major	0.378	0.485	0.393	0.488	0.357	0.479	0.391	0.488	0.367	0.482	-0.024***
Earned Business Major	0.261	0.439	0.213	0.410	0.324	0.468	0.241	0.428	0.278	0.448	0.037***
Earned Education Major	0.153	0.360	0.216	0.412	0.068	0.252	0.171	0.376	0.138	0.345	-0.033***
Earned Health Major	0.057	0.232	0.090	0.286	0.013	0.114	0.056	0.229	0.059	0.235	0.003
Earned Liberal Arts Major	0.157	0.364	0.155	0.362	0.160	0.367	0.151	0.358	0.163	0.369	0.011***
Earned Social Science Major	0.175	0.380	0.198	0.398	0.145	0.352	0.181	0.385	0.170	0.375	-0.012***
Post-HOPE Dummy	0.540	0.498	0.554	0.497	0.521	0.500					
SAT Math	518.4	92.8	498.9	85.8	544.3	95.4	513.1	89.8	523.0	95.1	9.953***
SAT Verbal	520.7	90.0	513.0	88.5	530.9	91.0	512.9	89.5	527.3	90.0	14.441***
High School GPA	3.037	0.620	3.092	0.600	2.963	0.639	2.925	0.636	3.133	0.589	0.208***
Female	0.572	0.495	1.000	0.000	0.000	0.000	0.555	0.497	0.587	0.492	0.032***
Black	0.182	0.386	0.224	0.417	0.126	0.332	0.163	0.370	0.199	0.399	0.036***
Hispanic	0.010	0.102	0.010	0.099	0.011	0.105	0.009	0.092	0.012	0.110	0.004***
Asian	0.029	0.167	0.026	0.159	0.033	0.177	0.024	0.153	0.033	0.178	0.009***
Native American	0.002	0.039	0.001	0.038	0.002	0.040	0.002	0.039	0.001	0.038	0.000
Observations	42,399		24,263		18,136		19,497		22,902		

*significant at10%; **significant at 5%; *** significant at 1%.

Table 2: Effects of HOPE on Choosing a STEM Major

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Initial Major				Earned Major			
A. Total	0.0231	-0.0048	-0.0201	0.0086	-0.0058	-0.0253	-0.0384	-0.0216
	(0.0080)*	(0.0059)	(0.0042)**	(0.0013)***	(0.0065)	(0.0033)***	(0.0041)***	(0.0029)***
	{12.6%}	{-2.6%}	{-10.9%}	{4.7%}	{-2.9%}	{-12.6%}	{-19.1%}	{-10.8%}
B. Females	0.0284	0.0074	-0.0046	0.0121	0.0041	-0.0121	-0.0240	-0.0128
	(0.0043)***	(0.0051)	(0.0038)	(0.0033)**	(0.0050)	(0.0048)*	(0.0049)**	(0.0023)**
	{21.8%}	{5.7%}	{-3.5%}	{9.3%}	{3.3%}	{-9.8%}	{-19.3%}	{-10.3%}
C. Males	0.0181	-0.0182	-0.0343	0.0065	-0.0180	-0.0416	-0.0538	-0.0321
	(0.0162)	(0.0086)	(0.0075)**	(0.0024)*	(0.0096)	(0.0025)***	(0.0029)***	(0.0039)***
	{7.2%}	{-7.3%}	{-13.7%}	{2.6%}	{-6.1%}	{-14.1%}	{-18.2%}	{-10.8%}
Sex, Race/Ethnicity Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
High School Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
SAT Dummies	No	Yes	Yes	Yes	No	Yes	Yes	Yes
High School GPA Dummies	No	No	Yes	Yes	No	No	Yes	Yes
USG Institution Dummies	No	No	No	Yes	No	No	No	Yes

Standard errors in parentheses are clustered by high school graduation year. The percent change, i.e., the coefficient divided by the mean, are shown in braces.

*Significant at 10% based on small sample t-distribution; **Significant at 5%; ***Significant at 1%.

Table 3: Effects of HOPE on Degree Completion for Initial STEM Majors

	(1)	(2)	(3)	(4)
A. Total	0.0073	-0.0135	-0.0356	-0.0336
	(0.0036)	(0.0075)	(0.0069)**	(0.0067)**
B. Females	-0.0047	-0.0184	-0.0417	-0.0350
	(0.0044)	(0.0069)*	(0.0076)**	(0.0079)**
C. Males	0.0158	-0.0121	-0.0321	-0.0317
	(0.0041)**	(0.0068)	(0.0060)**	(0.0062)**
Sex, Race, Ethnicity Dummies	Yes	Yes	Yes	Yes
High School Dummies	Yes	Yes	Yes	Yes
SAT Dummies	No	Yes	Yes	Yes
High School GPA Dummies	No	No	Yes	Yes
USG Institution Dummies	No	No	No	Yes

Standard errors in parentheses are clustered by high school graduation year.

*Significant at 10% based on small sample t-distribution; **Significant at 5%.

Table 4: Share of USG Graduates by Initial Major and Degree Major

		Initial Major			
		Undeclared	Non-STEM	STEM	Total
Degree	Non-STEM	0.342	0.381	0.080	0.803
Major	STEM	0.054	0.035	0.108	0.197
	Total	0.397	0.416	0.188	1.000
Degree	Non-STEM	0.863	0.916	0.426	
Major	STEM	0.137	0.084	0.574	
	Total	1.000	1.000	1.000	

Note that Initial Major is the major the student declared as a freshman, while Degree Major is the major that the student graduated with. The table includes only students who completed college. The upper panel shows the distribution across all graduates, while the second panel shows the allocation across Degree Major for each Initial Major. The data include both pre- and post-HOPE students.

Table 5: Effects of HOPE on Earning a STEM Degree by Initial Major

	(1) Full Sample	(2) Initial STEM Majors	(3) Initial Non-STEM Majors	(4) Initial Undeclared Majors
A. Total	-0.0253	-0.0788	-0.0098	-0.0085
	(0.0033)***	(0.0151)**	(0.0075)	(0.0044)
	{-12.6%}	{-12.5%}	{-11.5%}	{-6.3%}
B. Females	-0.0121	-0.0633	-0.0081	-0.0053
	(0.0048)*	(0.0163)**	(0.0040)	(0.0047)
	{-9.8%}	{-12.7%}	{-15.3%}	{-5.9%}
C. Males	-0.0416	-0.0937	-0.0110	-0.0138
	(0.0025)***	(0.0252)**	(0.0162)	(0.0062)
	{-14.1%}	{-13.1%}	{-8.2%}	{-7.0%}
Sex, Race, Ethnicity Dummies	Yes	Yes	Yes	Yes
High School Dummies	Yes	Yes	Yes	Yes
SAT Dummies	Yes	Yes	Yes	Yes
High School GPA Dummies	No	No	No	No
USG Institution Dummies	No	No	No	No

Standard errors in parentheses are clustered by high school graduation year. The percent change, i.e., the coefficient divided by the mean, are shown in braces.

*Significant at 10% based on small sample t-distribution; **Significant at 5%; ***Significant at 1%.

Table 6: Effects of HOPE on Earning a STEM Degree by Students' Initial Institutions

	(1) Full USG	(2) 4-Year Schools	(3) 4-Year Non-Research	(4) Research Universities	(5) Georgia Tech
A. Total	-0.0253	-0.0284	-0.0121	-0.0588	-0.0944
	(0.0033)***	(0.0036)***	(0.0033)**	(0.0084)***	(0.0152)***
	{-12.6%}	{-13.7%}	{-7.5%}	{-20.6%}	{-13.4%}
B. Females	-0.0121	-0.0145	0.0015	-0.0442	-0.1468
	(0.0048)*	(0.0048)*	(0.0026)	(0.0093)**	(0.0045)***
	{-9.8%}	{-11.2%}	{1.5%}	{-23.0%}	{-23.4%}
C. Males	-0.0416	-0.0455	-0.0331	-0.0679	-0.0762
	(0.0025)***	(0.0027)***	(0.0061)**	(0.0096)***	(0.0171)**
	{-14.1%}	{-14.9%}	{-13.1%}	{-18.1%}	{-10.3%}
Sex, Race, Ethnicity Dummies	Yes	Yes	Yes	Yes	Yes
High School Dummies	Yes	Yes	Yes	Yes	Yes
SAT Dummies	Yes	Yes	Yes	Yes	Yes
High School GPA Dummies	No	No	No	No	No
USG Institution Dummies	No	No	No	No	No

Standard errors in parentheses are clustered by high school graduation year. The percent change, i.e., the coefficient divided by the mean, are shown in braces.

*Significant at 10% based on small sample t-distribution; **Significant at 5%; ***Significant at 1%.

Table 7: Effects of HOPE on Earning a STEM Degree by SAT Math Score for Initial STEM Majors

	(1)	(2)	(3)	(4)	(5)
SAT Math	<400	400-499	500-599	600-699	700-800
A. Total	-0.0295	-0.0052	-0.0678	-0.0805	-0.0585
	(0.0280)	(0.0176)	(0.0141)**	(0.0238)**	(0.0168)**
	{-8.57%}	{-1.41%}	{-12.24%}	{-11.02%}	{-6.49%}
B. Females	0.0157	0.0262	-0.0321	-0.0594	-0.1134
	(0.1091)	(0.0312)	(0.0056)**	(0.0234)*	(0.0588)
	{5.24%}	{9.26%}	{-7.02%}	{-8.89%}	{-11.80%}
C. Males	-0.0128	-0.0691	-0.1169	-0.0824	-0.0409
	(0.1790)	(0.0621)	(0.0278)**	(0.0318)*	(0.0240)
	{-3.11%}	{-14.44%}	{-18.49%}	{-10.86%}	{-4.59%}
Sex, Race, Ethnicity	Yes	Yes	Yes	Yes	Yes
High School Dummies	Yes	Yes	Yes	Yes	Yes
SAT Dummies	Yes	Yes	Yes	Yes	Yes
High School GPA Dummies	No	No	No	No	No
USG Institution Dummies	No	No	No	No	No

Standard errors in parentheses are clustered by high school graduation year. The percent change, i.e., the coefficient divided by the mean, are shown in braces.

*Significant at 10% based on small sample t-distribution; **Significant at 5%; ***Significant at 1%.

Table 8: Post-HOPE Effects on Initial Major for Non-STEM Fields

	(1) Business	(2) Education	(3) Health	(4) Liberal Arts	(5) Social Sciences	(6) Undeclared
A. Total	-0.0025	0.0039	0.0135	0.0048	-0.0096	-0.0038
	(0.0086)	(0.0051)	(0.0043)*	(0.0115)	(0.0019)**	(0.0255)
	{-2.3%}	{9.4%}	{63.1%}	{2.5%}	{-15.2%}	{-1.0%}
B. Females	-0.0104	0.0030	0.0197	-0.0096	-0.0134	0.0059
	(0.0088)	(0.0071)	(0.0058)**	(0.0079)	(0.0022)***	(0.0265)
	{-10.8%}	{4.7%}	{54.7%}	{-4.9%}	{-18.0%}	{1.5%}
C. Males	0.0070	0.0054	0.0055	0.0228	-0.0041	-0.0186
	(0.0089)	(0.0024)	(0.0023)*	(0.0152)	(0.0028)	(0.0234)
	{5.8%}	{41.1%}	{176.8%}	{12.3%}	{-8.3%}	{-4.9%}
Sex, Race, Ethnicity Dummies	Yes	Yes	Yes	Yes	Yes	Yes
High School Dummies	Yes	Yes	Yes	Yes	Yes	Yes
SAT Dummies	Yes	Yes	Yes	Yes	Yes	Yes
High School GPA Dummies	No	No	No	No	No	No
USG Institution Dummies	No	No	No	No	No	No

Standard errors in parentheses are clustered by high school graduation year. The percent change, i.e., the coefficient divided by the mean, are shown in braces.

*Significant at 10% based on small sample t-distribution; **Significant at 5%; ***Significant at 1%.

Table 9: Post-HOPE Effects on Non-STEM Earned Majors

	(1) Business	(2) Education	(3) Health	(4) Liberal Arts	(5) Social Sciences
A. Total	0.0494	-0.0282	0.0045	0.0101	-0.0105
	(0.0025)***	(0.0037)***	(0.0017)*	(0.0052)	(0.0032)**
	{20.5%}	{-16.5%}	{8.1%}	{6.7%}	{-5.8%}
B. Females	0.0238	-0.0417	0.0094	0.0163	0.0042
	(0.0043)**	(0.0052)***	(0.0022)**	(0.0040)**	(0.0014)*
	{12.0%}	{-16.9%}	{10.6%}	{11.4%}	{2.1%}
C. Males	0.0797	-0.0072	-0.0013	-0.0008	-0.0288
	(0.0063)***	(0.0026)*	(0.0009)	(0.0068)	(0.0062)**
	{27.2%}	{-9.6%}	{-9.2%}	{-0.5%}	{-17.9%}
Sex, Race, Ethnicity Dummies	Yes	Yes	Yes	Yes	Yes
High School Dummies	Yes	Yes	Yes	Yes	Yes
SAT Dummies	Yes	Yes	Yes	Yes	Yes
High School GPA Dummies	No	No	No	No	No
USG Institution Dummies	No	No	No	No	No
Initial STEM Majors					
A. Total	0.0579	-0.0015	0.0079	0.0121	0.0024
	(0.0138)**	(0.0043)	(0.0048)	(0.0039)*	(0.0038)
	{42.8%}	{-2.8%}	{20.3%}	{19.0%}	{3.1%}
B. Females	0.0334	-0.0147	0.0134	0.0120	0.0192
	(0.0160)	(0.0071)	(0.0156)	(0.0015)***	(0.0106)
	{25.5%}	{-14.8%}	{15.7%}	{14.8%}	{18.7%}
C. Males	0.0768	0.0061	0.0033	0.0099	-0.0024
	(0.0222)**	(0.0018)**	(0.0011)*	(0.0091)	(0.0030)
	{55.7%}	{25.1%}	{42.4%}	{19.0%}	{-3.8%}

Standard errors in parentheses are clustered by high school graduation year. The percent change, i.e., the coefficient divided by the mean, are shown in braces.
*Significant at 10% based on small sample t-distribution; **Significant at 5%; ***Significant at 1%.

Table 10: Effects of HOPE on Earning a STEM Degree by First-Year GPA for Initial STEM Majors

	(1)	(2)	(3)	(4)	(5)	(6)
Freshman GPA	<2.50	2.50-2.79	2.80-2.99	3.00-3.19	3.20-3.49	3.50-4.00
A. Total	-0.0718	-0.1449	-0.0632	-0.0878	-0.0321	-0.1027
	(0.0322)	(0.0281)**	(0.0563)	(0.0131)***	(0.0143)	(0.0139)***
	{-14.75%}	{-22.90%}	{-10.01%}	{-13.11%}	{-4.47%}	{-12.70%}
B. Females	-0.0394	-0.1306	-0.1085	-0.1629	0.0411	-0.0704
	(0.0456)	(0.0820)	(0.0826)	(0.0726)	(0.0417)	(0.0141)**
	{-11.07%}	{-28.05%}	{-20.56%}	{-29.21%}	{7.18%}	{-9.73%}
C. Males	-0.0858	-0.1356	-0.0483	-0.0950	-0.1114	-0.1247
	(0.0404)	(0.0568)*	(0.0658)	(0.0148)***	(0.0308)**	(0.0248)**
	{-15.07%}	{-18.55%}	{-6.77%}	{-12.54%}	{-13.74%}	{-14.42%}
Sex, Race, Ethnicity	Yes	Yes	Yes	Yes	Yes	Yes
High School Dummies	Yes	Yes	Yes	Yes	Yes	Yes
SAT Dummies	Yes	Yes	Yes	Yes	Yes	Yes
High School GPA Dummies	No	No	No	No	No	No
USG Institution Dummies	No	No	No	No	No	No

Standard errors in parentheses are clustered by high school graduation year. The percent change, i.e., the coefficient divided by the mean, are shown in braces.

*Significant at 10% based on small sample t-distribution; **Significant at 5%; ***Significant at 1%.

Table 11: Effects of HOPE on First-Year GPA

	(1) All Graduates	(2) Initial STEM Majors	(3) Initial STEM Majors Earning STEM Degrees	(4) Initial STEM Majors Earning Non-STEM Degrees
A. Total	0.1793	0.1290	0.1229	0.1847
	(0.0119)***	(0.0120)***	(0.0201)***	(0.0106)***
B. Females	0.1928	0.1467	0.1533	0.1672
	(0.0118)***	(0.0247)***	(0.0345)**	(0.0465)**
C. Males	0.1604	0.1074	0.0998	0.1823
	(0.0146)***	(0.0129)***	(0.0272)**	(0.0274)***
Sex, Race, Ethnicity	Yes	Yes	Yes	Yes
High School Dummies	Yes	Yes	Yes	Yes
SAT Dummies	Yes	Yes	Yes	Yes
High School GPA Dummies	No	No	No	No
USG Institution Dummies	No	No	No	No

Standard errors in parentheses are clustered by high school graduation year.

*Significant at 10% based on small sample t-distribution; **Significant at 5%; ***Significant at 1%.

Appendix Table A: Summary Counts of Graduates and Total Enrollment for Pre- and Post-HOPE

	Pre-HOPE	Post-HOPE	% Change
A. Graduates			
Earned STEM Major	3,910	4,429	0.133
Earned Business Major	4,695	6,366	0.356
Earned Education Major	3,326	3,155	-0.051
Earned Health Major	1,084	1,343	0.239
Earned Liberal Arts Major	2,948	3,726	0.264
Earned Social Science Major	3,534	3,883	0.099
Total Graduates	19,497	22,902	0.175
B. Enrollment	Pre-HOPE	Post-HOPE	% Change
Initial STEM Major	4,887	6,045	0.237
Initial Business Major	3,892	4,640	0.192
Initial Education Major	1,354	1,867	0.379
Initial Health Major	1,568	2,452	0.564
Initial Liberal Arts Major	12,722	14,270	0.122
Initial Social Science Major	2,498	2,530	0.013
Initial Undeclared Major	16,711	17,903	0.071
Total Enrollment	43,632	49,707	0.139

Appendix Table B: USG Cohort Year Dummy Coefficients

Outcome:	Initial STEM Major	STEM Degree
A. Total Population		
1991 Cohort Dummy	0.0044	0.0053
	(0.0054)	(0.0053)
1995 Cohort Dummy	-0.0084	-0.0227
	(0.0054)	(0.0053)***
1996 Cohort Dummy	0.0032	-0.0222
	(0.0053)	(0.0053)***
B. Females		
1991 Cohort Dummy	-0.0028	0.0062
	(0.0067)	(0.0062)
1995 Cohort Dummy	0.0013	-0.0091
	(0.0066)	(0.0061)
1996 Cohort Dummy	0.0102	-0.0082
	(0.0065)	(0.0061)
C. Males		
1991 Cohort Dummy	0.0130	0.0059
	(0.0088)	(0.0092)
1995 Cohort Dummy	-0.0184	-0.0381
	(0.0089)**	(0.0094)***
1996 Cohort Dummy	-0.0040	-0.0387
	(0.0089)	(0.0093)***

Note: 1990 is the omitted based year. Other specifications correspond to columns 2 and 6 of Table 2. OLS Standard errors are in parentheses. **Significant at 5%; ***Significant at 1%.

Appendix Table C: Post-HOPE Effects on High School Grade Inflation

	(1) All Graduates	(2) STEM Graduates
A. Total	0.1523	0.1140
	(0.0199)***	(0.0197)**
B. Females	0.1671	0.1352
	(0.0206)***	(0.0169)***
C. Males	0.1341	0.0996
	(0.0193)***	(0.0266)**
Sex, Race, Ethnicity Dummies	Yes	Yes
High School Dummies	Yes	Yes
SAT Dummies	Yes	Yes
High School GPA Dummies	No	No
USG Institution Dummies	No	No

Standard errors in parentheses are clustered by high school graduation year.

**Significant at 5% based on small sample t-distribution; ***Significant at 1%.

Appendix Table D: Effect of HOPE on STEM Majors Unconditional on Degree Completion

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Initial Major				Earned Major			
A. Total	0.0203	0.0004	-0.0092	0.0099	0.0004	-0.0125	-0.0215	-0.0134
	(0.0058)**	(0.0040)	(0.0028)**	(0.0010)***	(0.0026)	(0.0011)***	(0.0015)***	(0.0016)***
	{14.8%}	{0.3%}	{-6.7%}	{7.2%}	{0.4%}	{-13.9%}	{-24.0%}	{-15.0%}
B. Females	0.0262	0.0114	0.0042	0.0145	0.0042	-0.0064	-0.0133	-0.0078
	(0.0044)***	(0.0042)*	(0.0033)	(0.0026)**	(0.0021)	(0.0016)**	(0.0015)***	(0.0005)***
	{27.7%}	{12.0%}	{4.4%}	{15.3%}	{7.3%}	{-11.2%}	{-23.2%}	{-13.6%}
C. Males	0.0132	-0.0118	-0.0221	0.0058	-0.004	-0.0195	-0.0286	-0.0189
	(0.0100)	(0.0057)	(0.0046)**	(0.0025)	(0.0036)	(0.0011)***	(0.0018)***	(0.0029)***
	{7.1%}	{-6.3%}	{-11.8%}	{3.1%}	{-3.1%}	{-15.3%}	{-22.5%}	{-14.9%}
Sex, Race, Ethnicity Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
High School Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
SAT Dummies	No	Yes	Yes	Yes	No	Yes	Yes	Yes
High School GPA Dummies	No	No	Yes	Yes	No	No	Yes	Yes
USG Institution Dummies	No	No	No	Yes	No	No	No	Yes

Standard errors in parentheses are clustered by high school graduation year. The percent change, i.e., the coefficient divided by the mean, are shown in braces.

*Significant at 10% based on small sample t-distribution; **Significant at 5%; ***Significant at 1%.

Appendix Table E: Time-Diff and DD Effects of HOPE at Georgia Tech and University of Georgia

	(1) Time-difference for residents	(2) DD using non-residents
A. Total	-0.0742	-0.0448
	(0.0080)***	(0.0169)*
B. Females	-0.0616	-0.0896
	(0.0123)**	(0.0249)**
C. Males	-0.0828	-0.0246
	(0.0104)***	(0.0160)
Sex, Race, Ethnicity Dummies	Yes	Yes
High School Dummies	Yes	Yes
SAT Dummies	Yes	Yes
High School GPA Dummies	No	No
USG Institution Dummies	No	No

Standard errors in parentheses are clustered by high school graduation year.

*Significant at 10% based on small sample t-distribution; **Significant at 5%; ***Significant at 1%.

Appendix Table F: DD Effects of HOPE Using the ACS

(1) 4-Year Window	(2) 5-Year Window	(3) 6-Year Window
-0.019	-0.018	-0.012
(0.013)	(0.010)	(0.010)

Notes: Standard errors are clustered by year age 18. Regression controls include dummies for yearage18, survey year, age, birth state, sex, race, and ethnicity. The control group includes persons born in states not adopting a merit aid program prior to 1998. An X-Year Window means that cohorts included were age 18 X years before or after the policy was adopted.