Can Financial Aid Help to Address the Growing Need for STEM Education? The Effects of Need-Based Grants on the Completion of Science, Technology, Engineering and Math Courses and Degrees

Benjamin L. Castleman
University of Virginia

Bridget Terry Long
Harvard Graduate School of Education and NBER

Zachary Mabel*
Harvard Graduate School of Education

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ABSTRACT

Although graduates in science, technology, engineering and math (STEM) fields post the largest average wage premiums, the number of STEM graduates lags behind labor market demands. A key question is how to keep college students in STEM majors. We offer new evidence by examining the role of financial aid in supporting STEM attainment. We find that eligibility for additional need-based aid increased STEM course completion by 18-33 percent and STEM degree production by 50-60 percent. These results appear to be driven by shifting students into STEM-heavy courseloads, suggesting aid availability impacts what academic choices students make after deciding to enroll.

Keywords: Postsecondary attainment; Financial aid; STEM education
JEL Classification Codes: I210; I220; I260; I280; J240

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*Please address all correspondence to Zachary Mabel at zam340@mail.harvard.edu.

I. INTRODUCTION

The fastest job growth in the U.S. today is in Science, Technology, Engineering, and Mathematics (STEM) fields. By 2018, the number of new and replacement jobs in STEM fields requiring an associate's degree or higher is projected to exceed two million (Carnevale, Smith and Strohl, 2010). The need for skilled workers in STEM fields translates into a large wage premium for college graduates who earn degrees in these disciplines, even after controlling for ability sorting in school and the workplace (Arcidiacono, 2004). Among new graduates, STEM majors earn $43,000 (in 2013 dollars) annually on average, a 30 percent premium over other majors (Carnevale, Cheah, and Hanson, 2015). STEM workers also experience the largest wage growth over their careers; as a result, the average earnings differential between the lowest and highest paying majors (which include STEM fields) is more than three times the gap between high school and college graduates (Carnevale, Cheah, and Hanson, 2015). Yet despite the availability of work in STEM and the payoff to these professions, policy makers are concerned that the supply of workers will not be sufficient to fill open positions in the near future. Labor market projections indicate that the country will require one million *additional* STEM professionals over the next decade to retain our global competiveness in science and technology (Lacey and Wright, 2009; Langdon, McKittrick, Beede, Khan, and Doms, 2011). Meeting current and future STEM employment needs will require substantially increasing the number of domestic STEM degree-holders.

Amidst growing demand for STEM workers, educational achievement and attainment in STEM fields has been steadily declining for decades. Less than one-third of U.S. eighth graders are currently proficient in math and science, and interest in pursuing postsecondary education in STEM fields among middle and high school students is declining (Lowell, Salzman, Bernstein, and Henderson, 2009). Sixty percent of all college students and more than 75 percent of Black and Latino college students who indicate initial interest in pursuing STEM majors do not persist to the point of earning their degree in a STEM discipline, in part because a large fraction are not academically prepared for the rigor of math and science coursework in college (Higher Education Research Institute, 2010; ACT, 2014). Among college students who leave STEM fields, approximately one-half switch their major to a non-STEM field and the other half exits school before earning a certificate or degree (Chen, 2013).

Given the private returns to STEM degree attainment and the labor market demands for more graduates in those fields, a key policy question is how to keep academically prepared students in STEM majors throughout their postsecondary career. One potentially overlooked barrier is the financial cost to pursuing college study in STEM disciplines. There are several reasons why policies targeting affordability could positively impact enrollment and persistence towards STEM degrees. One possibility is that aid reduces the cost of college or relaxes credit constraints to the point where students with STEM aptitude who are on the margin of enrolling decide to matriculate. Because most college students today must juggle both school and work commitments, financial aid could also improve outcomes in STEM courses for inframarginal enrollees by reducing the hours they need to work during freshman year and freeing up time they can devote to achieving good grades (Davis, 2012; Scott-Clayton, 2012). Financial aid may also alter where students choose to attend and which majors to pursue. For instance, need-based grants could increase the likelihood of attending flagship universities that offer more robust STEM programs and make those majors more attractive than institutions with fewer resources, or they may encourage students to pursue and persist in STEM fields rather than less costly (in terms of dollars or time) programs of study.[1] Each of these possibilities suggests that offering students additional need-based financial aid could have a positive impact on whether they pursue and persist in STEM fields.

In this paper, we investigate the effects of need-based grant eligibility on STEM attainment in college. Specifically, we focus on the impact of eligibility for the need-based Florida Student Assistance Grant (FSAG) on whether students complete courses and degrees in STEM fields. In the early 2000s, colleges and universities in Florida determined eligibility for the FSAG using the federal need analysis calculation.[2] During the 2000-01 school year, students whose Expected Family Contribution (EFC) was less than or equal to $1,590 were eligible for a $1,300 FSAG award (in 2000 dollars); this translates to families with incomes below approximately $30,000 being eligible for a FSAG. The state grant was sufficient to cover 57 percent of the average cost of tuition and fees at an average public, four-year university in Florida (IPEDS, 2011). These students also qualified for at least a $1,750 Federal Pell Grant. In contrast, students whose EFCs were just above $1,590 were not eligible for the FSAG and only received a Federal Pell Grant (up to $1,750). Capitalizing on this threshold that determined whether students were eligible for more need-based grant aid, we utilize a regression-discontinuity (RD) approach to estimate the causal effect of FSAG eligibility on STEM college outcomes. We examine in particular whether FSAG eligibility appeared to improve the academic outcomes of students across all majors, or had a concentrated effect on performance in STEM fields. We investigate whether FSAG eligibility shifted students to take a larger share of costlier

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[1] Between the 2000-01 and 2006-07 school years, the three public flagship universities in Florida – the University of Florida, Florida State University, and University of South Florida – offered 17 or more STEM programs of study. This exceeded the number of STEM programs available at each of the other 7 public universities in the State.

[2] Applying for federal financial aid, and often for state and institutional aid, requires a student to complete the Free Application for Federal Student Aid (FAFSA). The FAFSA collects information on family income and assets to determine the Expected Family Contribution (EFC), the amount that a family is estimated to be able to pay for college. To calculate need, the government subtracts the EFC from the total cost of attendance. A student's financial need, in combination with his or her EFC, determines whether the student is eligible for certain grants and loans.

STEM courses, and/or whether eligibility for the need-based grants induced more students to attend institutions with more robust STEM course and major offerings.

In earlier work, [Author] and [Author] (2016) use a similar research design and demonstrate that FSAG award offers led to substantial increases in overall credit completion and degree attainment at Florida public institutions. In their analysis, the authors focus on all high school seniors who filed a FAFSA and were therefore eligible to receive the FSAG award. In this paper, on the other hand, we focus on a subset of Florida high school graduates who demonstrate academic readiness for postsecondary study in STEM fields. We proxy for STEM readiness in two ways: first, we condition on students who surpass college-ready math standards on the Florida College Placement Test in Math (CPT-M) or the SAT Math exams; second, because high school math achievement is predictive of entrance into STEM majors (Wang, 2013), we condition on students who completed trigonometry or a more advanced mathematics class in high school.

Previewing our results, we find meaningful effects of need-based grant aid eligibility on STEM attainment among students ready for college-level STEM coursework. FSAG award offers increased cumulative STEM course completion three years following high school graduation by 2.2 credits for students who placed into college-level math and 4.7 credits for students who completed trigonometry or higher in high school, which represent respective gains of 17.5% and 33% relative to students just above the aid eligibility cut-off. Although our degree estimates are only marginally significant in one of our samples, the stability of the estimate across both samples suggest that award offers increased the rate of bachelor’s degree completion in STEM fields by nearly 3 percentage points, or by 50-60 percent relative to students just above the FSAG threshold. FSAG eligibility appeared to have a concentrated effect on STEM-related outcomes, rather than just improving academic outcomes across all subjects: the need-based grant offer shifted students' course loads towards more STEM-heavy choices and does not appear to be driven by the effect of aid offers on institutional choice. This pattern of results suggests that students make cost-conscious decisions when choosing not only where, but what to study in college.

We structure the remainder of the paper into four sections. In Section II, we review the existing literature on college access and success pertinent to our examination of need-based grants and STEM achievement. In Section III, we describe our data and research design. We present our results in Section IV. Section V concludes and discusses the implications of the results for policy and research.

II. LITERATURE REVIEW

Several factors may help to explain the shortage of academically qualified college students in pursuit of STEM degrees. One set of explanations is rooted in the lack of information students possess around college decision making and in the complexity embedded in making informed decisions (Castleman, 2015; Ross et al., 2013; Scott-Clayton, 2015). For instance, college students may undervalue the reasons to pursue and persist in STEM fields because they are poorly informed about their monetary and occupational benefits (Betts, 1996). Students' perceptions of social norms may also contribute to disparities in STEM attainment, as existing inequalities in STEM course enrollment may lead underrepresented students to question their own potential for success in STEM fields (Espinosa, 2011; Griffith, 2010; Price, 2010; Steele & Aaronson, 1995; Wang, 2013).

While other work has investigated the role of information, identity, preferences, and peer influence on STEM attainment, our paper offers new insight into the role that affordability plays in determining whether students pursue and persist in STEM fields. The cost of studying in a STEM field presents a potentially important barrier to pursuing STEM degrees. These may be real costs students incur, such as lab or materials fees, which make STEM fields more expensive than alternative options (Stange, 2015). In the face of liquidity constraints, students may be prevented from borrowing sufficient funds to pay the additional costs associated with STEM programs. Pursuing rigorous coursework, which STEM fields often require, may also be difficult for students who need to financially support themselves or their families while attending college. Students may also be deterred from pursuing STEM fields because of psychic costs, including perceived opportunity costs of foregone work and leisure time.

Previous work investigating the impact of financial aid on STEM college outcomes is very limited and has found mixed results. For example, both Denning and Turley (forthcoming) and Evans (2013) examined the effect of the SMART grant, a federal aid program awarded to low and moderate income college juniors and seniors who majored in STEM during the 2007-2011 academic years. Whereas Denning and Turley (forthcoming) find that income-eligible students in Texas were approximately 3 percentage points more likely to major in STEM fields in their junior or senior year, Evans (2013) finds no evidence of SMART grant impacts on whether students in Ohio persisted in STEM majors or earned STEM degrees. Sjoquist and Winters (2015) also find evidence that state merit aid programs decrease the number of STEM graduates, perhaps because academic renewal requirements have the unintended consequence of inducing students to avoid rigorous coursework to maintain their awards (Cornwell, Lee & Mustard, 2005; 2006). Yet because need-based aid programs typically have less stringent renewal requirements than merit aid programs and target more cost-constrained students, whether need-based aid creates positive or negative incentives for students to pursue STEM coursework remains an open question.

Ours is the first paper of which we are aware that examines the impact of eligibility for a need-based grant at the end of high school on whether students accumulate STEM credits and earn STEM degrees. Because the FSAG grant program was not targeted specifically to students pursuing STEM fields and neither is most need-based aid, its impact is likely more generalizable to financial aid policy making than previous research. For instance, compared to federal government expenditures of $195 million annually through the SMART grant program in the 2006-07 and 2007-08 school years, federal and state governments spend over $40 billion annually on need-based grant programs that are similar in structure and design to the FSAG award (Baum, Elliot and Ma, 2014; Newman, 2014). Programs like FSAG therefore represent the principle sources of need-based aid allocated to support college access and attainment.

Extending the Literature on College Affordability and STEM Attainment

This paper examines the following research question: does eligibility for additional need-based grant funding (above the federal Pell Grant) increase the number of STEM credits that students accumulate in college and increase their probability of earning a bachelor's degree in a STEM field? To investigate our research question, we focus on Florida high school seniors who graduated in the 1999-00 school year. The impact of need-based financial aid in Florida is potentially informative about the efficacy of financial aid programs in a broad range of settings across the country. Similar shares of students attend Florida public institutions and enroll at in-state institutions as in the country overall (88 percent vs. 91 percent and 86 percent vs. 92 percent, respectively). The average in-state tuition, room, and board levels at Florida public four-year institutions is also fairly similar in Florida compared to public four-years across the country

($14,677 vs. $18,632) (National Center for Education Statistics, 2016). Florida also represents the increasing racial and ethnic diversity of the country as a whole: 16 percent of its residents are Black and 23 percent of its residents are of Hispanic or Latino origin (U.S Census Bureau, 2011).

Specific to the context of financial aid, Florida students could qualify for both need- and merit-based state grants. Each year, families must complete the FAFSA, which asks for information on income, assets and family size. Using this information, the U.S. Department of Education (USDOE) estimates the families' EFC which it uses, along with the cost of attendance at students' intended institutions, to determine each student's eligibility for financial aid. States also use the EFC to award need-based grants, which totaled $8 billion in the 2012-13 academic year (Baum, Elliot and Ma, 2014).

To apply for the need-based FSAG, students needed to complete the FAFSA by March 1st of their senior year in high school. The Florida Department of Education sets an EFC cut-off each year to determine FSAG eligibility, which during the 2000-01 academic year was $1,590 (Florida Postsecondary Education Planning Commission, 2001). Institutions were prohibited from awarding grants to students whose families exceeded this amount, thus making this a sharp eligibility cut-off. Students could use the FSAG at any public two- or four-year college or university in Florida. During the 2000-01 academic year, the FSAG award for which students were eligible ($1,300) was sufficient to pay 57 percent of the average cost of tuition and fees at a public university in the state or about 28 percent of the average cost of tuition/fees, room, and board (IPEDS, 2011). Added on top of the federal Pell Grant, which all students around the FSAG cutoff were eligible to receive, students could receive up to $3,050 in need-based grants.

The FSAG was also renewable from one year to the next, conditional on students remaining financially eligible and maintaining a cumulative college GPA of 2.0 or higher.[3]

In addition to FSAG, Florida students were also eligible for the merit-based Florida Bright Futures Scholarship (BFS). There are two tiers of BFS awards. The lower tier amounted to approximately $1,700 for students who completed 15 core academic credits, had a cumulative high school GPA of 3.0 or higher, and had a composite SAT score of 970 or higher. Seventy percent of students who received a BFS award in the 2000-01 academic year received the lower-tier award. The higher tier offered a $2,500 award plus a small living stipend and was offered to students who completed 15 core academic credits, had a cumulative high school GPA of 3.5 or higher, and had a composite SAT score of 1270 or higher. Approximately 30 percent of students in our overall sample were eligible for a BFS award; we control for BFS eligibility in our analysis to account for this potential confounding source of state grant aid.

In Figure 1, we summarize the variation in total grant aid eligibility in Florida according to small differences in family resources. Focusing on the area around the FSAG eligibility cutoff, students ineligible for the BFS could receive $3,050 in total FSAG and Pell Grant funding if their EFC did not exceed $1,590, or only $1,750 in Pell Grants if their EFC was above $1,590. For students who met the criteria for BFS eligibility, being above or below the FSAG cutoff resulted in the same difference in aid, but the levels of grant aid were higher ($4,750 versus $3,450 for lower-tier BFS-eligible students on either side of the cut-off, and $5,650 versus $4,350 for the higher-tier BFS-eligible students). Importantly, the FSAG award does not appear to have crowded out other forms of federal, state, or institutional grant aid. In Table 1, we present estimates of the aid packages that students received at the FSAG eligibility cut-off in the 2000-01 academic year. The results in columns 1-3 show that students just below the FSAG cut-

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[3] There was no limit on the number of years for which students in our data could renew their FSAG award.

off received approximately $700 more in FSAG and total grant aid than students just above the cut-off.[4] There is some evidence in column 4 that the FSAG offer modestly displaced student borrowing, and as a result, the net increase in total financial aid that FSAG-eligible students received was slightly below the FSAG award amounts. However, the relevant counterfactual is that FSAG eligibility increased grant aid to students without affecting Pell Grant awards or other sources of need- or merit-based funding.

III. DATA AND RESEARCH DESIGN

The data in this article are from the Florida Department of Education K-20 Data Warehouse (KDW), which maintains longitudinal student-level records at Florida public colleges and universities. We also have data from KDW secondary-school records, including demographics, high school transcripts, and college entrance examination scores. These data are linked to KDW postsecondary data which provides the financial information that families supplied when completing the FAFSA and all financial-aid disbursements students received while enrolled in college. The postsecondary data also tracks students' enrollment and course-taking histories and their degrees received. We therefore observe students' semester-by-semester STEM credits attempted and completed and can examine credit accumulation over short-, medium-, and long-term intervals.

The data also includes students' field of study each semester, although we are unable to distinguish between intended and declared majors. We instead focus on the number of STEM credits students attempted each semester as a better measure of the extent to which they

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[4] There are two reasons why the estimates in column 1 are less than the statutory amount of $1,300. First, because we focus on the impacts of aid eligibility rather than aid receipt, some students included in our samples did not enroll in college and therefore did not receive FSAG awards. Second, students who enrolled in college were only eligible to receive awards if they filed the FAFSA by March 1st. Although we do not observe students' FAFSA filing date in our data, analyses of the NCES ELS:2002 survey data suggest that fewer than 40 percent of low-income students nationally file by March 1st.

advanced towards a STEM degree over time. We also observe whether students earned degrees and their field of study at the time of degree receipt, which enable us to report on bachelor's degree attainment in STEM fields. These three measures – STEM credits attempted, STEM credits completed, and bachelor's degree receipt in STEM disciplines – are our primary outcomes of interest.

This dataset captures college enrollment and completion records for a considerable majority of college-bound, low-income Florida high school seniors. During the 2000-01 academic year, 90 percent of Florida residents who enrolled in college for the first time did so at in-state institutions and 74 percent of first-time freshmen enrolled in public institutions (NCES, 2002). The coverage of these data are probably even higher for low-income Florida residents because the average cost of attendance at private and out-of-state colleges was considerably higher than the price of Florida public colleges and universities for in-state students. To investigate this, we examined the college enrollment patterns of high-achieving, low-income high school seniors in the Educational Longitudinal Study of 2002 (ELS:2002).[5] Because this is a nationally-representative sample of students there are only 43 – 63 high-achieving, low-income Florida students in the sample, depending on the definition of high-achieving that is used. However, among those students, only six to nine percent enrolled at out-of-state institutions. This lends further support for the case that the KDW data capture college outcomes for the vast majority of STEM-ready, low-income students in Florida.

In addition to the KDW postsecondary data, we also observe the enrollment of Florida high school graduates at private, four-year colleges and universities within the state, proxied for by students' receipt of the Florida Resident Assistance Grant (FRAG). The FRAG was a non-

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[5] We defined high-achieving students in two ways: 1) those with high school GPAs of 3.0 or higher, and for consistency with one of the sample definitions we use in this paper, 2) those who completed trigonometry while in high school.

need-based, tuition-assistance grant of $2,800 automatically awarded to students and designed to offset the cost of tuition at private institutions. In fall 2000, 7 percent of all public high school graduates in the 1999-00 school year who filed a FAFSA received a FRAG award.

Because a definition of STEM courses and degrees is not well-established in the literature, we operationalized one for our analysis. We took a conservative approach to identifying STEM courses and degrees to avoid counting math and science courses which non-STEM majors are often required to complete to graduate. At the course level, we identified STEM using FDOE course prefix codes included in the KDW postsecondary data file. This was our best approximation to identifying STEM courses by department at both 2- and 4-year institutions, and this approach eliminated our reliance on indiscriminate course names across subjects and institutions to flag courses as STEM. To identify STEM degrees, we matched NCES Classification of Instructional Program (CIP) codes in the KDW data to the list of STEM-designated CIP codes maintained by the National Center for Education Statistics and U.S. Department of Homeland Security (NCES, 2011; U.S. DHS, 2012). Unfortunately, we could not identify programs of study for most students attending 2-year colleges in the data; we therefore identified STEM degrees exclusively for bachelor's degree recipients.[6] We also separately identified the types of STEM courses and degrees (e.g. Computer Science, Physical Sciences, Health Sciences, etc.) to examine the sensitivity of our results to more and less restrictive definitions of STEM. The results we present throughout the paper are based on our most restrictive definition of STEM, comprised of Computer Science, Engineering, Mathematics & Statistics, Physical Sciences, and Biological Sciences, although our results are robust to alternative definitions that include Agricultural, Health, and Environmental Sciences.

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[6] Approximately three-quarters of students attending 2-year colleges had an uninformative major code of "General Degree Transfer".

Analytic Samples

For this analysis, we focus on a subset of Florida high school graduates in the 1999-00 academic year who demonstrate academic readiness for STEM coursework in college. We present results for two analytic samples.[7] Of the 101,094 graduates in Florida that year, we first restricted our samples to include only students who submitted a FAFSA application since this is a necessary step for receiving government and most institutional aid. This restriction resulted in the exclusion of 55,309 students from our sample.

We proxied for STEM readiness by further restricting the data in two ways: first, we conditioned on students who surpassed college-ready math standards on the Florida College Placement Test in Math (CPT-M) or the SAT Math exams. Florida's CPT is designed to provide placement, advisement, and guidance information for students entering 2- or 4-year colleges and universities. For the incoming class of first-year college students in the 2000-01 academic year, Florida established a mandatory cut score of 72 out of 120 points on the CPT-M exam for placement into college-level math (FDOE, 2006). Because students with SAT Math scores of 440 points or higher were exempted from taking the CPT placement exam, we also include in this sample students with missing CPT-M scores who had SAT Math scores above the exemption threshold (FDOE, 2006). This yields a sample of 2,834 low-income students near the FSAG eligibility cut-off with college entrance exam scores above the state-mandated cut-off for placement into college-level math courses.[8]

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[7] As a falsification test, we also estimated FSAG eligibility impacts for a third sample comprised of Florida high school graduates near the FSAG eligibility cut-off who were not academically prepared for STEM coursework in college. Results for this sample are presented in Appendix Table A3. We find negligible impacts on STEM outcomes for this group of students.

[8] We recognize that this sample is conditioned on a potentially endogenous regressor–completion of a college placement test–if FSAG offers induced high-achieving, low-income students to attend college. However, because our second sample is free of this endogeneity, we believe this sample offers a useful robustness check for whether our results hold across two different definitions of STEM-ready in college. As we show below, our results are substantively similar across both samples and the point estimates tend to be larger in the second sample.

We constructed a second sample because the mandatory CPT-M and SAT Math scores that determined placement into college-level coursework established relatively low thresholds for STEM readiness. Our second analytic sample is conditioned on students who completed trigonometry or a more advanced math class (e.g. calculus, differential equations, linear algebra, etc.) in high school. We established trigonometry as the cut-point by examining the math course enrollment patterns of Florida high school seniors; after the typical three-course sequence comprised of algebra 1, geometry, and algebra 2, trigonometry was the next most popular course students took in 12th grade. This restriction generated a sample of 1,283 low-income students near the FSAG eligibility cut-off and likely captures students most prepared to pursue STEM at the start of college. In Appendix Table A1, we present evidence of math achievement differences across our two analytic samples. Students who completed pre-calculus scored, on average, 89 and 526 points on the CPT-M and SAT Math exams, respectively. These scores lie well above the college math placement cut-offs on the CPT-M and SAT. Our second sample therefore includes higher math achievers, while our first sample captures all students near the FSAG eligibility cut-off who, according to FDOE guidelines, were prepared to undertake college-level math at the start of college.

Taken together, these two samples allow us to explore the impact of FSAG eligibility for different groups of students. In Table 2, we present descriptive statistics for the full sample of students (column 1) and compare them to all STEM-prepared graduates (columns 2 and 4) and the subset of STEM-prepared graduates included in our analytic samples (columns 3 and 5).[9] There are clear differences between the full census of public high school students and the subset in our estimation samples. For instance, our analytic samples are more heavily female than the full sample (59 and 61 percent versus 53 percent) and have greater minority representation (46

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[9] As discussed below, we restricted the samples in our analysis to students within $1,000 of the EFC cut-off.

and 49 percent in the analytic samples versus 39 percent in the full sample). Students in our conditioned samples also have considerably higher senior year GPAs (3.04 among students ready for college-level math and 3.18 for advanced high school math takers versus 2.84 in the full sample). By construction, we also observe higher achievement on college entrance exams among the conditioned samples. To the extent that these observed differences correlate with interest in and proclivity for STEM, our effect estimates likely demonstrate the impact of aid eligibility on STEM attainment for students who are most likely to consider pursuing STEM majors in college.[10]

Empirical Strategy

We use a regression-discontinuity (RD) approach to estimate the causal effect of FSAG eligibility on whether students pursued and completed courses and degrees in STEM fields. Under this approach, we estimate and compare the STEM outcomes for students just below the EFC cut-off to students who are just above the cut-off. The RD design therefore allows us to infer the effects of FSAG award offers for students on the margin of grant eligibility (Shadish, Cook, & Campbell, 2002; Murnane & Willett, 2011). We focus on intent-to-treat (ITT) estimates and employ a "sharp" RD design (Imbens & Lemieux, 2008). This means that we can directly interpret a jump in STEM outcomes at the FSAG cut-off as the causal effect of FSAG eligibility for marginal students around the cut-off.

To estimate the causal effects of FSAG eligibility on STEM college outcomes we fit the following OLS/LPM regression model:[11]

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[10] Because they have the highest math scores, and are therefore best positioned to pursue STEM fields in college, a priori we might expect that the students in our second analytic sample would be most responsive to the offer of need-based grant assistance.

[11] We present results from OLS/LPM models throughout the paper as a conservative estimate of the impact of FSAG eligibility on STEM attainment. Tobit models return estimates that are approximately one credit larger across all credit outcomes. We also modeled STEM degree receipt using a logistic regression specification, which also returned slightly larger but substantively similar estimates to those that we report.

(1) $$STEM\_OUTCOME_{ij} = \beta_0 + \beta_1 EFC_{ij} + \beta_2 FSAG_{ij} + \beta_3 FSAGijxEFC_{ij} + \gamma ACAD_{ij} + DEMOG_{ij} + \rho SCHOOL_{ij} + \epsilon_{ij},$$

where *STEM_OUTCOME* is one of several outcomes of interest corresponding to STEM attainment in college for student *i* attending high school j in 12th grade. *EFC* measures students' Estimated Family Contribution to college and is centered at the FSAG cut-off. *FSAG* is an indicator variable that takes on the value of "1" if students are below the FSAG cut-off, and zero otherwise. The $FSAGxEFC$ interaction term allows the slope of the relationship between EFC and each outcome to vary on either side of the eligibility cut-off. To increase the precision of our estimates, we also include several controls in the model.[12] *ACAD* is a vector of academic covariates, and *DEMOG* is a vector of demographic covariates. *SCHOOL* is a vector of high school fixed-effects to control for school-specific (and by proxy, neighborhood-specific) effects on educational attainment. ϵ_{ij} is a residual error term, which we cluster at the high-school-level to adjust for the potential correlation of residuals within school. In this model, parameter β_2 is our coefficient of interest and describes the causal effect of being just below the FSAG cut-off on STEM attainment in college.

As indicated in equation (1), we incorporate a broad range of academic and demographic covariates into our analyses. We include measures of students' senior year high school GPA, their SAT math and verbal scores, whether students participated in a gifted and talented program during high school, parents' adjusted gross income as reported on the FAFSA, and students' gender, race/ethnicity, and age at expected high school graduation.[13] We also include a dummy

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[12] Results from specifications without covariates are presented in Appendix Table A4 and are similar in magnitude to our main results.

[13] The students in our samples have complete information for all academic and demographic covariates with the exception of SAT scores; approximately 30 percent of students did not take the college entrance exam. We include those students in our samples to increase the precision of our estimates and we predict missing scores using the full

variable that indicates whether students were eligible for a Bright Futures scholarship award to account for the potential effect of other financial aid eligibility on STEM attainment.[14]

The selection of bandwidth is a critical decision in RD analyses: the wider the bandwidth, the greater the statistical power to detect an effect. However, a wider bandwidth also makes it more difficult to model the functional form of the relationship between the forcing variable (EFC) and the outcome of interest (Imbens & Lemieux, 2008). In our analysis, we employed the Calonico, Cattaneo, & Titiunik (2014) method for bandwidth selection, which returned optimal widths ranging from 0.8-1.2 across outcomes and samples. For sample consistency, we estimate our main results on a subset of students with EFCs between $590 and $2,590, equivalent to the modal CCT bandwidth selection of +/- $1,000 around the FSAG eligibility cut-off. To examine the sensitivity of our results to the choice of bandwidth, we re-fit our models using varying window widths and separately test polynomial specifications of the relationship between EFC and each outcome. We describe these sensitivity analyses in more detail in section IV.

There are two limitations to the external validity of our analyses. First, our inferences are limited to the effect of FSAG eligibility on whether students pursue STEM courses and degrees at Florida public or private universities. As we mention above, students who enrolled in out-of-state institutions do not appear in our data. This missing data issue is unlikely to alter our substantive findings since, in their previous work, [Author] and [Author] (2016) find no evidence that FSAG award offers impacted enrollment at in-state private institutions or induced students attending out-of-state schools to enroll at public, in-state colleges and universities. Because we

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set of other baseline characteristics. In all our results, we present estimates from multiple imputation regressions that account for uncertainty in the imputed test scores of students who did not take the exam.

[14] To maintain their scholarship from one year to the next, BFS students were required to achieve annual academic benchmarks, including completion of 12 credits and at least a 2.75 GPA. To explore whether these requirements created a perverse incentive among BFS awardees to enroll in fewer STEM courses to maintain their merit awards, we examined the number of STEM credits BFS students attempted in their second semester among those on either side of the GPA renewal threshold after first semester. The results, presented in Table A2, suggest that BFS scholars on the margin of renewing their awards did not avoid enrolling in STEM courses to maintain merit aid.

focus on low-income students and the main effects of the grant program were concentrated at the public institutions we observe in the dataset, we are likely capturing the impacts on STEM attainment for the vast majority of target students.

Second, given our sample restrictions, the students in our analytic samples represent only a fraction of college-bound low-income students. However, they likely comprise those most interested in and prepared to pursue STEM majors in college, and for whom affordability may determine whether they are able to enroll and persist in STEM programs of study. Furthermore, because Florida is demographically and socioeconomically representative of other large states in the US, our results should also inform how need-based financial aid impacts STEM credit and degree attainment among academically qualified low-income students at other public institutions nationwide.

Testing for Statistical Equivalence around the Cut-off

The key assumption underlying our research design is that students immediately on either side of the FSAG eligibility cut-off are equivalent, on average, on all observed and unobserved dimensions. That is, we expect that students on either side of the cut-off differ only in terms of whether they are eligible for the FSAG grant. This assumption implies that we should observe a smooth density of students across the EFC cut-off. Spikes in the fraction of students just below the cut-off could indicate sorting bias and violate the equality assumption upon which our identification strategy relies (Urquiola & Verhoogen, 2009). In the case of the FSAG award, sorting does not appear to be a major concern. The EFC cut-off values used to determine FSAG eligibility were not publicly reported by the Florida Department of Education Office, and institutional financial aid websites also did not make this information available to students and their families. While Florida statutes from the time period reference an EFC threshold beyond which students would not be eligible for the FSAG, an exhaustive search found only one document from the Florida Postsecondary Planning Commission (2001) that reports the actual cut-off value. Given the difficulty low-income students often experience in completing financial aid applications and the effort required to calculate the EFC, it is unlikely that the students in our study strategically positioned themselves below the eligibility cut-off to receive award offers.

To empirically test whether sorting is a concern in our study, we employ McCrary's (2008) density test around the EFC cut-off. In Figure 2, we present graphical results of these tests. A statistically significant spike in the density of students on either side of the cut-off would suggest that students were strategically manipulating their EFC values to be just above or below the cut-off. While there are small visual discontinuities at the cut-off for the two samples, neither is statistically significant, as evidenced by the overlapping 95 percent confidence intervals on either side of the vertical line positioned at the threshold. We therefore fail to reject that students in our analytic samples did not strategically position themselves around the EFC threshold, reinforcing that endogenous sorting does not appear to be a major concern in our analysis.

To further test the assumption of baseline equivalence around the EFC cut-off, we fit a version of equation (1) in which the dependent variable is one of several baseline student characteristics and all other student-level academic and demographic covariates are excluded. If students are equal in expectation on either side of the cut-off, then we should not observe statistically significant differences on student background measures at the cut-off. We performed this analysis within two windows around the FSAG cut-off – a narrow ±$250 around the cut-off, as well as ±$1,000, which corresponds to the bandwidth we use to estimate our main results – since we expect students to differ on observed and unobserved dimensions the further we move away from the cut-off. We present the results of these baseline equivalence tests in Table 3. It appears that the students just below the cut-off in our sample come from families with slightly higher family income than students just above the cut-off ($30,000-$31,500 vs. $28,500), but we otherwise find no systematic evidence that students differ on other observable dimensions.[15]

We also examined whether the full set of student covariates jointly predict whether students are eligible for the FSAG. The p-value associated with the F-test for joint significance is presented in the last row of Table 3. Across both samples, we fail to reject the null hypothesis that students on either side of the FSAG eligibility threshold are statistically equivalent within the narrow window of ±$250. These findings substantiate our use of an RD design to estimate causal effects for students immediately on either side of the eligibility cut-off. Still, the p-value in column 4 is marginally significant (p = 0.061). Observed differences at the cut-off in the high school math sample might bias our results upwards if the full set of covariates we include fails to account for unobserved differences. In all of our results, we therefore view the high school math sample as providing upper bound estimates of the impact of FSAG eligibility on students' decisions to pursue and complete postsecondary study in STEM disciplines.

IV. RESULTS

We begin our presentation of results with graphical descriptions of the bivariate relationship between the forcing variable (EFC) and our STEM credits completed and degree receipt outcomes. To capture differences over the full time span of our data set, we focus on the bivariate relationship between EFC and the outcome of interest after seven years. In Figure 3, we present scatter plots with the forcing variable on the horizontal axis and the dependent variable

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[15] Column 4 of Table 3 also shows a significant difference on high school GPA in the Trig+ sample within the ±$1,000 window, although this difference does not appear to be systematic. The difference disappears within the ±$250 window and is not distinguishable from zero in the college math sample. We also find no evidence that students at the cut-off (1) have different college entrance exam scores, (2) were differentially likely to have enrolled in gifted programs during high school, or (3) qualified for state merit aid. Taken together, we therefore find little evidence that FSAG-eligible students are more or less academically qualified than ineligible students immediately on either side of the cut-off.

on the vertical axis. Each point on the graph represents the mean value of the dependent variable within a $50 EFC bin, where EFC has been centered at the FSAG cut-off. We have also superimposed onto the scatter plots linear regression lines which capture secular trends in the bivariate relationship between EFC and the STEM outcome on either side of the eligibility cut-off.

By visual inspection, it appears that FSAG eligibility has a sizeable impact on STEM credit completion and degree attainment. As shown in Panel A of Figure 3, students who are prepared for college-level math based on their CPT or SAT scores and who fall just below the cut-off appear to have accumulated 21 STEM credits through seven years of college, which is 3 more credits than their peers above the FSAG threshold. The gap is most pronounced in Panel B, where FSAG-eligible students who completed trigonometry or higher during high school earned approximately 7 additional STEM credits compared to their peers just above the cut-off. Given that FSAG-ineligible students completed 20 STEM credits through seven years of college, this jump at the cut-off represents a 35 percent increase over the control group mean. A clear gap in STEM degree attainment is also evident at the cut-off in Figure 3. The graphical results suggest that an FSAG award offer increased STEM degree attainment by 2 to 3 percentage points. In summary, these visual illustrations suggest that FSAG eligibility had a positive effect on credit and bachelor's degree attainment in STEM fields for academically prepared students at the FSAG eligibility cut-off.

RD Analysis: The Effects on STEM Credit and Degree Attainment

We now turn to the results of fitting our statistical models to the data, which largely confirm the conclusions from the graphical analyses above. In Table 4, we present estimates of the effect of FSAG eligibility on cumulative STEM credits attempted and completed. The first two columns present short-term impacts through one year following high school graduation. Columns 3 and 4 present outcomes through three years of postsecondary study for students who seamlessly transitioned from high school to college. Columns 5 and 6 present long-term outcomes through seven years of college and are analogous to the outcomes presented graphically above. Across all time horizons, our estimates of the impact of an FSAG award offer on the cumulative number of STEM credits attempted lack precision and are mostly indistinguishable from zero. All of the coefficients are positive and non-trivial in magnitude, however, and we therefore cannot rule out that FSAG award offers encouraged eligible students to enroll in more STEM courses.

We find larger and more conclusive impacts on STEM credit completion. For students who were ready for college-level math, we estimate that FSAG award offers increased STEM course completion by 0.722, 2.254, and 3.705 credits through year one, three, and seven, respectively. These effects, though small in absolute terms, represent large relative gains of 16 – 19 percent because the average number of STEM credits completed among FSAG-ineligible students is small. We estimate the largest credit completion effects, which increase to 1.947, 4.721 and 7.259 credits in the short-, medium- and long-term, respectively, among students who completed trigonometry or higher in high school. For this subgroup, FSAG-eligible students earned 33 percent more STEM credits through three years of college compared to their peers just above the aid eligibility cut-off. In other words, students just below the cut-off were approximately one to two courses ahead of students just above the cut-off after three years, and they maintained this margin seven years following high school graduation.

In the final column of Table 4, we present impact estimates of an FSAG award offer on whether students earned bachelor’s degrees in STEM fields within seven years of high school graduation. The estimate in Panel A is statistically significant at the 10 percent level and the coefficient in both samples is positive and suggestive of a large relative impact on STEM degree attainment. For students with math scores above the college placement threshold, the coefficient on FSAG implies a 2.7 percentage point (63 percent) increase in STEM degree attainment among FSAG-eligible students. The estimate of 2.8 percentage points (47 percent) is similar for students in the high school trigonometry sample.

It is possible that the results in Table 4 merely reflect that FSAG offers drew new college-ready students in our samples into college. In Table 5, we examine whether this explains the effects on STEM attainment. The results provide no evidence that FSAG award offers increased overall enrollment at public colleges in Florida (column 1), nor do they suggest that award offers induced students to attend public instead of private institutions in Florida (column 2). Although imprecise, the point estimates on both outcomes are negative or near zero in both samples. In column 3, we examine whether FSAG award offers influenced the quality of institution where students chose to attend. The results indicate that FSAG award offers increased attendance at public flagship universities in Florida by 9-10 percentage points (30-35 percent).

If the effects on STEM attainment are not driven by overall attendance gains, we should observe a shift towards more intensive STEM course-taking at the FSAG cut-off. We examine evidence for this in column 4 of Table 5, which shows the proportion of total credits that students completed in STEM fields through seven years following high school completion. FSAG eligibility increased the share of total credits that were completed in STEM fields by 4.6 and 7.8 percentage points among all students in the college math and high school trigonometry samples, respectively, representing relative credit load shifts of 24 and 33 percent. To further examine whether these effects are mechanically produced by selection into college, in column 5 we condition the samples on students who entered college in fall 2000. The coefficients are similar in magnitude and significance in the conditioned samples, reinforcing that FSAG award offers had a large influence on course selection among inframarginal college-goers.[16]

As suggested by the literature on academic mismatch and our results on flagship attendance, one avenue through which FSAG eligibility might lead to improved STEM outcomes is by inducing students to attend higher-quality institutions where there are more STEM course offerings and more academic supports for students pursuing STEM programs of study (Arcidiacono, 2004; Roderick et al, 2008; Bowen, Chingos & McPherson, 2009).[17] However, another possibility is that additional grant aid lowers non-institutional obstacles to STEM attainment, perhaps by reducing the financial barriers to pursuing more costly courses or by enabling students to substitute working for pay with more demanding coursework. To investigate which of these mechanisms appears to be driving our results, we add college fixed effects to the regression model in column 6 of Table 5. If FSAG eligibility raised STEM attainment by inducing students to attend higher-quality institutions, then the magnitude of the effect should attenuate when we limit our comparisons to students who attended the same institutions. The estimates in column 6 (4.8 and 8.1 percentage points in the college math and Trig+ samples, respectively) do not diminish with the addition of college fixed effects. The results therefore

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[16] In Appendix Table A5, we present estimates of the effect of FSAG eligibility on non-STEM outcomes. The estimates are negative or near zero in both samples. Although they are not statistically distinguishable from the estimates on STEM outcomes at conventional levels (e.g., in the Trig+ sample, a cross-equation test returns a p-value of 0.103 for the difference in effects on STEM versus non-STEM credit attainment through seven years), taken together with the results in Table 5 and Table A3, the non-STEM results provide additional evidence that the gains in STEM attainment are not attributable to broad enrollment effects.

[17] Our analysis of STEM degree rates by institution also confirms this reasoning. Among high school graduates in 1997-98 who attended a Florida public university, the University of Florida, a flagship campus and the only public university with a “highly competitive” Barron’s ranking, reported the top STEM degree rate of 12.2 percent, more than 3 percentage points above the second highest-performing institution (Florida Agricultural & Mechanical University).

suggest that the FSAG effects on STEM attainment are primary explained by within-institution factors, not by which schools students chose to attend.

Robustness Checks

We perform a number of robustness tests to validate our results. We first address the possibility that our results are sensitive to the EFC window around which we conducted our analysis by re-fitting our regression models using a variety of window widths. To the extent that our results capture the true causal effect of FSAG eligibility, the parameter estimates associated with FSAG eligibility should be robust to the choice of bandwidth selected. For illustrative purposes, in Table 6 we present the effect of FSAG eligibility on STEM credit accumulation through seven years using various window widths. Moving from left to right, each of the first five columns presents the results of fitting equation (1) using progressively wider window widths. We observe very little fluctuation in the coefficients on FSAG for both estimation samples which suggests that our main results are robust to the choice of window width.

In addition to bandwidth selection, another possible concern is that our results may be sensitive to the functional form of the relationship between EFC and our STEM outcomes of interest. Misspecifying the functional form of the forcing variable in RD models can yield particularly problematic findings, as the relatively small number of observations within the analytic windows can cause outlying observations just above or below the cut-off to have disproportionate influence on the estimated slope coefficients. This, in turn, could lead to biased effect estimates in our models (Murnane & Willett, 2011). In all of our analyses we modeled a locally linear relationship between the forcing variable and the outcome of interest within $1,000 of the FSAG eligibility cut-off. To test whether we correctly specified the model, in columns 6 through 8 of Table 6 we add polynomial EFC terms to equation (1) and include two-way interactions between each of these terms and the FSAG eligibility indicator variable. None of the polynomial specifications is statistically significant, which suggests that within our chosen bandwidth of +/- $1,000 we have correctly specified a locally linear relationship between EFC and cumulative STEM credit completion.[18]

As a final robustness test, we consider the possibility that our results are not capturing true causal effects, but rather idiosyncratic fluctuations in the data at the EFC cut-off of $1,590. If this were the case, then we might also expect to detect increases in STEM attainment at arbitrarily chosen points along the EFC distribution. We conduct this falsification test by re-fitting equation (1) using a $1,000 window around four arbitrarily selected EFC "cut-offs": a) at the actual eligibility cut-off of $1,590 in column 1; b) at $500 below the actual cut-off in column 2; c) at $500 above the actual cut-off in column 3; and d) at $1,000 above the actual cut-off in column 4. We present the results of this test in Table 7. In columns 2 through 4, the estimated "effect" of FSAG eligibility on STEM credit accumulation through seven years is smaller in absolute magnitude than the actual estimate and not distinguishable from zero. This suggests that our estimates in column 1, and throughout our main results, are detecting causal effects rather than random fluctuations in the data around the EFC cut-off.

V. CONCLUSIONS & IMPLICATIONS

College major selection has an enormous impact on returns to postsecondary education, with bachelor's degree holders in science, technology, engineering and math (STEM) fields posting the largest average wage premiums. Keeping students with the interest and preparedness to succeed in STEM majors in those fields therefore promises to maximize private returns to college and help address the anticipated shortage of STEM workers in the labor force.

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[18] We conducted similar analyses for all outcomes with statistically significant effects and reach the same conclusion: the polynomial EFC terms and the interactions between FSAG and the polynomial terms are not necessary within the ± $1,000 analytic window.

A barrier to persistence in STEM majors largely overlooked to date is the financial cost to pursuing college study in STEM fields. Despite a wide array of policy initiatives at the institutional, state, and federal level, including financial aid for students pursuing STEM fields, there has been little research investigating the causal impact of grant aid on students' credit accumulation and degree attainment in STEM fields. In this study, we add to both the STEM and financial aid literatures by examining the effect of need-based grant eligibility on students' achievement and attainment in STEM fields.

Using a RD design, we find a positive effect of FSAG eligibility on whether students with sufficient high school academic preparation accumulate STEM credit. When we adjust our estimates into magnitudes per $1,000 of aid eligibility, as is the convention in the financial aid literature, our results suggest that $1,000 in grant aid (in 2000 dollars) led to students accumulating between 1.7 – 3.6 additional credits after three years in college, depending on the sample. While these impacts are modest in absolute magnitude, they represent increases of 13 – 26 percent over the STEM credit accumulation of students who were ineligible for the FSAG award. Although our degree estimates are only marginally significant in one of our samples, the stability of the coefficients across our samples also suggests that grant aid substantially increased the probability of earning a bachelor's degree in a STEM field.

The positive estimates on degree attainment suggest that the FSAG program is likely a cost-effective investment towards increasing the production of STEM degrees. On the assumption that 300 students (i.e. roughly 10 percent of the college math sample) were sufficiently close to the cut-off and enrolled in college, our results suggest that FSAG receipt induced approximately 14 more students (off a baseline of 16 students) to earn a STEM degree within 7 years. Since FSAG recipients in our samples received an average award of $940 per year and the average duration of grant receipt was 2.5 years, the total expenditure on students close to the cut-off was $705,000 and the cost per student to produce 14 more STEM graduates was just over $50,000. Given the STEM wage premium among entry-level college-educated workers, which was estimated at $10,000 in 2013, the social and private benefits of FSAG would have exceeded the costs within five years (Carnevale, Cheah, and Hanson, 2015). Furthermore, because average earnings of STEM majors grow more quickly than other majors over the course of a career, even this simple "back of the envelope" calculation indicates that FSAG likely has a positive rate of return for students who enter college ready to succeed in STEM fields. Whether conditionally tying aid to specific programs of study would more effectively increase STEM undergraduate production and produce a higher rate of return remains an open question that deserves further attention.

While our results suggest that financial aid policy has a role to play in the production of STEM graduates, an important implication of our findings is that financial aid alone is not sufficient to improve STEM attainment. The effects of the FSAG award on STEM credit completion and degree attainment were trivial for the entire sample of FAFSA-filing high school seniors. This suggests that policy efforts should continue to focus on improving the math and science preparation of students in high school. In concert with these investments, our finding that aid-eligible students shifted towards more STEM-heavy course loads indicates that students make cost-conscious decisions when choosing not only where, but what to study in college and that financial aid can help alleviate financial constraints to pursuing and persisting in STEM fields for low-income, academically-qualified students.

One question that emerges is whether the impact of aid on STEM attainment varies by STEM field. While certain fields like engineering may require students to incur additional lab and materials costs, other disciplines like mathematics or statistics are less likely to have additional costs (beyond the costs associated with taking any course, such as purchasing textbooks). Lower-income students pursuing relatively more expensive STEM fields might be particularly responsive to the offer of additional financial aid, and therefore we might expect to see pronounced effects of need-based aid for students in more cost-intensive courses. Although we find no evidence to support this hypothesis in our own data, Florida did not charge differential tuition in the school years we observe even though the instructional costs per credit hour in engineering during this time were 81% higher than the costs in mathematics, statistics and computer science (Conger, Bell, & Stanley, 2010). As a result, it is likely that the students in our samples encountered similar costs across STEM fields. A further mechanism by which FSAG may have positively impacted STEM outcomes is by reducing the hours students had to work in college, thereby allowing them to devote more time to their coursework. We were unable to empirically examine this hypothesis with our data, but it remains a plausible mechanism that merits further inquiry.

In summary, our results suggest that expanding need-based aid programs can play a critical role in addressing the growing mismatch in the United States between the degrees held by college graduates and the demands of employers in the domestic labor market. More broadly, our findings also reveal that the impact of targeted interventions designed to raise STEM postsecondary attainment may be limited if the financial barriers to pursuing STEM are not sufficiently considered. Because we continue to know little about how financial barriers impede STEM attainment, unpacking the mechanisms that link aid and STEM attainment is critical to meeting our future labor market needs and helping students reap the fullest returns to their postsecondary education.

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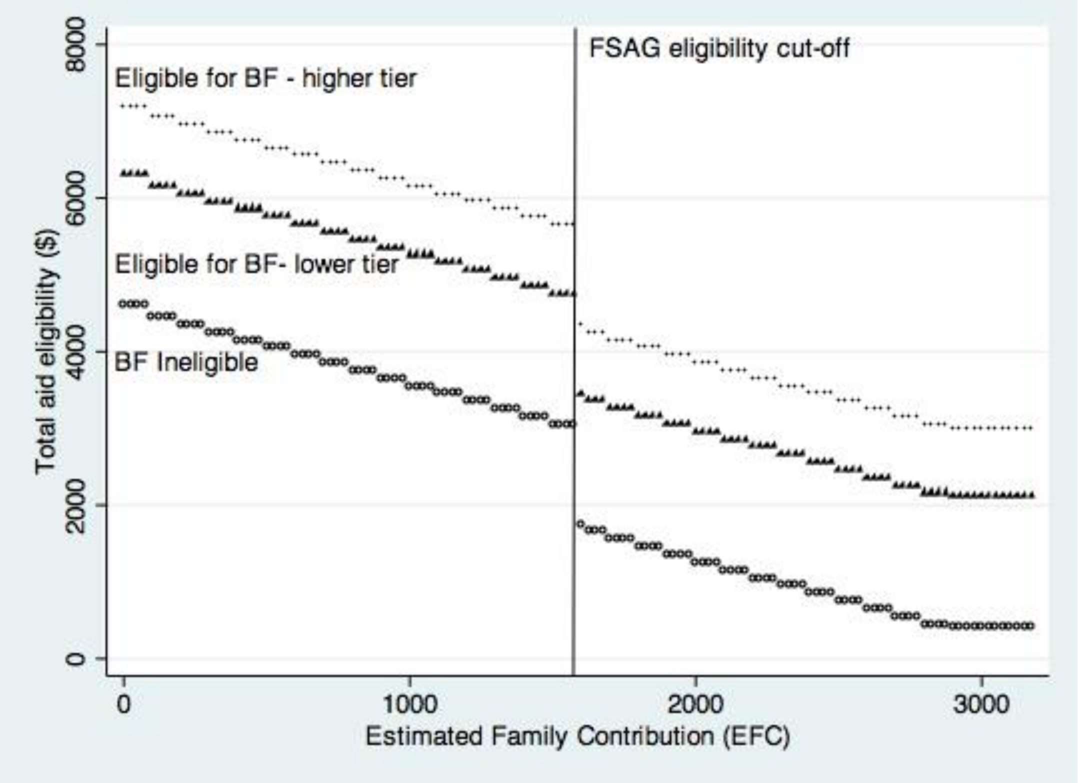
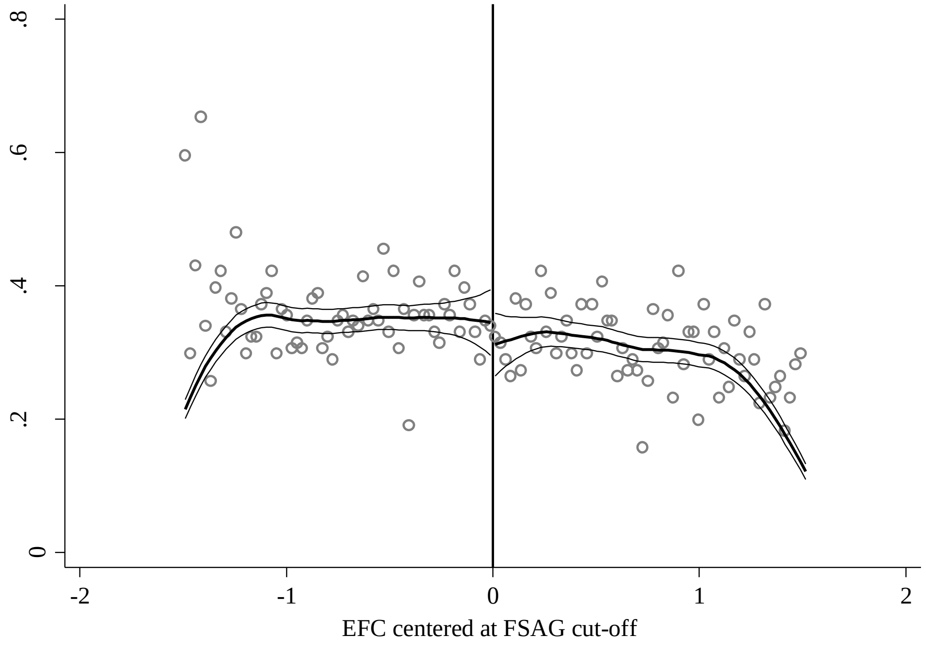
Figure 1: Federal and Florida Grant Aid Eligibility by EFC



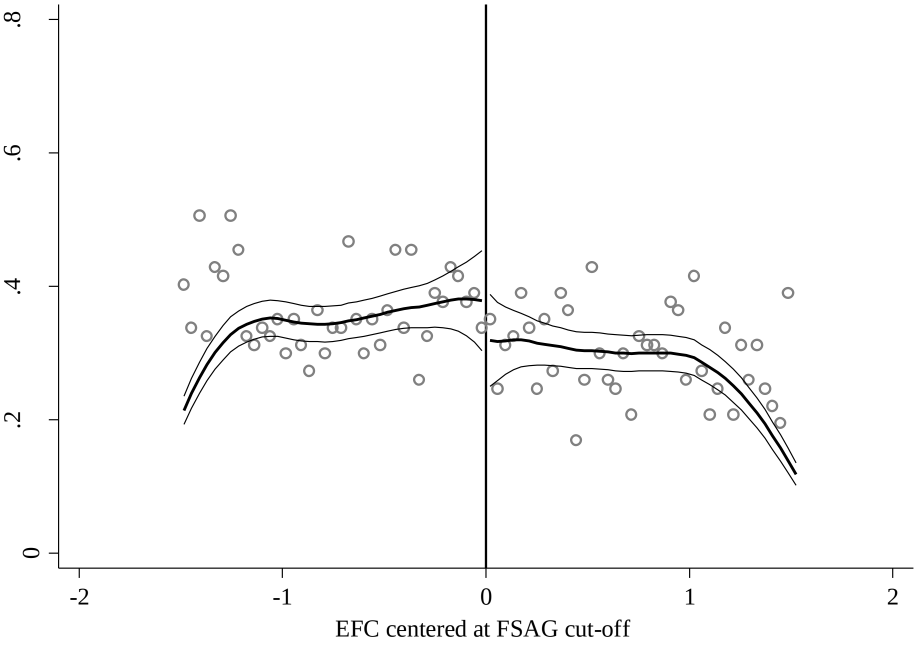
Notes: EFC is calculated by the U.S. Department of Education based primarily on income, assets, and family size information collected on the FAFSA. Total aid eligibility is the sum of the Federal Pell Grant, FSAG, and Bright Futures Scholarship funding for which a student is eligible. During the study period, students with an EFC of $0 to $3,100 were eligible for a Pell Grant ranging from $200 to $4,050. The FSAG was also awarded based on need, with families with EFCs below $1,590 being eligible for $1,300. There are two tiers of Bright Futures. The lower tier Bright Futures Florida Medallion Scholars award covered 75 percent of tuition and fees at in-state public colleges and universities (or the monetary equivalent at in-state private institutions). Students qualified for a Bright Futures Florida Medallion Scholars award if they completed 15 core academic credits in high school, had a cumulative high school GPA of 3.0 or higher, and had a composite SAT score of 970 or higher (or a composite ACT exam of 20 or higher). The higher tier Bright Futures Florida Academic Scholars award covered 100 percent of tuition and fees at in-state public colleges and universities (or the monetary equivalent at in-state private institutions). Students qualified for a Bright Futures Florida Academic Scholars award if they completed 15 core academic credits in high school, had a cumulative high school GPA of 3.5 or higher, and had a composite SAT score of 1270 or higher (or a composite ACT exam score of 28 or higher).

Figure 2: Density of observations within ±$1,000 of the FSAG eligibility cut-off

A. College Math Sample



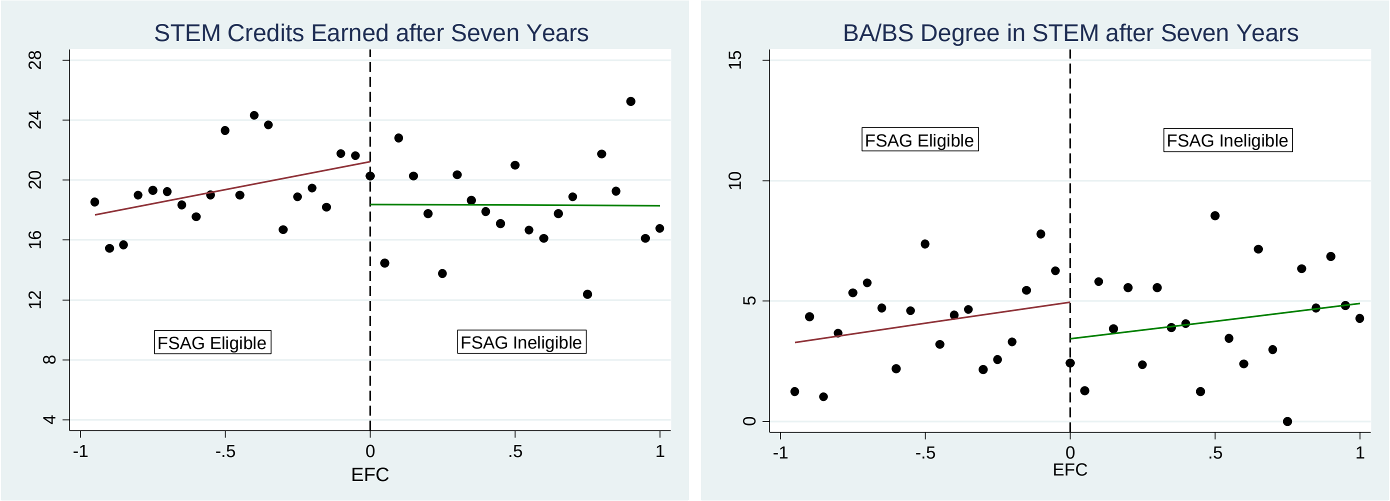
B. HS Trig+ Sample



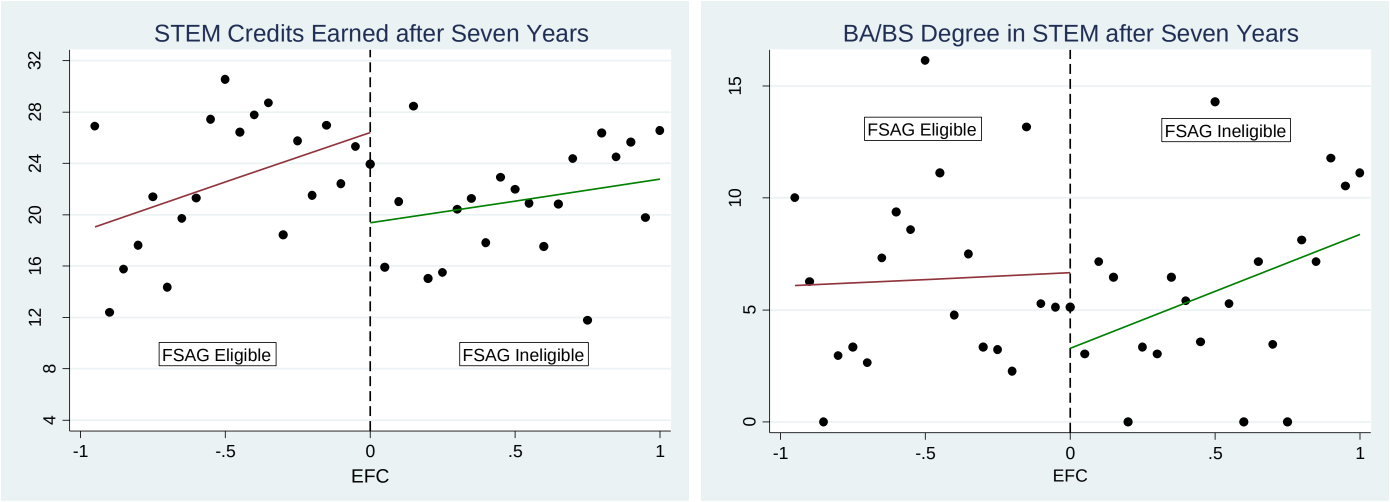
Notes: EFC is divided by $1,000 and centered at the FSAG cut-off. The density function of EFC was estimated using McCrary's (2008) test for manipulation of the forcing variable in regression discontinuity analyses.

Figure 3: Relationship between EFC and selected outcomes, with locally linear regressions fit on either side of the FSAG cut-off

A. College Math Sample



B. HS Trig+ Sample



Notes: EFC is divided by $1,000 and centered at the FSAG cut-off. Each point represents the mean of the dependent variable within a $50 bin of EFC. The trend lines present uncontrolled, locally-linear regressions within $1,000 of the aid eligibility cut-off.

Table 1. The Effect of FSAG Eligibility on Financial Aid Receipt in 2000-01

	(1) FSAG	(2) Total Grant Aid	(3) Grant Aid minus FSAG	(4) Loan Aid	(5) Total Aid from All Sources
Panel A: College Math Sample					
Eligible for FSAG	673.97***	694.92***	20.95	-145.04*	549.88**
	[38.45]	[198.15]	[186.31]	[84.60]	[234.09]
EFC (centered at FSAG cut-off)	-12.14	-457.94*	-445.80*	-144.99	-602.93**
	[31.38]	[236.41]	[230.25]	[126.36]	[292.84]
FSAG x EFC	33.37	398.88	365.50	147.67	546.54
	[71.12]	[404.25]	[375.44]	[163.41]	[467.36]
R-squared	0.449	0.403	0.401	0.161	0.371
Outcome mean above FSAG cut-off	0	2580	2580	358	2938
N			2,834		
Panel B: HS Trig+ Sample					
Eligible for FSAG	673.05***	735.40*	62.35	-105.65	629.75
	[67.84]	[423.58]	[408.00]	[207.08]	[501.40]
EFC (centered at FSAG cut-off)	-92.67	-520.41	-427.74	-176.61	-697.02
	[63.54]	[569.89]	[559.77]	[255.58]	[673.47]
FSAG x EFC	-15.25	422.23	437.49	311.07	733.30
	[125.69]	[814.13]	[780.06]	[297.04]	[918.23]
R-squared	0.568	0.452	0.453	0.252	0.416
Outcome mean above FSAG cut-off	0	3430	3430	496	3925
N			1,283		

*** p<0.01 ** p<0.05 * p<0.10

Notes: Robust standard errors, clustered at the high school level, are shown in brackets. All results are from multiple imputation OLS specifications estimated with an EFC window +/- $1,000 around the FSAG cut-off and include the following covariates: race dummy variables (Black, Hispanic, and Other race/ethnicity); female dummy variable; high school senior year GPA (weighted 4.5 scale); SAT math and verbal scores (imputed where missing); whether the student was in a gifted and talented program; parental adjusted gross income; student age, and whether the student was eligible for the Florida Bright Futures Scholarship. All models also include school fixed effects and a constant.

Table 2: Summary Statistics of the Data

	(1)	(2)	(3)	(4)	(5)
	All public Florida high school seniors	College Math Sample		HS Trig+ Sample	
		All Students	EFC ±$1,000	All Students	EFC ±$1,000
Female	0.53	0.58	0.59	0.57	0.61
White	0.62	0.63	0.54	0.64	0.52
Black	0.20	0.15	0.20	0.15	0.22
Hispanic	0.15	0.15	0.20	0.13	0.18
Other Race	0.04	0.06	0.06	0.08	0.09
Age	17.92	17.82	17.83	17.81	17.81
	(0.57)	(0.49)	(0.50)	(0.48)	(0.49)
	[99,067]	[20,400]		[8,775]	
EFC	$6,889	$7,750	$1,570	$9,060	$1,560
	($12,128)	($13,950)	($570)	($15,290)	($570)
	[45,785]				
AGI	$43,662	$51,780	$28,380	$55,110	$28,630
	($41,607)	($44,310)	($10,280)	($46,740)	($10,040)
	[43,784]	[20,028]		[8,668]	
12th Grade GPA	2.84	3.10	3.04	3.23	3.18
	(0.75)	(0.63)	(0.64)	(0.56)	(0.55)
	[57,021]	[18,599]		[8,879]	
CPT Math Score	59.43	92.81	91.62	89.27	87.18
	(27.02)	(13.55)	(13.28)	(22.49)	(23.31)
	[36,328]	[6,005]	[886]	[2,121]	[345]
SAT Math Score	528.73	554.04	536.98	579.55	557.1
	(97.27)	(81.76)	(75.63)	(88.80)	(85.94)
	[35,080]	[16,188]	[2,102]	[6,487]	[877]
FSAG in 2000-01	$195	$221	$412	$242	$482
	($432)	($462)	($462)	($462)	($462)
	[45,727]				
Total Grants & Loans in 2000-01	$1,795	$2,834	$3,355	$3,602	$4,389
	($2,787)	($3,087)	($3,397)	($3,297)	($3,680)
	[45,727]				
Observations	101,094	20,738	2,834	8,907	1,283

Notes: Means are shown with standard deviations in parentheses and the number of observations in brackets if less than the full sample. Columns 2-5 are restricted to students with non-missing FAFSA information. EFC = Expected Family Contribution towards college, AGI = parents' adjusted gross income, CPT = College Placement Test, and Grade 12 GPA is weighted on a 4.5 scale.

Table 3: Test for Baseline Equivalence around the FSAG Eligibility Cut-Off

	(1)	(2)	(3)	(4)
	College Math Sample		HS Trig+ Sample	
EFCs window around FSAG eligibility cut-off	±$250	±$1,000	±$250	±$1,000
Female	-0.172	-0.007	-0.150	-0.015
	[0.104]	[0.042]	[0.225]	[0.072]
Black	0.017	-0.031	0.198	-0.054
	[0.090]	[0.033]	[0.160]	[0.057]
Hispanic	-0.024	-0.001	-0.061	-0.003
	[0.077]	[0.029]	[0.157]	[0.051]
Other Race	0.004	0.021	0.018	0.008
	[0.054]	[0.020]	[0.118]	[0.044]
Age	0.099	0.005	0.009	-0.025
	[0.141]	[0.043]	[0.322]	[0.076]
Parents' Adjusted Gross Income (AGI)	1.845	1.572*	2.247	2.923**
	[2.107]	[0.848]	[4.794]	[1.361]
Eligible for Bright Futures Scholarship	-0.090	-0.006	-0.237	-0.103
	[0.115]	[0.042]	[0.212]	[0.068]
Enrolled in Gifted/Talented Program	-0.007	0.019	0.025	-0.002
	[0.045]	[0.018]	[0.088]	[0.030]
High School Senior Year GPA	0.126	0.078	0.004	0.149**
	[0.141]	[0.056]	[0.269]	[0.069]
SAT Math	-6.654	-4.639	-32.622	0.816
	[18.361]	[7.105]	[39.872]	[12.980]
SAT Verbal	-12.505	-6.893	-36.264	-5.982
	[20.528]	[7.725]	[43.228]	[13.360]
Observations	739	2,834	346	1,283
P-value on F-test for Joint Significance	0.710	0.353	0.986	0.061

*** p<0.01 ** p<0.05 * p<0.10

Notes: Each cell reports the coefficient estimate from an OLS/LPM regression of the student characteristic on the FSAG eligibility indicator. All models control for EFC (centered at the cut-off), the interaction of the FSAG eligibility indicator and EFC, and high school fixed effects. Standard errors, clustered by high school, are reported in brackets. SAT math and verbal scores have been imputed where missing using multiple imputations. The F-test for joint significance tests whether the full set of baseline characteristics jointly explain variation in whether students were just above or below the FSAG eligibility cut-off.

Table 4: The Effect of FSAG Eligibility on Cumulative STEM Credits and BA/BS Degrees Earned in STEM Fields

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Through Year 1		Through Year 3		Through Year 7		
	STEM Credits Attempted	STEM Credits Completed	STEM Credits Attempted	STEM Credits Completed	STEM Credits Attempted	STEM Credits Completed	BA/BS Degree in STEM
Panel A: College Math Sample (N = 2,834)							
Eligible for FSAG	0.514	0.722*	1.600	2.254**	2.701	3.705**	0.027*
	[0.471]	[0.413]	[1.311]	[1.113]	[2.076]	[1.800]	[0.015]
EFC (centered at FSAG cut-off)	0.553	0.439	1.756	1.577	1.165	1.219	0.022
	[0.558]	[0.491]	[1.553]	[1.312]	[2.462]	[2.054]	[0.021]
FSAG x EFC	-0.574	-0.106	-1.360	-0.137	1.061	2.642	0.008
	[0.719]	[0.677]	[1.996]	[1.847]	[3.185]	[2.793]	[0.026]
R-squared	0.191	0.208	0.202	0.216	0.195	0.204	0.191
Outcome mean above FSAG cut-off	5.63	4.31	15.99	12.41	23.55	18.27	0.043
Panel B: HS Trig+ Sample (N =1,283)							
Eligible for FSAG	1.805*	1.947**	3.615	4.721**	5.456	7.259**	0.028
	[0.940]	[0.837]	[2.514]	[2.164]	[4.115]	[3.533]	[0.032]
EFC (centered at FSAG cut-off)	2.105*	1.723	4.555	4.785	3.016	4.389	0.040
	[1.219]	[1.080]	[3.371]	[2.953]	[5.043]	[4.379]	[0.044]
FSAG x EFC	-1.019	-0.300	-4.015	-3.430	0.340	0.153	-0.055
	[1.531]	[1.431]	[4.163]	[3.801]	[6.588]	[5.708]	[0.051]
R-squared	0.319	0.326	0.322	0.330	0.300	0.310	0.290
Outcome mean above FSAG cut-off	6.51	5.28	18.06	14.44	26.47	20.98	0.059

*** p<0.01 ** p<0.05 * p<0.10

Notes: Robust standard errors, clustered at the high school level, are shown in brackets. All results are from multiple imputation OLS/LPM specifications estimated with an EFC window +/- $1,000 around the FSAG cut-off and include the following covariates: race dummy variables (Black, Hispanic, and Other race/ethnicity); female dummy variable; high school senior year GPA (weighted 4.5 scale); SAT math and verbal scores (imputed where missing); whether the student was in a gifted and talented program; parental adjusted gross income; student age, and whether the student was eligible for the Florida Bright Futures Scholarship. All models also include high school fixed effects and a constant.

Table 5: The Effect of FSAG Eligibility on Enrollment and the Share of Credits Completed in STEM Fields through Seven Years Following High School Graduation

	(1)	(2)	(3)	(4)	(5)	(6)
	All Students				Students Enrolled in Fall 2000	
	Enrolled at Any College	Enrolled at in-State Private College (FRAG proxy)	Enrolled at UF, FSU, or USF	Share of Credits Completed in STEM	Share of Credits Completed in STEM	Share of Credits Completed in STEM
Panel A: College Math Sample						
Eligible for FSAG	-0.006	0.003	0.086***	0.046**	0.047**	0.048***
	[0.025]	[0.025]	[0.032]	[0.018]	[0.019]	[0.018]
EFC (centered at FSAG cut-off)	0.003	-0.015	0.064	0.034	0.021	0.018
	[0.028]	[0.030]	[0.041]	[0.022]	[0.021]	[0.021]
FSAG x EFC	-0.011	-0.001	0.009	0.003	0.016	0.021
	[0.036]	[0.042]	[0.061]	[0.029]	[0.028]	[0.028]
R-squared	0.182	0.149	0.258	0.188	0.243	0.265
Outcome mean above FSAG cut-off	0.926	0.0848	0.242	0.223	0.217	0.217
Observations	2,834	2,834	2,834	2,834	2,151	2,151
Panel B: HS Trig+ Sample						
Eligible for FSAG	-0.020	0.007	0.098	0.078**	0.071**	0.081**
	[0.045]	[0.038]	[0.061]	[0.033]	[0.035]	[0.036]
EFC (centered at FSAG cut-off)	-0.004	-0.019	0.100	0.055	0.059	0.072
	[0.054]	[0.044]	[0.076]	[0.041]	[0.044]	[0.046]
FSAG x EFC	0.036	-0.006	-0.051	-0.020	-0.058	-0.065
	[0.077]	[0.073]	[0.103]	[0.057]	[0.059]	[0.062]
R-squared	0.315	0.300	0.362	0.321	0.384	0.426
Outcome mean above FSAG cut-off	0.893	0.0911	0.324	0.235	0.232	0.232
Observations	1,283	1,283	1,283	1,283	971	971

*** p<0.01 ** p<0.05 * p<0.10

See Table 4 for model details. Results in column (6) also include college fixed effects.

Table 6: Robustness of the estimated effect on cumulative STEM credit completion within seven years to differing window widths around the FSAG cut-off and specification of the functional form

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
			EFC Window around the Cut-Off				Checks of Functional Form	
	±$800	±$900	±$1,000	±$1,100	±$1,200		EFC Window = ±$1,000	
Panel A: College Math Sample								
Eligible for FSAG	3.354	3.561*	3.705**	3.897**	2.857*	2.327	3.575	6.050
	[2.118]	[1.906]	[1.800]	[1.679]	[1.637]	[2.617]	[3.451]	[3.721]
EFC (centered at FSAG cut-off)	2.637	2.463	1.219	0.346	0.621	7.995	19.050	50.338
	[3.352]	[2.562]	[2.054]	[1.673]	[1.530]	[8.133]	[20.761]	[39.445]
FSAG x EFC	-0.705	0.071	2.642	4.976**	1.294	-18.856	-25.993	-39.032
	[4.519]	[3.350]	[2.793]	[2.317]	[2.265]	[12.005]	[30.997]	[59.233]
EFC^2 and (FSAG x EFC)^2						✓	✓	✓
EFC^3 and (FSAG x EFC)^3							✓	✓
EFC^4 and (FSAG x EFC)^4								✓
Observations	2,272	2,573	2,834	3,102	3,368	2,834	2,834	2,834
R-squared	0.221	0.219	0.204	0.194	0.192	0.170	0.170	0.170
P-value on F-test of EFC polynomials						0.384	0.549	0.496
P-value on F-test of FSAG x EFC interactions						0.440	0.885	0.729
Panel B: HS Trig+ Sample								
Eligible for FSAG	7.580*	8.201**	7.259**	8.208**	7.267**	5.235	6.438	12.948*
	[4.385]	[3.943]	[3.533]	[3.299]	[3.172]	[5.061]	[6.127]	[6.830]
EFC (centered at FSAG cut-off)	7.441	8.176	4.389	4.010	5.286*	20.997	49.877	116.161
	[6.913]	[5.530]	[4.379]	[3.383]	[2.860]	[16.346]	[46.401]	[75.980]
FSAG x EFC	-5.240	-5.371	0.153	2.942	-3.279	-46.708**	-89.887	-91.368
	[9.329]	[7.273]	[5.708]	[4.530]	[4.332]	[23.154]	[71.136]	[115.590]
EFC^2 and (FSAG x EFC)^2						✓	✓	✓
EFC^3 and (FSAG x EFC)^3							✓	✓
EFC^4 and (FSAG x EFC)^4								✓
Observations	1,035	1,157	1,283	1,408	1,525	1,283	1,283	1,283
R-squared	0.339	0.336	0.309	0.298	0.283	0.289	0.289	0.289
P-value on F-test of EFC polynomials						0.317	0.433	0.340
P-value on F-test of FSAG x EFC interactions						0.521	0.821	0.639

*** $p<0.01$ ** $p<0.05$ * $p<0.10$

Notes: Robust standard errors, clustered at the high school level, are shown in brackets. All results are from multiple imputation OLS specifications that include the same set of covariates as in Table 4. See Table 4 for details.

Table 7: Falsification test for whether estimated effects of FSAG eligibility on STEM credit completion within seven years are unique to the actual FSAG cut-off

	(1)	(2)	(3)	(4)
Eligibility Cut-Off at EFC =	$1,590 (actual)	$1,090	$2,090	$2,590
Panel A: College Math Sample				
Eligible for FSAG	3.705**	-0.729	0.376	1.127
	[1.800]	[1.704]	[1.756]	[1.933]
EFC (centered at FSAG cut-off)	1.219	-2.391	1.440	1.938
	[2.054]	[2.024]	[2.472]	[2.396]
FSAG x EFC	2.642	4.233	-3.329	-1.294
	[2.793]	[2.909]	[3.145]	[2.906]
Observations	2,834	2,988	2,673	2,519
R-squared	0.204	0.200	0.195	0.180
Outcome mean above FSAG cut-off	18.27	19.32	17.83	17.95
Panel B: HS Trig+ Sample				
Eligible for FSAG	7.259**	-1.536	-2.546	3.093
	[3.533]	[3.523]	[3.971]	[3.884]
EFC (centered at FSAG cut-off)	4.389	-6.784	4.168	4.266
	[4.379]	[4.536]	[5.096]	[4.935]
FSAG x EFC	0.153	6.456	-10.176	0.895
	[5.708]	[6.829]	[6.508]	[6.794]
Observations	1,283	1,355	1,232	1,121
R-squared	0.310	0.288	0.321	0.363
Outcome mean above FSAG cut-off	20.98	22.56	22.03	22.40

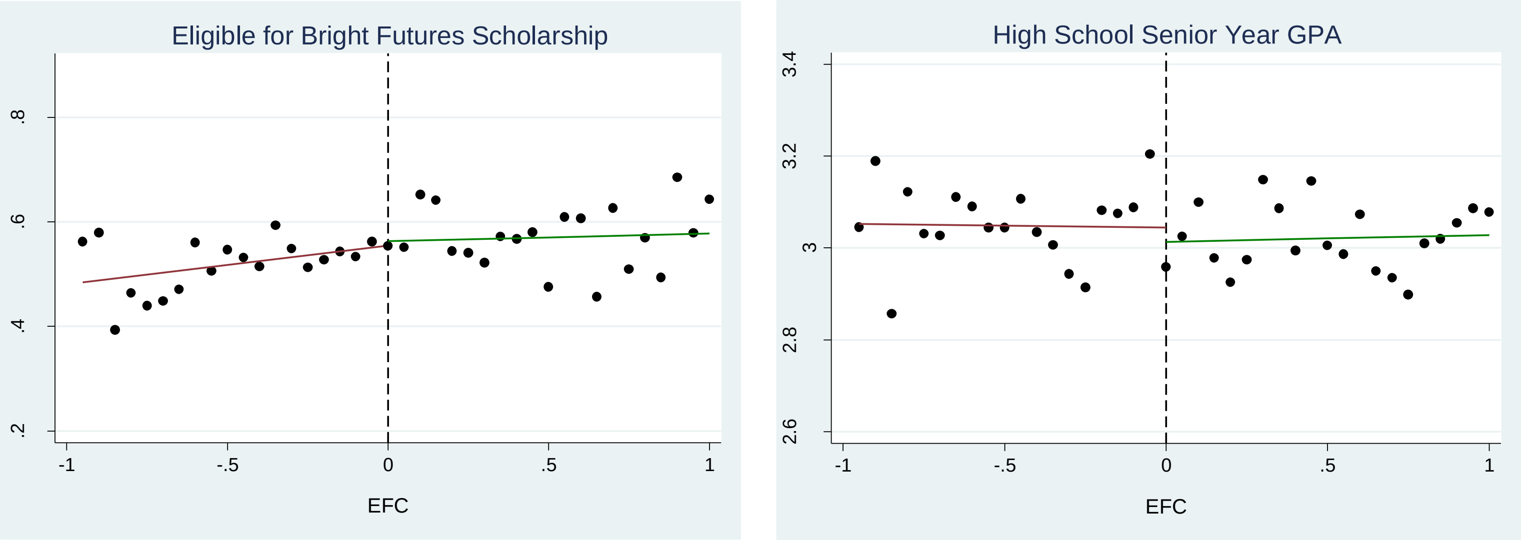
*** p<0.01 ** p<0.05 * p<0.10

Notes: Robust standard errors, clustered at the high school level, are shown in brackets. All results are from multiple imputation OLS specifications estimated with an EFC window +/- $1,000 around the FSAG cut-off and include the following covariates: race dummy variables (Black, Hispanic, and Other race/ethnicity); female dummy variable; high school senior year GPA (weighted 4.5 scale); SAT math and verbal scores (imputed where missing); whether the student was in a gifted and talented program; parental adjusted gross income; student age, and whether the student was eligible for the Florida Bright Futures Scholarship. All models also include school fixed effects and a constant.

APPENDIX

Figure A1: Bivariate relationship between the forcing variable and selected covariates, with locally linear regressions fit on either side of the cut-off

A. College Math Sample



B. HS Trig+ Sample

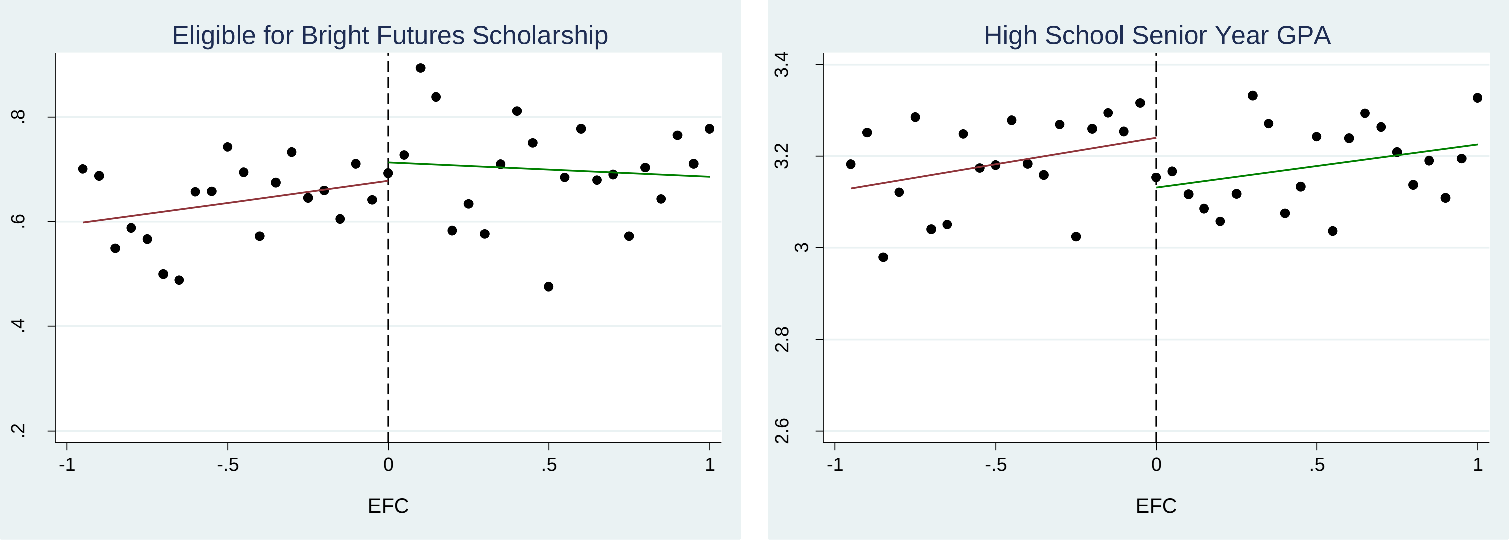


Table A1: CPT and SAT Math Scores by Highest Math Course Completed in High School

	(1)	(2)	(3)	(4)
	All public Florida high school seniors		EFCs ±$1,000 of FSAG eligibility cut-off	
	CPT	SAT	CPT	SAT
Algebra 1	41.87	452.20	42.40	442.00
	(19.08)	(95.66)	(18.92)	(100.46)
	[1,387]	[199]	[140]	[25]
Geometry	47.13	457.44	47.62	445.83
	(20.51)	(71.94)	(20.24)	(70.60)
	[4,582]	[3,592]	[436]	[391]
Algebra 2	59.15	459.32	58.86	432.39
	(22.04)	(93.99)	(21.62)	(86.64)
	[4,788]	[1,464]	[426]	[155]
Trigonometry	80.87	546.17	78.85	524.90
	(22.71)	(72.81)	(24.50)	(75.85)
	[1,411]	[2,574]	[143]	[255]
Pre-Calculus	85.01	530.85	88.92	525.56
	(22.67)	(71.43)	(21.23)	(77.52)
	[1,170]	[2,792]	[111]	[239]

Notes: Means are shown with standard deviations in parentheses and the number of observations in brackets.

Table A2: STEM Credits Attempted Second Semester by First Semester GPA, among BFS Scholarship Recipients

	(1)	(2)	(3)	(4)	(5)	(6)
Below BF GPA Renewal Threshold	-0.290***	0.318**	0.371**	0.334*	0.410*	1.053***
	[0.076]	[0.145]	[0.157]	[0.178]	[0.229]	[0.336]
First Semester GPA (centered at BF renewal cut-off)		0.652***	0.303**	-0.053	-0.008	0.358
		[0.152]	[0.153]	[0.254]	[0.432]	[1.021]
Below BF GPA Renewal Threshold x GPA		-0.100	0.343	1.024**	1.312*	5.671***
		[0.243]	[0.263]	[0.407]	[0.724]	[1.873]
Additional Covariates			✓	✓	✓	✓
School Fixed Effects			✓	✓	✓	✓
GPA Window (1.00 = optimal)	1.00	1.00	1.00	0.75	0.50	0.25
Observations	9,000	9,000	8,225	6,307	4,288	2,421
R-squared	0.002	0.005	0.135	0.139	0.162	0.230
Outcome mean above GPA renewal cut-off	3.74	3.74	3.74	3.68	3.78	3.78

*** p<0.01 ** p<0.05 * p<0.10

Notes: Robust standard errors, clustered at the high school level, are shown in brackets. All results are estimates from multiple imputation OLS specifications that include a constant. Columns 3 through 6 also include school fixed effects and the following covariates: race dummy variables (Black, Hispanic, and Other race/ethnicity); female dummy variable; high school senior year GPA (weighted 4.5 scale); SAT math and verbal scores (imputed where missing); whether the student was in a gifted and talented program; parental adjusted gross income; and student age.

Table A3: The Effect of FSAG Eligibility on Cumulative STEM Credits and BA/BS Degrees Earned in STEM Fields, among Florida High School Graduates Not Academically Prepared for Postsecondary Study in STEM fields (N = 3,769)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Through Year 1		Through Year 3		Through Year 7		
	STEM Credits Attempted	STEM Credits Completed	STEM Credits Attempted	STEM Credits Completed	STEM Credits Attempted	STEM Credits Completed	BA/BS Degree in STEM
Eligible for FSAG	0.377*	0.318*	0.93	0.684	1.01	0.558	-0.001
	[0.221]	[0.184]	[0.645]	[0.501]	[1.095]	[0.814]	[0.004]
EFC (centered at FSAG cut-off)	-0.063	0.13	-0.047	0.155	0.379	0.472	0.004
	[0.268]	[0.222]	[0.844]	[0.648]	[1.393]	[1.011]	[0.005]
FSAG x EFC	0.867**	0.394	1.471	1.015	0.471	0.208	-0.01
	[0.342]	[0.289]	[1.092]	[0.874]	[1.737]	[1.315]	[0.007]
R-squared	0.181	0.183	0.158	0.164	0.138	0.147	0.151
Outcome mean above FSAG cut-off	1.47	0.95	5.41	3.64	8.85	6.05	0.003

Notes: Robust standard errors, clustered at the high school level, are shown in brackets. All results are from OLS/LPM specifications estimated with an EFC window +/- $1,000 around the FSAG cut-off and include the following covariates: race dummy variables (Black, Hispanic, and Other race/ethnicity); female dummy variable; high school senior year GPA (weighted 4.5 scale); whether the student was in a gifted and talented program; parental adjusted gross income; student age, and whether the student was eligible for the Florida Bright Futures Scholarship. All models also include high school fixed effects and a constant.

Table A4: The Effect of FSAG Eligibility on Cumulative STEM Credits and BA/BS Degrees Earned in STEM Fields, excluding student-level academic and demographic covariates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Through Year 1		Through Year 3		Through Year 7		
	STEM Credits Attempted	STEM Credits Completed	STEM Credits Attempted	STEM Credits Completed	STEM Credits Attempted	STEM Credits Completed	BA/BS Degree in STEM
Panel A: College Math Sample (N = 2,834)							
Eligible for FSAG	0.633	0.756**	2.300*	2.653***	3.142	3.982**	0.027*
	[0.429]	[0.384]	[1.200]	[1.025]	[1.936]	[1.663]	[0.014]
EFC (centered at FSAG cut-off)	0.528	0.371	1.616	1.336	0.954	1.04	0.019
	[0.510]	[0.450]	[1.430]	[1.200]	[2.279]	[1.883]	[0.018]
FSAG x EFC	-0.169	0.251	-0.342	0.838	1.947	3.356	0.013
	[0.633]	[0.600]	[1.806]	[1.644]	[2.994]	[2.588]	[0.024]
R-squared	0.001	0.002	0.001	0.002	0.001	0.003	0.002
Outcome mean above FSAG cut-off	5.63	4.31	15.99	12.41	23.55	18.27	0.043
Panel B: HS Trig+ Sample (N =1,283)							
Eligible for FSAG	1.649**	1.856***	4.542**	5.388***	7.250**	8.853***	0.047*
	[0.715]	[0.638]	[2.006]	[1.749]	[3.166]	[2.748]	[0.025]
EFC (centered at FSAG cut-off)	1.665*	1.614**	5.281**	5.520***	5.711	6.609**	0.070**
	[0.869]	[0.763]	[2.405]	[2.119]	[3.652]	[3.195]	[0.033]
FSAG x EFC	-0.185	0.136	-2.522	-1.912	0.601	0.928	-0.059
	[1.096]	[1.035]	[3.118]	[2.876]	[5.071]	[4.414]	[0.042]
R-squared	0.006	0.008	0.005	0.008	0.004	0.008	0.004
Outcome mean above FSAG cut-off	6.51	5.28	18.06	14.44	26.47	20.98	0.059

Notes: Robust standard errors, clustered at the high school level, are shown in brackets. All results are estimates from OLS specifications that include a constant.

Table A5: The Effect of FSAG Eligibility on non-STEM College Outcomes

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Through Year 1		Through Year 3		Through Year 7		
	Non-STEM Credits Attempted	Non-STEM Credits Completed	Non-STEM Credits Attempted	Non-STEM Credits Completed	Non-STEM Credits Attempted	Non-STEM Credits Completed	BA/BS Degree in Non-STEM Field
Panel A: College Math Sample (N = 2,834)							
Eligible for FSAG	0.216	0.445	0.295	0.692	-2.021	-0.602	0.051
	[0.796]	[0.764]	[2.333]	[2.299]	[3.885]	[3.656]	[0.042]
EFC (centered at FSAG cut-off)	0.472	0.354	-1.271	-1.749	-5.038	-4.075	0.02
	[0.976]	[0.895]	[2.801]	[2.747]	[4.683]	[4.418]	[0.051]
FSAG x EFC	0.419	0.802	3.45	4.11	7.421	7.133	0.033
	[1.288]	[1.171]	[3.789]	[3.640]	[6.109]	[5.810]	[0.066]
R-squared	0.169	0.207	0.182	0.213	0.176	0.206	0.214
Outcome mean above FSAG cut-off	13.29	11.19	42.32	36.06	72.09	61.95	0.367
Panel B: HS Trig+ Sample (N =1,283)							
Eligible for FSAG	-0.852	0.088	-1.961	-0.083	-5.988	-2.459	0.007
	[1.188]	[1.186]	[3.972]	[3.659]	[7.077]	[6.178]	[0.068]
EFC (centered at FSAG cut-off)	-0.259	0.492	-0.362	0.829	-5.144	-1.71	0.014
	[1.551]	[1.485]	[4.954]	[4.603]	[8.108]	[7.272]	[0.084]
FSAG x EFC	0.97	0.454	4.673	3.607	12.177	9.392	0.032
	[2.180]	[2.026]	[7.214]	[6.720]	[11.977]	[11.131]	[0.121]
R-squared	0.290	0.290	0.305	0.318	0.296	0.307	0.278
Outcome mean above FSAG cut-off	12.95	11.22	43.24	37.64	74.57	65.05	0.433

Notes: Robust standard errors, clustered at the high school level, are shown in brackets. All results are from multiple imputation OLS/LPM specifications estimated with an EFC window +/- $1,000 around the FSAG cut-off and include the following covariates: race dummy variables (Black, Hispanic, and Other race/ethnicity); female dummy variable; high school senior year GPA (weighted 4.5 scale); SAT math and verbal scores (imputed where missing); whether the student was in a gifted and talented program; parental adjusted gross income; student age, and whether the student was eligible for the Florida Bright Futures Scholarship. All models also include high school fixed effects and a constant.