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Looking Beyond Enrollment

The Causal Effect of Need-Based Grants on College Access, Persistence, and Graduation

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Abstract

Gaps in average college success among students of differing backgrounds have persisted in the United States for decades. One of the primary ways governments have attempted to ameliorate such gaps is by providing need-based grants, but little evidence exists on the impacts of such aid on longer term outcomes such as college persistence and degree completion. We examine the effects of the Florida Student Access Grant (FSAG) using a regression-discontinuity strategy and exploiting the cutoff used to determine eligibility. Grant eligibility had a positive effect on college attendance at public four-year institutions. Eligibility for the FSAG also increased early persistence and the cumulative number of college-level credits students earned in their first four years. Most importantly, FSAG receipt increased the likelihood of bachelor's degree receipt within six years at a public college or university by 4.6 percentage points—a 22 percent increase among students near the eligibility cutoff. The results are robust to sensitivity analyses.

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1. Introduction

Despite large increases in higher education enrollment over the past several decades, the college attendance rates of youth from low-income families continue to lag behind those of their middle- and upper-income peers. Among students who graduated high school in 2008, for instance, 55 percent of students in the lowest income quintile enrolled in college within twelve months of high school graduation, compared with 80 percent of students in the highest income quintile (Baum, Ma, & Payea, 2010). Even after controlling for academic achievement, low-income students have a lower probability of enrollment than do more affluent students (Ellwood & Kane, 2000). Gaps in college degree attainment by socioeconomic status are even more pronounced. Among the high school graduating class of 1992, only 7 percent of students from families in the lowest socioeconomic quartile completed a baccalaureate degree by age 26, compared with 51 percent of students from families in the highest socioeconomic quartile (Haveman & Smeeding, 2006).

One explanation for these persistent gaps is the lack of college affordability for low-income students. Since the 1970s, the cost of college has risen at a much faster rate than have median family wages—meaning that tuition as a share of family income has increased steadily (Advisory Committee on Student Financial Assistance, 2010). To address this problem, federal and state governments have offered need-based financial grants to mitigate the effect of rising college costs on the postsecondary decisions of students from low-income families. The largest of these grants (both in terms of the total number of awards and total dollars awarded) is the Federal Pell Grant, a need-based grant awarded to low- and moderate-income students pursuing a college education at an accredited institution.

A key policy question is whether need-based grants lead to improvements in students' college outcomes. To date, there has been considerable research examining the effect of need-based grants on college access. For instance, there is robust evidence that need-based grant eligibility can have a strong, positive effect on whether students enroll in college, with the average estimated probability of enrollment increasing by 3 to 4 percentage points for each additional $1,000 in grant aid eligibility (Deming & Dynarski, 2009). Meanwhile, the literature is scant on the causal impact of aid on longer term college outcomes. Several recent studies have examined the long-term effects of merit-based scholarships (grants awarded on the basis of academic achievement) (Dynarksi, 2008; Scott-Clayton, 2011). Surprisingly little research examines the effect of need-based grants on whether students persist and ultimately complete a college degree. Evidence from a study by Bettinger, Long, Oreopoulos, and Sabonmatsu (2012) suggests that helping students apply for federal aid such as the Pell Grant does help support college persistence within three years. In addition, an early evaluation of a private, need-based aid program in Wisconsin found that aid can improve student retention into the second year of college (Goldrick-Rab, Harris, Kelchen, & Benson, 2012). However, much more needs to be understood about need-based assistance, given that it accounts for the considerable majority of all grant aid awarded by the federal and state governments. As of the 2010–11 academic year, federal need-based grants amounted to $38.4 billion and roughly two thirds of state spending on grant aid (College Board, 2012; NASSGAP, 2011). During the 2009–10 academic year, state need-based awards totaled $7 billion (College Board, 2012).

In this paper, we investigate the effects of need-based grant eligibility on college attainment. Specifically, we focus on the impact of eligibility for the need-based Florida Student Access Grant (FSAG) on whether students enter, remain enrolled in, and graduate from college. Thus, we contribute to the literature by focusing on the longer term effects of need-based financial aid. In the early 2000s, colleges and universities in Florida determined eligibility for the FSAG using the federal need analysis calculation.[1] During the 2000–01 school year, students whose Expected Family Contribution (EFC) was less than $1,590 were eligible for a $1,300 FSAG award (2000 constant dollars); this roughly translates to families with incomes below $30,000 that year ($40,300 in 2011 dollars) being eligible for the FSAG. The state grant was sufficient to cover 57 percent of the average cost of tuition and fees at a public, four-year university in Florida (IPEDS, 2011). Students eligible for the FSAG 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 or less need-based grant aid, we utilize a regression-discontinuity (RD) approach to estimate the causal effect of FSAG eligibility on a range of college outcomes.

Our study contributes to the scant literature on the effects of financial aid, and particularly need-based aid, on college persistence and degree completion. Moreover, because we are investigating the effects of a grant that can be combined with other need-based aid (i.e., the Pell Grant), our results relate to current debates about whether to increase the size of aid awards; in other words, our analysis illuminates the marginal effects of changing current aid policy rather than the effects of some aid versus no aid. Most notably, there are continual questions about whether increasing the size of the Pell Grant would have an effect on college outcomes, and our results provide some insight into this issue. We also investigate how need-based aid interacts with merit-based aid.

[1] 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 contribute toward higher education expenses. Other information that affects this calculation is the size of the family, the number of family members in college, and the age of the oldest parent, as well as information on the student's earnings and assets. 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.

Previewing our results, we find that FSAG eligibility had a positive impact on several short-, medium-, and long-term college outcomes. The additional $1,300 in grant aid eligibility (in 2000 dollars) increased students' probability of immediate enrollment at a public, four-year university by 3.2 percentage points while also increasing their probability of staying continuously enrolled through the spring semester of their freshman year by 4.3 percentage points; no effect was found in terms of enrollment at a private, four-year college. Most importantly, an additional $1,300 in aid eligibility increased students' probability of earning a bachelor's degree within six years by 4.6 percentage points, or 22 percent. FSAG receipt had a particularly pronounced impact on students with higher grade point averages (GPAs) in their high school senior year, including both those who qualified for the state merit-based scholarship, Bright Futures, and those who did not but still had moderately high academic achievement.

In the next section of this paper, we review the existing literature on college access and success pertinent to our examination of need-based grants. In section 3, we describe our research design. Section 4 presents our results of the causal effects of need-based grants on college access, persistence, and graduation. Finally, in section 5, we discuss the implications of the results for policy and research.

2. Literature Review

The Impact of Aid on College Enrollment

Economic theory predicts that financial aid may influence the college-going decisions of low-income students. In his model of human capital investments, Becker (1964) suggests that students will pursue a college education if the perceived present discounted value of the benefits of higher education exceeds the present discounted value of the costs of going to college. Thus, by reducing the cost of going to college, financial aid may lower the real or perceived cost of attendance to the point where students on the margin of enrolling decide to matriculate.

The findings from the empirical literature are largely consistent with this prediction. Researchers have consistently found positive effects on college enrollment for grant programs that have transparent eligibility criteria and straightforward application processes (Deming & Dynarski, 2009). In an examination of the Social Security Student Benefit Program, which awarded substantial grants to the children of deceased, disabled, or retired Social Security beneficiaries until 1982, Dynarski (2003) found that a $1,000 reduction in grant aid eligibility led to a 4 percentage point reduction in college enrollment. Kane (2003, 2004) found effects of a similar magnitude associated with eligibility for the Cal Grant, which provided grants for students to attend four-year colleges in California, and the DC Tuition Assistance Grant, which allowed residents of the District of Columbia to pay in-state tuition rates at public universities across the country. Dynarski (2000, 2004) found even larger effects (4 to 6 percentage points) for programs that were highly publicized and had clear, transparent rules determining the amount of aid for which students were eligible.

The Impact of Aid on Persistence and Degree Completion

Although theory and the research literature suggest that financial aid can positively impact initial college enrollment, economic theory is more ambiguous about the effect of financial aid on whether students *succeed* in college. Aid may have an indirect positive effect on academic success for students who have already committed to enrolling—for example, by reducing the amount of time that students need to work once they are enrolled. Alternatively, aid may have no effect on college performance, or it may have a negative effect if the offer of grant aid induces students with a low probability of academic success to enroll by artificially lowering the financial costs they incur for their educations.

Recent studies have examined the impact of state merit-based scholarship programs on students' longer term success in college. Dynarski (2008) found that the introduction of state merit scholarships in Arkansas and Georgia led to increases in the share of the population in each state with college degrees within 10 years. Scott-Clayton (2011) found that students who were just above the cutoff in the ACT exam score that determined whether students were eligible for the West Virginia PROMISE scholarship were 6.7 and 4.5 percentage points more likely to earn a bachelor's degree within four or five years, respectively, than students just below the eligibility threshold.

An open question is whether the results of these studies of merit-based scholarship programs generalize to the impact of need-based grants on students' college attainment. Merit-based scholarships and need-based grants generally target different populations of students. For instance, in Florida, of students who qualified for the merit-based Bright Futures Scholarship in 2000, 78 percent were White, and only 9 percent qualified for free or reduced lunch. In contrast, of students who qualified for the need-based FSAG, only 32 percent were White, and 40 percent qualified for free or reduced lunch.

Few studies have investigated the effect of need-based grants on whether students persist in and complete college. The relative paucity of research on the long-term impacts of need-based grants can be attributed to three intertwined challenges.[2] First, until recently, little longitudinal data has been available to track students' success in college after their initial enrollment. Second, because aid is not awarded randomly, it is methodologically difficult to isolate the effect of grant eligibility from all of the other factors that influence whether students succeed in college. Without a source of exogenous variation in whether students are eligible for a grant, estimates of the effect of grant eligibility on degree attainment could be biased in either direction. Students who receive need-based aid may be more likely to succeed in college because they were motivated enough to seek out additional financial resources and complete the necessary application forms. This would lead to an overestimate of the effect of need-based aid eligibility on college attainment. Alternatively, student aid recipients could be less likely to earn a degree if need-based aid eligibility is correlated with factors that are traditionally barriers to degree attainment (e.g., lower levels of academic preparation). This in turn would lead researchers and policymakers to underestimate the effect of need-based aid eligibility on college attainment.

The final challenge in evaluating the impact of grant aid on student outcomes is that aid eligibility itself may affect enrollment in college, a necessary precursor to a college credential. To illustrate this point, suppose for a moment that eligibility for a need-based grant were random, so that eligible and non-eligible students would be equal in expectation at the time they are notified of whether they receive the grant. Differences in enrollment rates between the two groups could then be attributed to the unique effect of grant eligibility, and it is quite likely that the subset of grant-eligible students who enrolled in college would differ substantively in non-

[2] Although recent studies documenting the impact of merit-based aid on degree attainment have overcome these challenges, we are not aware of a study investigating the long-term impacts of need-based grant aid that has managed to do so.

random and meaningful ways from the subset of non-recipients who enrolled in college. Because only a subset of each group would choose to enroll in college, and thus have the possibility of completing a college degree, if one were just to compare the enrollees of each group when trying to establish the effect of aid on persistence, then one would violate the equal-in-expectation assumption on which causal inference rests. To address this concern, researchers have focused on intent-to-treat (ITT) estimates of the effect of financial aid. In contrast to treatment-on-the-treated (TOT) effects, which include only students who actually received aid, ITT estimates include all students in the analysis, regardless of whether they enrolled and received the aid or not (i.e., all high school seniors). The advantage of this approach is that it avoids the endogeneity problems associated with conditioning the analysis on whether students enrolled in college. On the other hand, the set of research questions one can investigate using ITT estimates is different from the set of research questions that can be investigated using TOT estimates. For instance, using ITT estimates permits researchers to examine whether aid-*eligible* high-school seniors received a college degree by a certain year. Because only eligibility can be regulated by a policy, the ITT analysis yields a true estimate of the effect of the aid policy rather than the effect of the aid itself. Although this methodological concern is particularly relevant for understanding the effects of aid on college degree completion, researchers who examine the impact of aid on initial college enrollment also often focus on ITT estimates so that they can determine the effect of an aid *policy*, realizing that some students who are eligible for aid may not actually receive it.

A number of researchers have overcome the latter two challenges by identifying a source of quasi-random variation in why some students qualified for need-based aid and others did not. Some studies have focused only on the effect of need-based aid on college enrollment (e.g., Hansen, 1983; Kane, 1995, 2003), whereas others have relied on data sources that provided coarse measures of students' educational attainment (e.g., Dynarski, 2003). Few studies, however, have examined the impact of need-based aid on detailed measures of students' progress through and completion of college. One exception, Bettinger (2004), exploited variation in the size of students' Pell Grant awards, based on changes in the eligibility formula over time and differences in family size, to investigate the effect of increases in Pell Grant eligibility on whether students stopped out of college. Although Bettinger found suggestive evidence that the Pell Grant had a positive impact on college persistence (i.e., reduced students' likelihood of stopping out), the results were sensitive to model specification and did not include longer term student outcomes such as degree attainment.

Extending the Literature: Financial Aid in Florida

This paper focuses on the following research question: Does eligibility for additional need-based grant funding (above the Federal Pell Grant) increase the probability that a student will enroll in college, stay continuously enrolled, accumulate credits, and ultimately earn a degree? By focusing on this question, we aim to build on prior research in two concrete ways. First, we avoid the potential biases evident in some previous studies by exploiting a cutoff score in the index used to measure a family's ability to pay for college as a source of exogenous variation in student eligibility for a need-based grant in Florida. The actual cutoff received very little publicity, and the index was computed based on a complicated algorithm that would be very difficult for families to replicate even if they were aware of the eligibility formula. Therefore, the cutoff provides a source of variation in aid eligibility that approaches randomization and can be used to estimate causal effects. Second, by drawing on state administrative data, we are able to examine the effect of need-based grant eligibility on outcomes (longer term persistence, credit completion, and degree attainment) that have not been rigorously examined in prior studies of the causal effects of need-based aid.

To investigate our research question, we focus on Florida high school seniors in the 2000–01 school year. Florida offers many advantages as the geographic focus for our analysis. It is the fourth largest state in the country (U.S. Census Bureau, 2011). Fourteen of the 100 largest school districts in the 2008–09 academic year were located in Florida (Sable, Plotts, & Mitchell, 2010). 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, 2010).

Specific to the context of financial aid, in addition to federal grants and loans, Florida students could qualify for both need- and merit-based state grants. Each year, families must complete the Free Application for Federal Student Aid (FAFSA), which asks for information on family income, assets, and size. Using this information, the U.S. Department of Education estimates the families' ability to pay for college, which is called the Estimated Family Contribution (EFC). The department uses the EFC, along with the cost of attendance at students' intended institutions, to determine each student's eligibility for federal financial aid, such as the Pell Grant. States also use the EFC to award need-based grants; during the 2009–10 academic year, state need-based awards totaled $6.2 billion (Baum, Payea, & Cardenas-Elliot, 2010). To apply for the need-based FSAG, students needed to complete the FAFSA by March 1 of their senior year in high school. Each year, the Florida Department of Education sets a "maximum expected family contribution," which during the 2000–01 academic year (the focal year of this analysis) was $1,590 (Florida Postsecondary Education Planning Commission, 2001). Institutions were prohibited from awarding need-based grants to students whose EFCs exceeded this maximum (Florida Public Student Assistance Grant Program, 2000), thus making this a sharp eligibility cutoff. 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 amount 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). Students who also received a Federal Pell Grant—for which all students around the FSAG cutoff were eligible—could receive up to $3,050 in need-based grants. The FSAG was also renewable during subsequent years for students who remained financially eligible and maintained a cumulative college GPA of 2.0 or higher.[3]

In addition to the FSAG, Florida students were eligible for the merit-based Bright Futures Scholarship, which had (and still has) two tiers. The lower tier, the Florida Medallion Scholars award, covered 75 percent of the cost of tuition and fees at public colleges and universities (or the monetary equivalent at in-state private institutions) for students who completed 15 core academic credits, had a cumulative weighted high school GPA of 3.0 or higher, and had a composite SAT score of 970 or higher out of 1600 (or a composite ACT exam of 20 or higher). During the 2000–01 school year, this amounted to about $1,700. Seventy percent of students who received a Bright Futures Scholarship award in 2000–01 received a Florida Medallion Scholars award.[4] The higher tier, the Florida Academic Scholars award, covered 100 percent of the cost of tuition and fees at public colleges and universities (or the monetary equivalent at in-state private institutions) along with a small living stipend. During the 2000–01 school year, this amounted to about $2,500. The Florida Academic Scholars award was offered to students who completed 15 core academic credits, had a cumulative weighted 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). In our sample, about 30 percent of students were eligible for Bright Futures. This proportion does not vary around the cutoff for the FSAG—which is important to our research methodology. We control for Bright Futures eligibility in our analysis to account for these other possible sources of aid.[5]

The FSAG award does not appear to have crowded out other forms of federal, state, or institutional grant aid. Controlling for Bright Futures and Pell Grant assistance, students just

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[3] There is no limit on the number of years for which students can renew the FSAG award.

[4] In the 2000–01 year, the Florida Medallion Scholars award was referred to as the Florida Merit Scholars award.

[5] In a separate study, we exploit the interplay of the FSAG and Bright Futures eligibility rules as the source of identification to estimate the causal effect of eligibility for a need- and/or merit-based grant on students' college outcomes. The two studies use entirely different student samples. In our other work, we condition our analysis on students who have both a non-missing EFC and the academic criteria that determine eligibility for the Bright Futures Scholarship. In this paper, we condition the analysis only on students who have a non-missing EFC. This allows us to draw inferences about the effect of FSAG eligibility on a larger group of low-income high-school seniors on either side of the EFC cutoff; the Bright Futures Scholarship targets a much smaller subset of academically accomplished students.

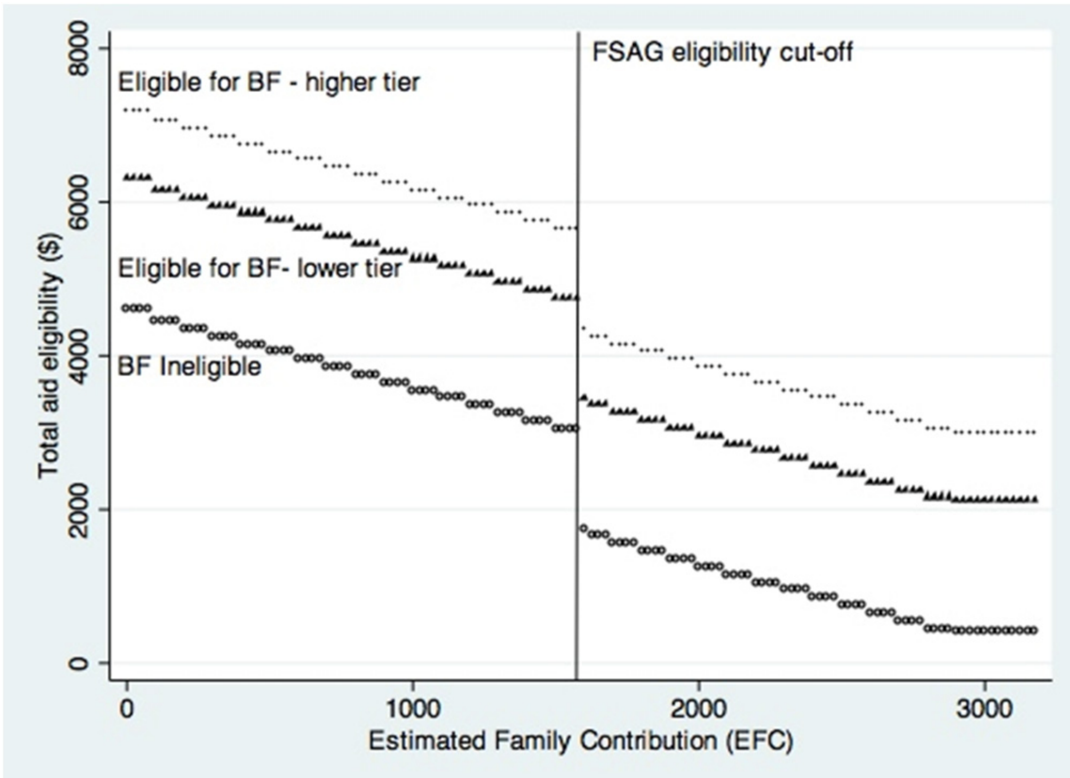
below the FSAG cutoff received approximately $550 more in total grant aid than students just above the cutoff during the 2000–01 academic year.[6]

Figure 1 focuses on the area around the cutoff for FSAG eligibility and summarizes how the total grant aid for which students were eligible varied based on very small differences in family resources. Students ineligible for the Bright Futures Scholarship were eligible to receive $3,050 in total FSAG and Pell Grant funding if their EFC was less than $1,590, or only $1,750 in Pell Grants if their EFC was above $1,590. For students who met the criteria for Bright Futures eligibility, being above or below the FSAG cutoff resulted in the same difference in aid, but the levels of grant aid were higher. Students who were eligible for the lower tier of Bright Futures and who were just below the FSAG cutoff qualified for $4,750 in total Bright Futures, FSAG, and Pell Grant funding, and students who were eligible for the lower tier of Bright Futures and were just above the FSAG cutoff qualified for $3,450 in Bright Futures and Pell Grant funding (a difference of $1,300). Students who were eligible for the higher tier of Bright Futures and who were just below the FSAG cutoff qualified for $5,650 in total Bright Futures, FSAG, and Pell Grant funding, whereas students who were eligible for the higher tier of Bright Futures and were just above the eligibility threshold qualified for $4,350 in Bright Futures and Pell Grant funding (a difference of $1,300). In our analyses, we examine the impact of being just below the FSAG eligibility cutoff on students' college outcomes, holding constant Bright Futures eligibility.

[6] Results available upon request. These comparisons additionally control for demographic and academic student characteristics as well as high school fixed effects.

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).

3. Data and Research Design

Data

The data for this paper are from the Florida Department of Education K-20 Data Warehouse, which maintains longitudinal student-level records from primary school through postsecondary study at Florida public colleges and universities. We have data from the K-20 Data Warehouse secondary-school records, including demographics, high school transcript records, and college entrance examination scores. These data are linked to the K-20 Data Warehouse postsecondary data, so we also have the financial information that families supplied while completing the FAFSA and information on any private, institutional, state, or federal financial-aid disbursements students received while enrolled. The postsecondary data also include students' enrollment and course-taking histories, major(s) pursued, and degrees received.

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. During the same year, 74 percent of first-time freshmen attending college in Florida enrolled in public institutions (Snyder & Hoffman, 2003). 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. In addition to the K-20 Data Warehouse postsecondary data, we have data on the enrollment of Florida high school graduates at private, four-year colleges and universities within the state due to the Florida Resident Assistance Grant, a non-need-based tuition-assistance grant of $2,800 designed to offset the cost of tuition at private institutions. Students attending in-state private colleges full-time automatically received the grant, so it is a good indicator of private, in-state enrollment.[7]

For this analysis, our full sample contains students who were seniors in Florida public high schools during the 1999–2000 academic year. From these 101,094 students, we restrict our analytic sample to include only students who submitted a FAFSA application because this is a necessary step for receiving government and most institutional financial aid. High school seniors who did not submit the FAFSA likely differ on a number of dimensions from the students who did. For instance, they may not be intent upon enrolling in college or may not know about the FAFSA or aid application process—two issues more common among low-income students. Alternatively, students who do not complete the FAFSA may come from

[7] Booker, Sass, Gill, and Zimmer (2008) also used information on the Florida Resident Assistance Grant in their examination of the impact of charter school attendance on college-going in Florida.

wealthy families and assume that they are therefore not eligible for need-based aid. Thus, we are likely excluding students from both the bottom and top tails of the income distribution. This restriction resulted in the exclusion of 55,309 students from our sample.[8] We discuss the implications of this sample restriction to the external validity of our results in section 5.

In Table 1, we present selected descriptive statistics for the full sample of public high school students in Florida (column 1) and compare them with the sample after we impose our FAFSA-submission restriction (column 2). The restricted sample has a higher proportion of female students than the full sample (59 versus 53 percent, respectively) and has a greater percentage of Black and Hispanic students (45 percent, compared with 35 percent in the full sample). On the other hand, students in the full sample have very similar high school senior year mean GPAs (2.84) to students in the restricted sample (2.87).

Column 3 displays the sample used in the analysis: students who fall within a narrow window of the EFC cutoff for FSAG eligibility (±$1,000) and for whom we have complete information.[9] When we focus on a narrow window around the EFC cutoff for FSAG eligibility, we see additional differences in the sample. Unsurprisingly, given our focus on a need-based aid program, the sample used for the analysis has lower parental incomes on average ($28,035, compared with $43,680 for the FAFSA sample). The sample for the analysis also has a somewhat higher proportion of Black and Hispanic students (51 percent). However, there appears to be little difference in high school academic performance across the samples. The mean senior year GPA for the analytic sample differs only by 0.04 from the mean senior year GPA for the full census of public high school seniors during 1999–2000.

[8] We also exclude an additional 58 students for whom we lack basic demographic information.

[9] As discussed below, ±$1,000 is the optimal bandwidth for this analysis based on Imbens and Kalyanaraman's (2009) method for bandwidth selection. Although optimal bandwidths vary for each outcome, the bandwidth of ±$1,000 is common across several outcomes, and bandwidths for other outcomes are as wide or wider.

Table 1

Summary of Student Characteristics for Full, Restricted, and Analytic Samples

Characteristic	Full Sample (1)	Restricted Sample (2)	Analytic Sample (3)
Female	0.53	0.59	0.60
White	0.62	0.51	0.45
Black	0.20	0.27	0.30
Hispanic	0.15	0.18	0.21
Other race	0.04	0.04	0.04
Age at expected high school graduation	17.92	17.88	17.88
	(0.57)	(0.55)	(0.54)
	[99,067]	[44,865]	
EFC	$6,889	$6,894	$1,541
	($12,128)	($12,132)	($570)
	[45,785]		
Parents' adjusted gross income	$43,662	$43,680	$28,035
	($41,607)	($41,634)	($9,926)
	[43,784]	[42,933]	
Student's adjusted gross income	$3,497	$3,433	$2,784
	($13,663)	($13,051)	($2,523)
	[34,227]	[33,508]	[5,101]
High school senior year GPA	2.84	2.87	2.80
(weighted 4.5 scale)	(0.75)	(0.69)	(0.68)
	[57,021]	[41,316]	
Observations	101,094	45,727	6,917

SOURCE: Florida Department of Education K-20 Data Warehouse.

NOTES: Means are shown with standard deviations in parentheses and the number of observations in brackets if it is less than the full sample. Full sample includes all seniors in public Florida high schools in 1999–2000. Restricted sample includes students who completed the FAFSA. Analytic sample includes students whose EFC values fell within $1,000 of the cutoff for FSAG eligibility and had non-missing values for all variables except student's adjusted gross income.

Empirical Strategy

We use a regression-discontinuity (RD) approach to estimate the causal effect of FSAG eligibility on whether students enter college, accumulate credits, remain continuously enrolled, and complete college. Under this approach, we estimate and compare the probability of each college outcome for students just below and just above the FSAG cutoff. The RD design allows us to infer the effects of eligibility for the FSAG grant for students who are on the margin of grant eligibility (Murnane & Willett, 2010; Shadish, Cook, & Campbell, 2002). We focus on

ITT estimates and employ a "sharp" RD design (Imbens & Lemieux, 2008). This means that we can directly interpret a jump in the probability of entering, remaining continuously enrolled in, or completing college at the FSAG cutoff as the causal effect of FSAG eligibility. The results of our analysis are relevant to marginal students around the cutoff but not necessarily inframarginal students far from the threshold.

To estimate the causal effect of FSAG eligibility on college entry and attainment, we fit the following statistical model:

$$COLLEGE_{ij} = \beta_0 + \beta_1 EFC_{ij} + \beta_2 FSAG_{ij} + \beta_3 FSAG_{ij} \times EFC_{ij} + \gamma ACAD'_{ij} + \delta DEMOG_{ij}' + \rho SCHOOL'_{ij} + \varepsilon_{ij} \quad (1)$$

where *COLLEGE* is one of several outcomes of interest corresponding to college entry, persistence, and success for student i attending high school j as a senior. *EFC* measures students' Estimated Family Contribution to college and is centered at the FSAG cutoff. *FSAG* is an indicator variable that takes on the value of 1 if students are below the FSAG cutoff and zero otherwise. The interaction of FSAG eligibility and EFC, captured by *FSAG × EFC*, allows the slope of the relationship between EFC and each outcome to vary on either side of the FSAG eligibility cutoff. *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 students' educational attainment. ε_{ij} is a residual error term. We cluster errors 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 cutoff on the probability that students will enter and/or succeed 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; 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, disability status, and age at expected high school graduation. We also include a dummy 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 students' observed college outcomes.[10]

Using Imbens and Kalyanaraman's (2009) method for bandwidth selection, we determine a separate optimal bandwidth around the EFC cutoff for each outcome. The selection of bandwidth is a critical decision in RD analyses; the wider the bandwidth, the greater the

[10] Because all students on either side of the cutoff for FSAG eligibility were eligible for Pell Grant awards, and because Pell Grant awards are a linear function of EFC, the coefficient on EFC captures differences in Pell Grant receipt, which may also contribute to differences in total aid received by students in our analytic sample.

statistical power to detect an effect. At the same time, however, a wider bandwidth makes it more difficult to appropriately model the functional form of the relationship between the forcing variable and the outcome. To examine the sensitivity of our results to the choice of bandwidth, we refit 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 4.

The external validity of our analyses is limited in two ways. First, our inferences are limited to the effect of FSAG eligibility on whether students access and succeed at Florida public two-year and four-year institutions (from the K-20 Data Warehouse postsecondary dataset) along with information about attendance at in-state, private colleges (with data on the recipients of the Florida Resident Assistance Grant). Students who enrolled in out-of-state institutions do not appear in our data. We are also unable to observe degree receipt at non-public institutions, but as shown below, we do not find an effect on enrollment at in-state private institutions and believe the main effects of the aid were concentrated at public institutions; because we focus on low-income students, we are most likely capturing the enrollment patterns and outcomes of the vast majority of target students. To the degree that Florida is demographically and socioeconomically representative of other large states in the country, our findings should also be relevant to the broader question of how state need-based financial aid impacts enrollment, persistence, and degree completion at in-state public institutions, where the vast majority of students attend college.

Second, given our sample restrictions, our inferences apply to low-income students with sufficient know-how and/or family- and school-based supports to complete the FAFSA. On the one hand, these students represent only a subset of college-bound, low-income students. However, on the other hand, given the policy goal of increasing college success among socioeconomically disadvantaged students, this sample may be viewed as a subset of low-income students who are positioned to benefit from changes in need-based aid policy.

Testing for Statistical Equivalence Around the Cutoff

The key assumption underlying our use of an RD strategy to estimate causal effects is that students immediately on either side of the cutoff are "equal in expectation." That is, we assume that students are equivalent, on average, on all observed and unobserved dimensions and differ only in terms of whether they are eligible for the FSAG. One implication of this assumption is that the density of students should be smooth across the FSAG eligibility cutoff; an atypical spike in the density of students just below the cutoff could be evidence that students manipulated their EFCs to position themselves to be eligible for the grant. This endogenous sorting would violate the equality-in-expectation assumption on which RD strategies depend (Urquiola & Verhoogen, 2009). In the case of the FSAG award, this does not appear to be a major concern. Neither the Florida Department of Education Office of Student Financial Assistance website nor individual university financial aid websites made mention made of the specific EFC cutoff used to determine eligibility for the FSAG. Although Florida statutes from the time period refer to a maximum EFC 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 tangentially referenced the actual EFC cutoff. Given the difficulty low-income students often experience in completing complicated financial aid eligibility applications, combined with the amount of effort required to deduce the algorithm for calculating the EFC, it is unlikely that students in our study strategically positioned themselves around the EFC cutoff to receive FSAG funds.

We employ McCrary's (2008) density test to provide statistical support for the argument that strategic positioning is not a major concern in our analyses. In Figure 2 we present a graphic depiction of this density test that compares students within ±\$1,000 of the FSAG eligibility cutoff. A spike in the density of observations on either side of the cutoff would suggest that students were strategically positioning their EFC levels to be just above or below the cutoff. However, in Figure 2 the density of observations appears smooth across the cutoff. Therefore, endogenous sorting does not appear to be a major concern.

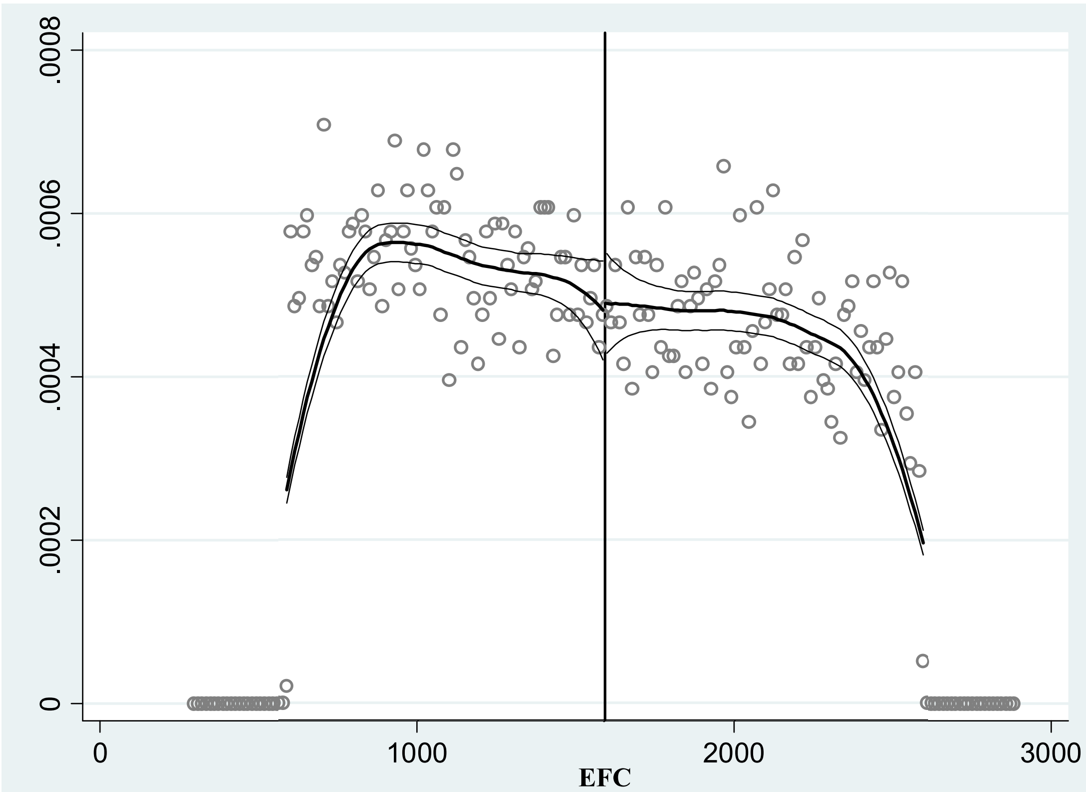
To further test the assumption of statistical equivalence, we regress FSAG eligibility on a host of student-level academic and demographic covariates. If students were indeed equal in expectation on either side of the cutoff, we should find that the covariates jointly fail to predict variation in whether students were FSAG-eligible or not. We perform this analysis within a variety of narrow windows around the FSAG cutoff because we expect students to differ on both observed and unobserved dimensions the further we move away from the cutoff. In each analysis, we conduct an F-test to evaluate the null hypothesis that the covariates jointly failed to explain variation in whether students were FSAG-eligible. We present the results of these tests for baseline equivalence in Table 2.[11] We fit the regressions in progressively wider bandwidths, starting with ±\$250 in column 1 and ending with ±\$1,000 in column 4. All four columns include high school fixed effects. The key results, the p-values associated with the F-test for joint significance of the covariates in each model, are presented in the last row of Table 2. Across all window widths, we fail to reject the null hypothesis that FSAG-eligible and FSAG-ineligible students are statistically equivalent. These findings support our use of the RD strategy to estimate the causal effects of need-based grant aid on students near the eligibility cutoff.[12]

[11] We also conduct individual t-tests of each covariate by FSAG eligibility, through which we reach the same conclusion: Based on observable variables, students appear to be equivalent on either side of the cutoff.

[12] In Figure A.1 (located in the appendix), we include additional graphical analyses that reinforce our conclusion that the covariates are continuous across the FSAG cutoff and that the equality-in-expectation assumption holds.

Figure 2

Density of Observations Within ±$1,000 of the FSAG Eligibility Cutoff



NOTES: EFC is calculated by the U.S. Department of Education based on income, asset, and family size information collected on the FAFSA. The density function of EFC was estimated using McCrary's (2008) test for manipulation of the forcing variable in regression discontinuity analyses.

Table 2

Test for Baseline Equivalence on Either Side of the EFC Cutoff for FSAG Eligibility

Variables	EFC Window Around the FSAG Eligibility Cutoff			
	±$250 (1)	±$500 (2)	±$750 (3)	±$1,000 (4)
Demographic variables				
Black	0.014 (0.022)	-0.006 (0.013)	-0.004 (0.011)	0.001 (0.009)
Hispanic	0.027 (0.025)	0.006 (0.016)	-0.003 (0.013)	-0.003 (0.011)
Other race/ethnicity	0.005 (0.038)	-0.032 (0.026)	-0.020 (0.020)	-0.005 (0.017)
Female	-0.024* (0.015)	-0.014 (0.010)	-0.013* (0.008)	-0.010 (0.006)
Age at expected high school graduation	0.001 (0.015)	0.011 (0.001)	0.009 (0.007)	0.001 (0.006)
Financial variables				
EFC	-2.96*** (0.036)	-1.51*** (0.012)	-1.00*** (0.006)	0.759*** (0.004)
Parents' adjusted gross income	0.001 (0.001)	0.001 (0.001)	0.000 (0.000)	0.000 (0.000)
Academic covariates				
Eligible for Bright Futures	-0.020 (0.017)	-0.017 (0.011)	-0.014 (0.009)	-0.006 (0.008)
In a gifted/talented program	0.014 (0.012)	0.019 (0.026)	0.044* (0.027)	0.046* (0.024)
High school senior year GPA (weighted 4.5 scale)	0.014 (0.012)	0.017** (0.008)	0.009 (0.006)	0.006 (0.005)
Observations	1,758	3,471	5,237	6,917
R^2	0.81	0.78	0.77	0.77
p-value on *F*-test for joint significance	0.556	0.195	0.255	0.518

NOTES: Robust standard errors, clustered at the high school level, are shown in parentheses. All models also include school fixed effects. The *F*-test for joint significance tests whether the explanatory variables in the model jointly explain variation in whether students were just above or below the FSAG cutoff. A constant is also included in all the models.

$^{*}p < .10$. $^{**}p < .05$. $^{***}p < .01$.

4. Results

Graphical Analysis

Following Imbens and Lemieux (2008), we begin our analyses with graphical descriptions of the bivariate relationship between the forcing variable (EFC) and our outcomes of interest. In Figure 3 we present a scatter plot with the forcing variable on the horizontal axis and the dependent variable on the vertical axis. Each point represents the predicted value of the dependent variable within a $100 bin of EFC, obtained from a regression of the dependent variable on EFC (centered at the FSAG cutoff), an indicator for FSAG eligibility, and a vector of demographic and academic covariates and school fixed effects. The trend lines present locally linear regressions on either side of the cutoff.[13] We focus on the relationship between EFC and four of the outcome variables used in our analysis: immediate enrollment in college assuming on-time high school graduation (i.e., fall 2000) in the top left; continuous enrollment into the spring of 2001 (top right); credits accumulated by the spring of 2003, three years after on-time high school graduation (bottom left);[14] and receipt of a bachelor's degree by the spring of 2006, six years after on-time high school graduation (bottom right). We selected these outcomes to explore the effect of FSAG eligibility on a range of short-, medium- and long-term college outcomes.

By visual inspection, it appears that FSAG eligibility has a substantial effect on all four college outcomes. As shown in Figure 3A, students just below the cutoff (i.e., students eligible for the FSAG) appear to enroll immediately in college at a rate approximately three percentage points higher than do students just above the cutoff (i.e., students not eligible for the FSAG), and the effect on continuous enrollment into the spring of 2001 (Figure 3B) appears to be slightly larger. Students just below the cutoff appear to accumulate roughly four more credits after three years than students above the FSAG threshold who were not eligible (Figure 3C). Most notably, as shown in Figure 3D, FSAG-eligible students appear to be approximately four percentage points more likely to earn a bachelor's degree within six years than students just above the cutoff. In short, this graphical analysis suggests that FSAG eligibility has a positive effect on short-, medium-, and long-term college outcomes.

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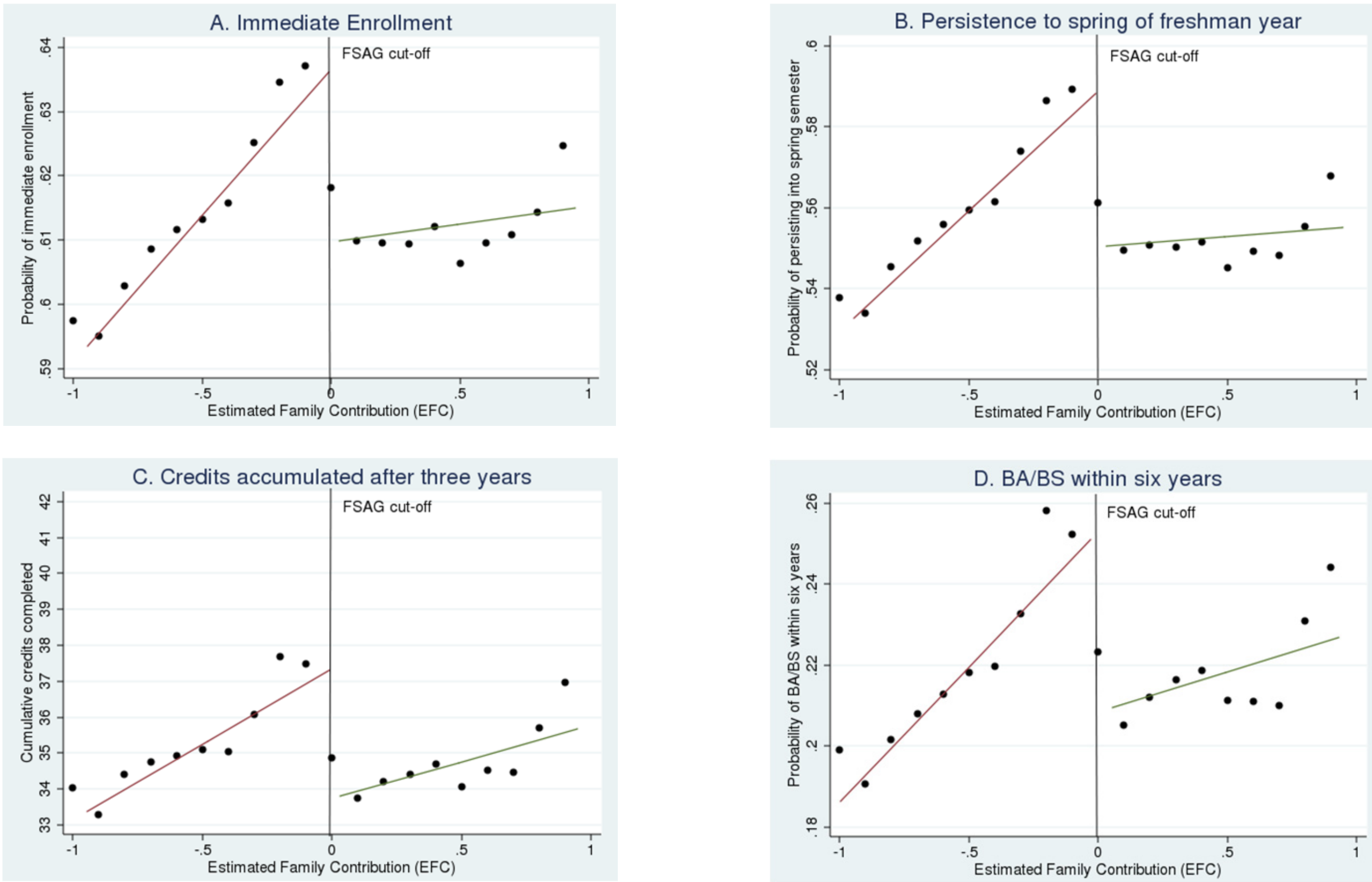
[13] In these plots and in all subsequent tables, the time periods (e.g., "after three years") refer to the length of time assuming entry into college in the fall immediately after on-time high school graduation in spring 2000.

[14] The credit outcomes presented here and in subsequent analyses are inclusive of credits attempted and completed during summer terms. We include summer term credits within the total for the previous academic year. For instance, we add credits that students attempted and completed in summer 2002 to their cumulative credit totals for the 2001–02 academic year.

Figure 3

Relationship Between EFC and Selected Outcomes, With Locally Linear Regressions Fit on Either Side of the FSAG Cutoff



NOTES: EFC is divided by $1,000 and centered at the FSAG cutoff. Each point represents the predicted value of the dependent variable within a $100 bin of EFC, obtained from a regression of the dependent variable on EFC, an indicator for FSAG eligibility, and a vector of demographic and academic covariates and school fixed effects. The credit outcomes are inclusive of credits attempted and completed during summer terms. We include summer term credits within the total for the previous academic year.

RD Analysis: Effects on Enrollment, Persistence, and Degree Completion

The results of fitting our statistical models to the data largely confirm the conclusions from the graphical analyses above. In Table 3, we present results from our RD analyses of the main effect of FSAG eligibility on enrollment-related and early persistence outcomes. The first row in Table 3 presents the coefficient associated with the impact of FSAG eligibility on each outcome. We calculate the optimal bandwidth for each outcome using the Imbens-Kalyanaraman (2009) method, shown near the bottom of the table; ±$1,000 is the most common optimal bandwidth.

The first four columns display the effect of FSAG eligibility on enrollment during fall 2000, which was immediately after on-time high school graduation. We find that eligibility for the FSAG increased the probability that students enrolled in any college immediately following high school by 3.2 percentage points (column 1), though this effect is imprecisely estimated and below the margin of statistical significance.[15] The results in column 2 imply that the impact of FSAG eligibility on whether students enrolled is driven almost entirely by inducing students to attend a public, four-year university. Students who were just below the FSAG cutoff were 3.2 percentage points more likely to enroll at a four-year university than students just above the cutoff. Compared with a mean four-year enrollment rate of 26 percent for the total sample of students within the EFC window of ±$1,000, this effect represents a 12 percent increase.

The third column reflects whether students enrolled at an in-state private, four-year college or university, using data from the above-mentioned Florida Resident Assistance Grant. Our results suggest that there was no impact of FSAG eligibility on attendance at private institutions (column 3). Likewise, FSAG-eligible students were not more likely than ineligible students to enroll in a Florida community college (column 4). Together, these results suggest that the FSAG impacts on enrollment are from drawing new students into public, four-year colleges, not from drawing students away from other in-state schools. It is also possible that the FSAG pulled students who would have enrolled out-of-state back into the state. However, given the fact that low-income, marginal college students are generally unlikely to attend college out-of-state, and that 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, we suspect there was little effect on out-of-state enrollment. Moreover, analysis of

[15] In an analysis not shown, we find that students who qualified for need-based aid in Florida were 3.6 percentage points more likely to enroll full-time, but this effect is imprecisely estimated and not statistically significant.

historical data suggests that previous increases in the size of the FSAG award did not result in an increased proportion of Florida students who attended college in-state versus out-of-state.[16]

In column 5, we present the impact of FSAG eligibility on whether students enrolled at college at any point during the period in which we observe them in the dataset (i.e., through the 2006–07 academic year). Students below the threshold were 2.5 percentage points more likely to enroll in college at some point within seven years (column 5), but the effect is not statistically significant. The final two columns examine the effect of FSAG eligibility on different durations of continuous enrollment: whether students were continuously enrolled from fall 2000 into the spring of 2001 (i.e., through the first year) in column 6 and into the fall of 2001 (i.e., into the second year) in column 7. In the near term, FSAG eligibility has a positive impact on whether students stay continuously enrolled. Students who were just below the cutoff were 4.3 percentage points more likely to remain continuously enrolled into the spring semester of 2001 (column 6). This represents an 8 percent increase above the mean continuous enrollment rate of 55 percent for the analytic sample. It is important to note that this outcome, and those that follow, are not conditional on enrollment. Thus, these are ITT effects rather than the effects of the FSAG on actual recipients or college attendants. FSAG eligibility appears to also have increased the probability that students below the cutoff remain continuously enrolled into the fall of 2001 (column 7), though the coefficient is below the margin of significance.

[16] We examined whether inter-cohort changes in the size of the FSAG award impacted the proportion of students enrolling at in-state institutions in Florida. Specifically, we obtained annual FSAG award amounts (in 2000 dollars) from the Florida Office of Student Financial Assistance's (1998, 1999) *Annual Reports to the Commissioner* and data on the proportion of first-time college students from Florida and three surrounding states (Georgia, Alabama, and South Carolina) who enrolled at in-state institutions, which are available from the annual *Digest of Education Statistics* in even years before 2000 (Snyder, 1988, 1992, 1999; Snyder & Hoffman, 1991, 2001). We then selected two time periods for our analysis: 1986–1988, when the FSAG award increased by $1,641 (2000 dollars), and 1988–1990, when the FSAG award decreased by $1,167 (2000 dollars). We computed simple difference-in-difference estimates of the impact of changes in FSAG award amount on in-state enrollment in Florida, net of temporal changes in the average in-state enrollment in the three comparison states. We present the results of these analyses in Table A.3. If anything, we find a negative relationship between FSAG award amount and the proportion of students enrolling in-state. When the FSAG award increased from 1986 to 1988, the proportion of students enrolling in-state decreased by 3 percentage points; when the FSAG award decreased from 1988 to 1990, the proportion of students enrolling in-state increased by 1.7 percentage points. We hesitate to draw strong conclusions from this simple analysis, but there does not appear to be compelling evidence that increases in FSAG award amounts led to a higher proportion of students choosing to enroll at in-state institutions.

Table 3

Effect of FSAG Eligibility on Enrollment at a Florida College or University

	Enrollment Immediately After High School (Fall 2000)				Ever Enrolled (2000–01 to 2006–07)	Continuous Enrollment	
	Any College	FL Public Four-Year	FL Private Four-Year	FL Public Two-Year		Through 1st Year (Spring 2001)	Into 2nd Year (Fall 2001)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Eligible for FSAG	0.032 (0.023)	**0.032*** **(0.019)**	0.00 (0.013)	0.001 (0.022)	0.025 (0.019)	**0.043*** **(0.024)**	0.027 (0.023)
EFC (centered at cutoff) (000s)	0.003 (0.032)	0.017 (0.026)	-0.01 (0.019)	-0.021 (0.027)	0.040** (0.019)	-0.001 (0.031)	0.012 (0.029)
FSAG × Centered EFC	0.049 (0.041)	0.042 (0.036)	-0.01 (0.023)	0.024 (0.037)	-0.035 (0.026)	0.066 (0.042)	0.022 (0.038)
Eligible for Bright Futures	0.087*** (0.015)	0.351*** (0.014)	0.04*** (0.009)	-0.261*** (0.013)	0.022* (0.011)	0.122*** (0.015)	0.150** (0.015)
EFC window	±$1,000	±$1,000	±$1,000	±$1,100	±$1,200	±$1,000	±$1,100
Observations	6,917	6,917	6,917	7,553	8,161	6,917	7,553
R^2	0.11	0.26	0.08	0.16	0.09	0.13	0.15
Mean of outcome	0.61	0.26	0.07	0.34	0.80	0.55	0.47

NOTES: Robust standard errors, clustered at the high school level, are shown in parentheses. The Florida K-20 Data Warehouse reports whether students were eligible for Bright Futures as of the end of their senior year in high school. Also included in the model are 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; and student age. All models also include high school fixed effects and a constant. A unique optimal bandwidth for each outcome was calculated using the Imbens-Kalyanaraman (2009) method for selecting optimal bandwidths. The bandwidth is indicated by the EFC window row. In column 4, we infer whether students enrolled at a Florida private college or university based on whether they received the non-need-based Florida Resident Assistance Grant, awarded to students who attend in-state private institutions.

*$p < .10$. **$p < .05$. ***$p < .01$.

Although students clearly need to remain enrolled to eventually earn a degree, continuous enrollment is a coarse measure of students' progression toward graduation. Two prototypical students could both stay in college for the same time period following high school but complete a markedly different number of credits toward graduation. Similarly, a student who completed two semesters with full course loads but then took a semester off would still be closer to graduation than a student who remained continuously enrolled over the same time period but who only completed a few courses. To explore student progress toward completion in more detail, we therefore examine whether FSAG eligibility affected students' cumulative credit completion through their first four years of college. The five columns in Table 4 pertain to the effect of FSAG eligibility on different time periods over which students could accumulate credits, based on the assumption of on-time high school enrollment and immediate college entry: after one semester (i.e., fall 2000) in column 1, after one year (i.e., spring 2001) in column 2, after two years (column 3), after three years (column 4), and after four years (column 5). We present results using the same organization of rows as in Table 3.[17]

After the first semester following high school, students below the cutoff completed essentially the same number of credits as students just above the threshold (column 1). A full year after high school graduation (column 2), FSAG-eligible students earned 1.10 credits more than students just above the EFC cutoff for FSAG. By two years following high school, this margin had widened to 2.67 credits (column 3), nearly the equivalent of a typical college course. This margin widened further after three years: FSAG-eligible students earned 3.85 more credits than students above the threshold (column 4)—a 10.8 percent increase over the analytic sample mean of 35.42. Put in different terms, students just below the cutoff were more than one course ahead of students just above the cutoff after three years. Students just below the cutoff further extended this margin after four years following high school, when they earned 4.37 more credits than students just above the cutoff (column 5).[18] In separate analyses, we observe similar margins between students just below and above the cutoff in terms of the number of credits students attempted.

[17] We obtained the results that follow by fitting linear probability models (LPM) to the data. However, because many students do not complete any college credits at a Florida public college or university, there is a large density of students with a value of 0 for each measure, and Tobit models might be more appropriate. To test this, we explored the sensitivity of our findings by fitting Tobit models to the data. The point estimates on FSAG eligibility in the Tobit models are approximately a full credit larger across each time period. We present the results from the LPM models as a more conservative estimate of the impact of FSAG eligibility on students' credit accumulation. See Table A.1 to compare the LPM and Tobit results for selected credit outcomes.

[18] These results include differences in the number of credits completed during the summer. Excluding credits earned during summer terms, the difference in cumulative college credit completion is 2.994 credits after four years and is statistically significant.

Table 4

Effect of FSAG Eligibility on Cumulative Credit Completion at Florida Public Colleges and Universities

	After Fall 2000 (1 Semester) (1)	After Spring 2001 (1 Year) (2)	After Spring 2002 (2 Years) (3)	After Spring 2003 (3 Years) (4)	After Spring 2004 (4 Years) (5)
Eligible for FSAG	0.355	1.098**	2.666***	3.847***	4.366**
	(0.281)	(0.487)	(0.982)	(1.442)	(1.937)
EFC (centered at FSAG cutoff)	0.047	0.289	1.185	1.024	0.327
	(0.358)	(0.653)	(1.351)	(2.010)	(2.655)
FSAG × Centered EFC	0.506	1.138	1.343	3.164	5.327
	(0.466)	(0.879)	(1.752)	(2.603)	(3.400)
Eligible for Bright Futures	1.655***	3.540***	8.470***	13.587***	19.046***
	(0.190)	(0.350)	(0.699)	(1.021)	(1.360)
Observations	6,917	6,917	6,917	6,917	6,917
R^2	0.17	0.19	0.21	0.22	0.23
EFC window	±$1,000	±$1,000	±$1,000	±$1,000	±$1,000
Sample mean of outcome	6.02	12.21	23.88	35.42	45.13

NOTES: Robust standard errors, clustered at the high school level, are shown in parentheses. The Florida K-20 Data Warehouse reports whether students were eligible for Bright Futures as of the end of their senior year in high school. Also included in the model are 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; and student age. All models also include high school fixed effects and a constant. A unique optimal bandwidth for each outcome was calculated using the Imbens-Kalyanaraman (2009) method for selecting optimal bandwidths. The credit outcomes are inclusive of credits attempted and completed during summer terms. We include summer term credits within the total for the previous academic year. The time periods (e.g., "1 semester") refer to the length of time assuming entry into college the immediate fall after on-time high school graduation in spring 2000. However, the estimates are not conditional on high school graduation or immediate college enrollment.

*$p < .10$. **$p < .05$. ***$p < .01$.

Further investigation suggests that the credit impacts are driven entirely by differences in the number of college-level credits earned. We observe no difference in the number of remedial credits completed between FSAG-eligible and FSAG-ineligible students.[19] We also examine, using quantile regression, whether the effect of FSAG eligibility on credit accumulation is more pronounced at different places in the distribution of credit earners. The results suggest the effects of the FSAG are most concentrated in the middle of the distribution of credit earners.[20]

In Table 5, we present results of the main effect of FSAG eligibility on whether students earn an associate or a bachelor's degree. The first three columns pertain to the impact of FSAG eligibility on whether students earned an associate degree within a certain number of years following on-time high school graduation: by the spring of 2003, or three years later (column 1); 2004, or four years later (column 2); and 2005, or five years later (column 3). As shown, eligibility for the FSAG award had essentially no impact on whether students earned an associate degree, which is not surprising, given our finding that the effects of the FSAG may be concentrated at public, four-year colleges. The latter four columns present the effect of FSAG eligibility on whether students earned a bachelor's degree within different time frames. FSAG eligibility did not appear to increase the probability that students earned a bachelor's degree in four years (column 4), but it had a positive effect on whether students earned a bachelor's degree given more time. Students just below the EFC cutoff were 3.2 percentage points more likely to earn a bachelor's degree by the spring of 2005, or within five years (column 5); 4.6 percentage points more likely to earn a bachelor's degree by the spring of 2006, or within six years (column 6); and 5.2 percentage points more likely to earn a bachelor's degree by the spring of 2007, or within seven years. These six- and seven-year effects represent a 22 and 21 percent increase over the analytic sample mean probabilities of graduating, respectively.

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[19] Results on the impact of FSAG eligibility on total credits attempted, college-level credits completed, and remedial credits completed are available upon request.

[20] See Table A.2, which presents the impact of FSAG eligibility at each decile in the distribution of credit accumulation within four years of high school graduation. Students at the median of the distribution who were just below the FSAG cutoff earned 6.34 more credits within four years than students just above the cutoff. FSAG-eligible students at the $Q_{0.6}$ of the distribution earned 7.05 more credits within four years than FSAG-ineligible students.

Table 5

Effect of FSAG Eligibility on Degree Attainment at a Florida Public College or University

	Associate Degree			Bachelor's Degree			
	Spring 2003 (3 Years)	Spring 2004 (4 Years)	Spring 2005 (5 Years)	Spring 2004 (4 Years)	Spring 2005 (5 Years)	Spring 2006 (6 Years)	Spring 2007 (7 Years)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Eligible for FSAG	0.001 (0.012)	0.007 (0.016)	-0.003 (0.016)	0.004 (0.012)	**0.032*** **(0.018)**	**0.046**** **(0.020)**	**0.052**** **(0.021)**
EFC (centered at the FSAG cutoff)	-0.008 (0.013)	-0.001 (0.019)	-0.006 (0.016)	0.007 (0.014)	-0.010 (0.023)	0.005 (0.026)	0.014 (0.027)
FSAG × Centered EFC	0.013 (0.017)	0.019 (0.024)	0.011 (0.020)	-0.006 (0.018)	0.058* (0.031)	0.055 (0.034)	0.048 (0.034)
Eligible for Bright Futures	0.023** (0.010)	-0.003 (0.012)	-0.007 (0.012)	0.110*** (0.010)	0.214*** (0.014)	0.240*** (0.138)	0.250*** (0.014)
Observations	8,846	8,161	9,501	8,161	6,917	6,917	6,917
R^2	0.10	0.10	0.09	0.14	0.21	0.23	0.22
EFC window	±$1,300	±$1,200	±$1,400	±$1,200	±$1,000	±$1,000	±$1,000
Outcome mean	0.09	0.14	0.17	0.07	0.16	0.21	0.25

NOTES: Robust standard errors, clustered at the high school level, are shown in parentheses. The Florida K-20 Data Warehouse reports whether students were eligible for Bright Futures as of the end of their senior year in high school. Also included in the model are 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; and student age. All models also include high school fixed effects and a constant. A unique optimal bandwidth for each outcome was calculated using the Imbens-Kalyanaraman (2009) method for selecting optimal bandwidths. The time periods (e.g., "3 years") refer to the length of time assuming entry into college the immediate fall after on-time high school graduation in spring 2000. However, the estimates are not conditional on high school graduation or immediate college enrollment.

*$p < .10$. **$p < .05$. ***$p < .01$.

RD Analysis: Effects by High School Achievement Level and Bright Futures Status

The effects of the FSAG may differ by type of student. As discussed in the literature review, previous studies have found merit-based aid to have an impact on persistence. These effects may be attributable to the relative transparency of merit-based aid programs such as the Georgia HOPE Scholarship (Dynarski, 2008), or to the renewal requirements that often accompany merit-based aid programs such as the West Virginia PROMISE Scholarship (Scott-Clayton, 2011). They may also indicate that academically accomplished students' college outcomes are more responsive either to reductions in college costs or to the performance incentives embedded in the requirements of many merit-based programs. Therefore, in Table 6, we explore the effects of FSAG eligibility on bachelor's degree attainment within six years after on-time high school graduation by students' level of achievement in high school.[21]

In column 1, we interact FSAG eligibility with high school senior year GPA and find a positive relationship, with a one-point increase in GPA being associated with an increase of 4.2 percentage points in bachelor's degree attainment. We explore the relationship further by fitting a separate model (column 2) in which we use dummy variables for GPA quartile in place of the continuous GPA measure (using the second quartile as the excluded baseline category). We find that FSAG eligibility had a particularly pronounced impact for students with higher senior year GPAs. Students with high school GPAs in the top 25 percent (GPA of at least 3.4; mean GPA 3.68) experienced much larger effects from FSAG eligibility than did students in the second quartile (mean GPA 2.66). Relative to FSAG-eligible students in the second GPA quartile, students in the fourth quartile who were just below the FSAG cutoff were 6.5 percentage points more likely to earn a bachelor's degree within six years.

Based on these estimated effects, one might wonder whether what we actually see is the effect of being eligible for both the FSAG and the Bright Futures Scholarship, the state merit-based grant awarded partially based on high school GPA. Therefore, column 3 displays the results of interacting FSAG eligibility with Bright Futures eligibility. Though we estimate a positive relationship, it is not statistically significant and does not exactly mirror the results for students in the top 25 percent of the GPA distribution. This is at least partially be due to the fact that one third of students with a high school GPA in the top 25 percent were not eligible for Bright Futures.[22] When jointly testing the effect of the FSAG and the FSAG–Bright Futures

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[21] We also explored whether the effects of FSAG eligibility differed by student demographics using interactions with dummy variables for student gender (comparing the effects for female versus male students) and separately by race/ethnicity (comparing the effects for White versus Black, Hispanic, and Asian students). None of these results are statistically significant.

[22] In many cases, these students did not meet the test score requirements for Bright Futures. Students qualify 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

interaction for statistical significance, we do find a positive effect (p = 0.02). The next column also provides support for the conclusion that FSAG eligibility has a pronounced impact for Bright Futures–eligible students.

In column 4, we extend the analysis by investigating the results of splitting the sample by Bright Futures eligibility. This analysis also allows us to examine different parts of the aid distribution; students also eligible for the lower tier Bright Futures award would receive $4,750 in FSAG, Pell, and Bright Futures funding, compared with only $3,450 if they did not qualify for the FSAG. (Students not eligible for Bright Futures would receive $3,050 in Pell and FSAG funding if eligible for the FSAG or $1,750 in Pell Grant funding if not eligible for the FSAG—the difference is always $1,300, but the levels change depending on eligibility for other aid.) Students who were eligible for the FSAG *and* Bright Futures were estimated to be 9.1 percentage points more likely to complete a bachelor's degree within six years of on-time high school graduation than students who were eligible for just Bright Futures. Based on the higher sample mean (a six-year completion rate of 44 percent for Bright Futures–eligible students, compared with 21 percent for the entire analytic sample), this translates into a 21 percent increase, similar to the estimated effect for the entire sample (as shown in Table 5). In column 5, once we focus on these high achievers, we do not find differential effects by high school senior year GPA.

The differential results of FSAG eligibility by high school GPA remain strong once we focus on students not eligible for Bright Futures. Although the overall effects are not statistically significant for this group (see column 6), as shown in column 7, the effects of eligibility are especially large and statistically significant for the students in the fourth quartile of high school GPA relative to those in the second quartile (9.2 percentage points). The overall effect for these students with senior year GPAs in the top 25 percent who are not also eligible for Bright Futures is 11.9 percentage points, or a 52 percent increase based on a mean six-year completion rate of 23 percent for this group.[23] Even if one assumes FSAG eligibility did not have an effect on degree completion for students with lower high school GPAs (given that the estimate for FSAG eligibility for the baseline group in the second quartile is not statistically significant), these results suggest a 40 increase for the fourth quartile. Taken together, our results suggest that FSAG eligibility had larger effects for high achievers, whether defined by senior year GPA or Bright Futures eligibility. However, the largest effects were for students who did well in high school (i.e., those who were in the fourth GPA quartile) but did not qualify for Bright Futures.

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970 or higher (or a composite ACT exam score of 20 or higher). To qualify for the higher tier Florida Academic Scholars award, students needed to complete 15 core academic credits in high school, have a cumulative high school GPA of 3.5 or higher, and have a composite SAT score of 1270 or higher (or a composite ACT exam score of 28 or higher).

[23] 11.9 percentage points is the sum of the main effect of the FSAG and the interaction between the FSAG and the indicator for whether a student was in the top quartile of the GPA distribution.

Table 6

Differential Effects of FSAG Eligibility on Bachelor's Degree Attainment by Spring 2006 at a Florida Public College or University

	Whole Sample			Eligible for Bright Futures		Not Eligible for Bright Futures	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Eligible for FSAG	**-0.070***	0.036	**0.031**	**0.091***	0.059	0.021	0.027
	(0.037)	(0.025)	**(0.020)**	**(0.047)**	(0.067)	(0.019)	(0.025)
EFC (centered at FSAG cutoff)	0.007	0.009	0.003	0.039	0.040	-0.015	-0.015
	(0.026)	(0.026)	(0.026)	(0.061)	(0.061)	(0.026)	(0.026)
FSAG × Centered EFC	0.053	0.048	0.052	0.040	0.041	0.056*	0.056
	(0.034)	(0.034)	(0.033)	(0.088)	(0.088)	(0.034)	(0.034)
FSAG × High school senior year GPA	**0.042*** (0.013)**						
High school senior year GPA (weighted 4.5 scale)	0.107*** (0.011)		0.114*** (0.008)				
Eligible for Bright Futures	0.240***	0.243***	0.250***				
	(0.014)	(0.014)	(0.016)				
FSAG × Bright Futures eligible			0.034 (0.022)				
FSAG × GPA 4th quartile		**0.065****			0.058		**0.092****
		(0.031)			(0.069)		**(0.043)**
FSAG × GPA 3rd quartile		0.012			0.022		-0.005
		(0.031)			(0.074)		(0.033)
FSAG × GPA 1st quartile		-0.025			-0.008		-0.036*
		(0.023)			(0.110)		(0.022)
GPA 4th quartile		0.120***		0.115***	0.085*	0.136***	0.085***
		(0.024)		(0.034)	(0.051)	(0.023)	(0.032)
GPA 3rd quartile		0.063***		0.062	0.049	0.053***	0.055**
		(0.022)		(0.039)	(0.055)	(0.014)	(0.022)
GPA 1st quartile		-0.061***		-0.118**	-0.117	-0.064***	-0.043***
		(0.016)		(0.053)	(0.080)	(0.010)	(0.016)
Observations	6,917	6,917	6,917	2,305	2,305	4,612	4,612
R^2	0.23	0.22	0.24	0.19	0.19	0.14	0.14
p-value: *F*-test for FSAG x GPA quartile interactions	--	0.01	--	--	0.75	--	0.01
Sample mean of outcome	0.21	0.21	0.21	0.44	0.44	0.11	0.11
Sample mean of outcome for top GPA quartile	0.41	0.41	0.41	0.49	0.49	0.23	0.23

NOTES: Robust standard errors, clustered at the high school level, are shown in parentheses. The Florida K-20 Data Warehouse reports whether students were eligible for Bright Futures as of the end of their senior year in high school. Also included in the model are the following covariates: race dummy variables (Black, Hispanic, and other race/ethnicity); female dummy variable; whether the student was in a gifted and talented program; parental adjusted gross income; and student age. All models also include high school fixed effects and a constant. We calculate the optimal bandwidth—an EFC window of ±$1,000—using the Imbens-Kalyanaraman (2009) method.

*$p < .10$. **$p < .05$. ***$p < .01$.

Robustness Checks

To test the robustness of our results, we perform a number of tests. We first address the possibility that our results are sensitive to the particular EFC window in which we conducted our analyses. One way to examine this threat empirically is to repeat our analyses using a variety of window widths (Angrist & Lavy, 1999; Murnane & Willett, 2010). Although we would expect standard errors to change as the sample size increases or decreases, the parameter estimates associated with FSAG eligibility should remain stable. For illustration purposes, we present in Table 7 the effect of FSAG eligibility on the six-year graduation rate using various window widths.[24] The models in this table include the same explanatory variables as the models in Table 5. Each of the columns presents the results of fitting the same model in a slightly different window width. From left to right, the columns present models in progressively narrower window widths, starting with ±$1,200 in column 1 and ending with ±$800 in column 5. We observe little fluctuation in the coefficients for FSAG eligibility in the first row of the table. Overall, this analysis suggests that our overall results are in fact robust to the choice of window width.

We also evaluate whether our results are sensitive to the functional form of the relationship between the forcing variable (EFC) and the college outcomes. Given the relatively small number of observations within our analytic windows, the fitted shape of a curvilinear relationship between EFC and each outcome would be very sensitive to the presence of atypical values just above or below the cutoff. This in turn could lead to highly biased estimates of the causal effect of FSAG eligibility (Murnane & Willett, 2010). Given the sensitivity of RD estimates to nonlinear specifications, Imbens and Lemieux (2008) recommend selecting a bandwidth within which the relationship between the forcing variable and outcome is locally linear. To further test whether the relationship between EFC and each outcome is linear within our selected bandwidths, we add polynomial specifications of EFC to each model in Tables 3 to 5 and include two-way interactions between each polynomial term in the specification of EFC and the binary indicator for FSAG eligibility. We present in Table 8 the results of these sensitivity analyses for the effect of FSAG eligibility on the probability of earning a bachelor's degree within six years.[25] None of the polynomial specifications of the relationship are statistically significant, suggesting we do indeed have a bandwidth within which the relationship is locally linear.

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[24] We conducted similar analyses for the other outcomes for which we found a significant program effect. Across all of these outcomes, the parameter estimates are stable to the selection of window width.

[25] We conducted similar analyses for the other outcomes for which we find a significant program effect and reach the same conclusion—that both the polynomial specifications of EFC and the interactions between the FSAG and the EFC polynomial terms are unnecessary within our analytic window.

Finally, we consider the possibility that what our graphical and statistical analyses indicate is the causal effect of FSAG eligibility on bachelor's degree attainment may, in actuality, be an idiosyncratic fluctuation in the data at the EFC cutoff of $1,590. If this were the case, we might equally expect to find a jump in the probability of graduating within six years at other arbitrarily selected cutoffs in the EFC distribution. We conduct this falsification test by re-fitting local linear regression models (again using an optimal bandwidth of ±$1,000) around three arbitrary cutoffs: $500 below the actual cutoff (an EFC of $1,090), $500 above the actual cutoff (an EFC of $2,090), and $1,000 above the actual cutoff (an EFC of $2,590). We include the same set of controls as those included in all our previous analyses. We present the results of this falsification exercise in Table 9. In column 1, we replicate the effects of bachelor's degree attainment around the true FSAG eligibility cutoff; in column, 2 we present results around an EFC cutoff of $1,090; in column 3, we present the model around an EFC cutoff of $2,090; and in column 4, we present the model around an EFC cutoff of $2,590. The estimated effect of FSAG eligibility on whether students graduate within six years is not distinguishable from zero around all three artificial cutoffs in columns 2–4, suggesting that our analyses are detecting what appear to be causal effects and not simply random fluctuations in the data around the EFC cutoff.

Table 7

Robustness of the Estimated Effect of the FSAG on Bachelor's Degree Receipt by Spring 2006 to Differing Window Widths Around the FSAG Cutoff

	EFC Window Around the Cutoff				
	±$1,200	±$1,100	±$1,000 (Optimal)	±$900	±$800
	(1)	(2)	(3)	(4)	(5)
Eligible for FSAG	**0.046****	**0.041****	**0.046****	**0.042****	0.030
	(0.018)	**(0.019)**	**(0.020)**	**(0.021)**	(0.023)
EFC (centered at the FSAG cutoff)	0.029	0.008	0.005	-0.002	-0.026*
	(0.021)	(0.023)	(0.026)	(0.031)	(0.035)
FSAG × Centered EFC	0.004	0.037	0.055	0.050	0.073
	(0.027)	(0.028)	(0.034)	(0.042)	(0.498)
Eligible for Bright Futures	0.239***	0.237***	0.240***	0.239***	0.240***
	(0.013)	(0.014)	(0.138)	(0.015)	(0.015)
High school fixed effects	Yes	Yes	Yes	Yes	Yes
Additional controls	Yes	Yes	Yes	Yes	Yes
Observations	8,161	7,553	6,917	6,283	5,601
R^2	0.22	0.22	0.23	0.23	0.23

NOTES: Robust standard errors, clustered at the high school level, are shown in parentheses. The Florida K-20 Data Warehouse reports whether students were eligible for Bright Futures as of the end of their senior year in high school. Also included in the model are 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; and student age. All models also include high school fixed effects and a constant.

*$p < .10$. **$p < .05$. ***$p < .01$.

Table 8

Robustness of the FSAG's Effect on Bachelor's Degree Receipt by Spring 2006 to Specification of the Functional Form of the Relationship Between the Forcing Variable and the Outcome

	(1)	(2)	(3)	(4)
Eligible for FSAG	**0.046****	0.046	0.022	0.030
	(0.020)	(0.029)	(0.040)	(0.047)
EFC (centered at the cutoff)	0.005	-0.140	0.018	0.205
	(0.026)	(0.099)	(0.246)	(0.486)
Centered EFC^2		0.147	-0.254	-1.105
		(0.096)	(0.574)	(2.045)
Centered EFC^3			0.271	1.610
			(0.382)	(3.152)
Centered EFC^4				-0.676
				(1.594)
FSAG × Centered EFC	0.055	0.095	-0.015	-0.215
	(0.034)	(0.139)	(0.322)	(0.705)
FSAG × Centered EFC^2		-0.251*	0.268	1.060
		(0.123)	(0.798)	(2.740)
FSAG × Centered EFC^3			-0.192	-1.624
			(0.506)	(4.291)
FSAG × Centered EFC^4				0.630
				(2.119)
Observations	6,917	6,917	6,917	6,917
R^2	0.07	0.21	0.23	0.23
p-value on the joint F-test of the FSAG × EFC interactions	--	0.123	0.288	0.489

NOTES: Robust standard errors, clustered at the high school level, are shown in parentheses. The Florida K-20 Data Warehouse reports whether students were eligible for Bright Futures as of the end of their senior year in high school. Also included in the model are the following covariates: whether the student was in a gifted and talented program; parental adjusted gross income; and student age. A constant is also included in all the models. All models also include high school fixed effects. We calculate the optimal bandwidth—an EFC window of ±$1,000—using the Imbens-Kalyanaraman (2009) method.

*$p < .10$. **$p < .05$. ***$p < .01$.

Table 9

Falsification Test for Whether Estimated Effects of FSAG Eligibility on Bachelor's Degree Attainment Within Six Years Are Unique to the Actual FSAG Cutoff

	Eligibility Cutoff			
	EFC = $1,590 (Actual Cutoff)	EFC = $1,090	EFC = $2,090	EFC = $2,590
	(1)	(2)	(3)	(4)
Eligible for FSAG	**0.046****	-0.023	0.014	-0.019
	(0.020)	(0.018)	(0.020)	(0.020)
EFC (centered at the FSAG cutoff)	0.005	-0.041*	0.055**	0.014
	(0.026)	(0.023)	(0.025)	(0.027)
FSAG × Centered EFC	0.055	0.059*	-0.090***	-0.020
	(0.034)	(0.031)	(0.033)	(0.038)
Eligible for Bright Futures	0.240***	0.257***	0.229***	0.223***
	(0.138)	(0.014)	(0.015)	(0.016)
N	6,917	7,515	6,252	5,699
R^2	0.23	0.23	0.23	0.22
Sample mean of outcome	0.21	0.21	0.21	0.21

NOTES: Robust standard errors, clustered at the high school level, are shown in parentheses. The Florida K-20 Data Warehouse reports whether students were eligible for Bright Futures as of the end of their senior year in high school. Also included in the model are the following covariates: whether the student was in a gifted and talented program; parental adjusted gross income; and student age. A constant is also included in all the models. All models also include high school fixed effects. We calculate the optimal bandwidth using the Imbens-Kalyanaraman (2009) method for selecting optimal bandwidth. For each model, we restrict the data to ±$1,000.

*$p < .10$. **$p < .05$. ***$p < .01$.

5. Conclusions and Implications

Gaps in college success by socioeconomic status have persisted for decades. A primary way that state and federal governments have attempted to address these gaps is by providing need-based financial grants to students from low-income families. The size of this investment is substantial: well over $45 billion a year from federal and state governments (College Board, 2012). In this study, we add to the financial aid literature by examining the effect of need-based grant eligibility on the probability that will students enter, persist in, and complete college.

Using a regression-discontinuity design, we find a positive effect of FSAG eligibility on whether students enroll immediately at a public, four-year university. When we adjust our estimates into magnitudes per $1,000 of aid eligibility, as is the convention in the literature, our results suggest that $1,000 in grant aid (in 2000 dollars) led to an enrollment effect of 2.5 percentage points.[26] This effect is in line with prior estimates of the effect of grant aid on immediate enrollment (e.g., Dynarski, 2003; Kane, 2003), though slightly smaller than most. However, prior causal research has provided little information regarding how need-based aid eligibility impacts students' progress toward degree attainment, and our research addresses this question. We find that eligibility for $1,000 more in grant funding increased students' probability of staying continuously enrolled through the spring semester of their freshman year by 3.3 percentage points.[27] Furthermore, FSAG eligibility had a positive impact on students' rate of college credit accumulation and on whether they earned a bachelor's degree: $1,000 in grant eligibility (in 2000 dollars) increased the cumulative number of credits students completed after four years by 3.4 credits and increased the probability of earning a bachelor's degree within five, six, and seven years by 2.5, 3.5, and 4.0 percentage points, respectively. The impact of FSAG eligibility on bachelor's degree attainment was particularly pronounced for students

[26] The FSAG is a $1,300 grant, so the tables display larger estimates based on this slightly large aid amount.

[27] On the surface, it may seem surprising that we find an impact of FSAG eligibility on enrollment at four-year colleges because studies of the Federal Pell Grant, which also uses EFC to determine applicant eligibility, have not found impacts on enrollment at four-year institutions. However, there are several important differences between our study and studies evaluating the Pell Grant. Many of those studies capitalized on the introduction of the Pell Grant in 1972 to identify the program effect. Our study takes place nearly 30 years later, and the impact of financial aid may differ across both time periods. Moreover, studies of the Pell Grant have typically employed data from the Current Population Survey in their analyses and therefore do not condition on students who have applied for the FAFSA, as we do in our analyses. Our analytic sample may therefore be quite different than the analytic samples in the Pell studies. Finally, we estimate a local average treatment effect of the impact of FSAG eligibility for students just below the FSAG cutoff. The Pell studies typically employed a difference-in-differences methodology, which provides an average treatment effect for all individuals in the analytic sample who became eligible for the Pell Grant when it was introduced in 1972.

who were academically accomplished in high school. Taken in concert, these results suggest that the impact of need-based aid eligibility extends well beyond initial enrollment.

It is important to note that the FSAG can be renewed if students have a 2.0 GPA in college and complete at least 12 credits per term. Due to this fact, one may wonder whether we are estimating the effect of aid eligibility for only the first year of college or whether our effects reflect the impact of multiple years of eligibility. Although is possible for students to receive the FSAG for multiple years, in practice, this rarely happens. Only 36 percent of students who receive the FSAG in their first year of college also receive it in their second year. By four years after high school, only 21 percent of eligible students receive the grant. Therefore, although we might interpret our results as representing the effects of multiple years of aid eligibility for some students, one should not think of this as a multi-year award for the majority of eligible students, even when focusing on students with high school GPAs in the top 25 percent of the distribution.[28]

While reflecting how to interpret the results, it is also worthwhile to consider whether our effects are the result of giving students an additional $1,300 and/or due to incentive effects that may occur because the award is only available to students who enroll for 12 credits per term in their first year and renewable only if they complete 12 credits and reach a modest academic benchmark in college. However, it is important to note that all students in our analytic sample have an incentive to take 12 credits per term because their Pell Grant award maxes out this level.[29] In fact, when we estimate the impact of FSAG eligibility on whether a student completes at least 12 credits during either fall 2000 or spring 2001, we do not find statistically significant effects. The college GPA renewal requirement of 2.0 is also much lower than the levels customary for merit-based aid, such as the scholarships studied by Dynarski (2008) and Scott-Clayton (2011). Although such a minimum standard may be related to early course passage rates, as found by Brock and Richburg-Hayes (2006) in their study of a performance-based scholarship in Louisiana with a similar GPA cutoff, it seems unlikely to have such a profound effect on bachelor's degree completion multiple years later, especially given the fact so few students receive an FSAG award in multiple years. Thus, the effects we observe appear to be driven much more by the reduction in the cost of attendance at public, four-year institutions than by possible incentive effects.

[28] Students also eligible for Bright Futures, which has renewal requirements of a 2.75 GPA for the lower tier and a 3.0 GPA for the higher tier, were slightly more likely to have an FSAG for multiple years. Thus, the effects for the population of Bright Futures–eligible students could be interpreted as the result of being eligible for aid for more than one year and having performance incentives—though this conclusion is tempered by the fact that, similar to the overall sample, less than half of Bright Futures recipients maintain the FSAG into their second year and thereafter.

[29] The Pell Grant program considers 12 credits to be full-time attendance and thus will award students the maximum amount they are eligible for if they enroll at this level.

Overall, our results suggest not only that need-based aid has a positive effect on persistence and degree completion but also that increasing the award amounts of current aid programs could have beneficial effects. In our sample, we compare students who received up to $1,750 in need-based aid (i.e., just the Pell Grant) with those receiving up to $3,050 (i.e., the Pell Grant and the FSAG). This could effectively be seen as a test of whether increasing the size of programs such as the Federal Pell Grant Program would have a positive effect on college outcomes—a slightly different question than whether any aid at all (versus no aid) has positive effects. Given current expenditures of over $45 billion in need-based government aid, understanding the effects of the marginal dollar of aid is particularly relevant to many ongoing policy debates. It is also worth noting that our analysis takes into account multiple types of aid (both need- and merit-based; both federal and state), as student aid packages can be comprised of a variety of awards. Our results are relevant for students from families in the lower middle class; the mean family income for our sample is about $30,000 ($40,300 in 2011 dollars).

Given the FSAG's positive impacts on degree attainment, a "back-of-the-envelope" calculation suggests that the FSAG award is a beneficial social investment. Consider the population of Florida high school seniors to whom we can generalize our results (i.e., students just above and below the EFC cutoff for FSAG eligibility). We make the simplifying assumption that 1,000 students were sufficiently close to the cutoff that our impact estimates would apply to them. Our results suggest that FSAG eligibility would have induced approximately 46 more students (or 4.6 percent) to earn a bachelor's degree within six years. The total FSAG award amount for students close to the cutoff was $1,300 per student, or $1.3 million total in this example. Therefore, the cost per student induced to earn a bachelor's degree was approximately $28,000. Then, consider the benefits of this increase in educational attainment. The differential in earnings and tax payments between median full-time workers with a bachelor's degree and those with only some college was $13,800 in 2005 (Baum & Ma, 2007). Assuming, for the sake of simplicity, that this differential remained constant in subsequent years, the social and private benefits of the FSAG would have exceeded the costs within three years.[30] Even considering the fact that some students received the FSAG in multiple years and that the cost of graduating a student is more than just the cost of the FSAG (i.e., it includes college subsidies and resources for the additional courses taken to graduate), the FSAG still looks to have a positive rate of return, given that our simple example underestimates the benefits of the FSAG by not including the positive effects of eligibility on students who might not have completed a degree but still received additional education.

This work prompts additional research questions that warrant further exploration. One question that emerges is whether need-based aid eligibility in successive years would result in longer term impacts on college attainment. The existence of academic and financial cutoffs for

[30] In fact, the differential widened after 2005. See Baum, Ma, and Payea (2010).

FSAG renewal provide an opportunity to empirically assess whether students who are eligible for need-based assistance for two years have a higher probability of earning a degree than statistically equivalent students who are only eligible for need-based aid during their first year in college. There are also questions about the impact of financial aid on college outcomes such as course selection and major choice and about whether increasing financial aid has a substitution effect with student employment.

In closing, our research lends new evidence that need-based grant eligibility has a positive and substantial effect not only on whether students enroll at public four-year universities but also on the number of credits they accumulate and on whether they earn a bachelor's degree. Especially in lean budgetary times, these findings provide policymakers with valuable information about the long-term benefits of public investments in need-based financial assistance for college and suggest that investments in need-based grant aid generate substantial private and social monetary benefits.

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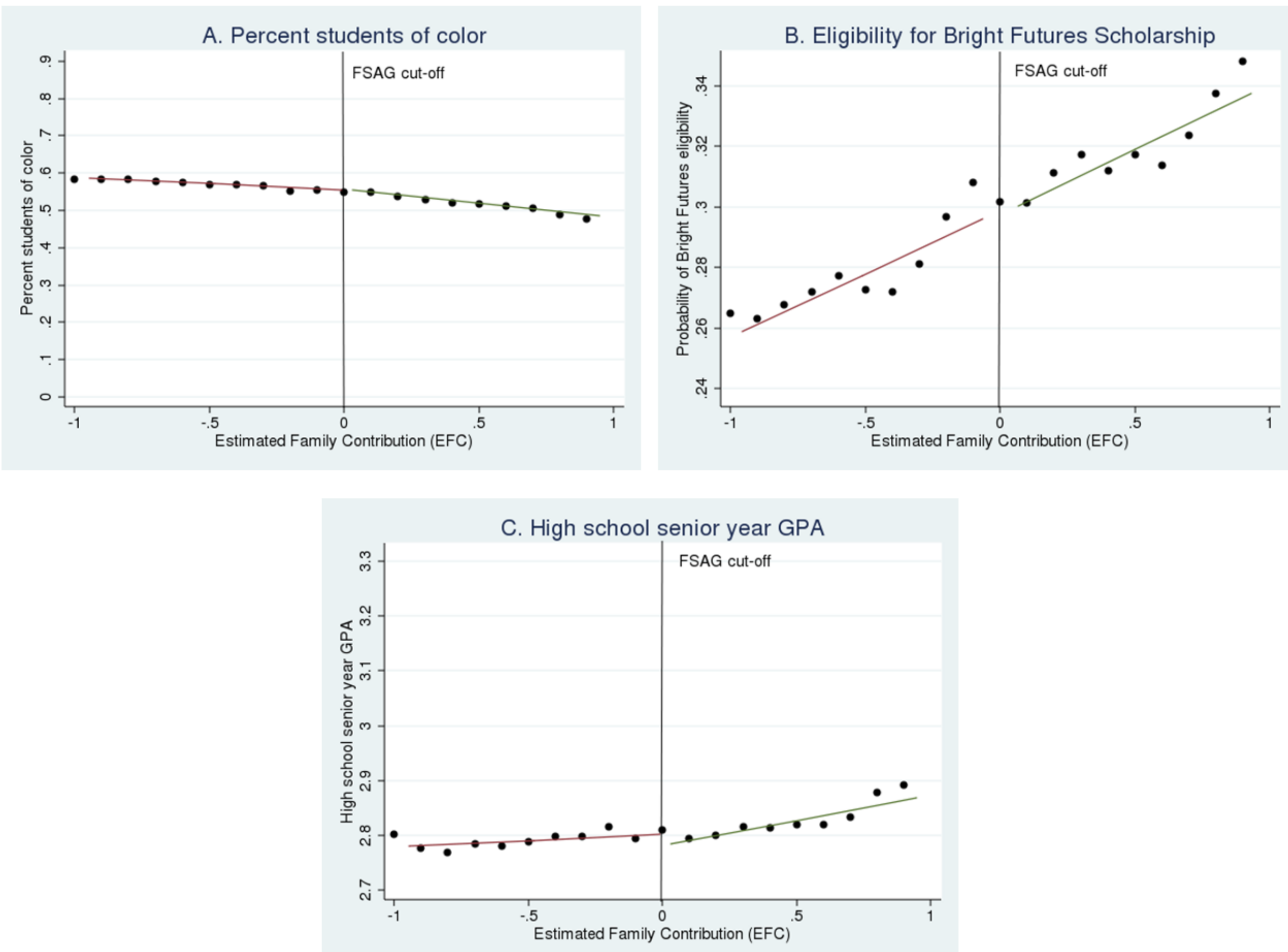
Appendix

Figure A.1

Relationship Between the Forcing Variable, EFC, and Three Selected Covariates With Locally Linear Regressions Fit on Either Side of the FSAG Cutoff



NOTES: EFC is calculated by the U.S. Department of Education based on income, asset, and family size information students supply on the FAFSA. EFC is divided by $1,000 and centered at the FSAG cutoff. Each point represents the predicted value of the dependent variable within a $100 bin of EFC, obtained from a regression of the dependent variable on EFC, an indicator for FSAG eligibility, and a vector of demographic and academic covariates and school fixed effects. The trend lines present locally linear regressions on either side of the cutoff. We selected the bandwidth of ±$1,000 using the Imbens-Kalyanaraman (2009) method for selecting optimal bandwidths.

Table A.1

Linear Probability Models (LPM) and Tobit Model Estimates of the Effect of FSAG Eligibility on Cumulative College Credits Completed

	Spring 2001 (1 Year)		Spring 2002 (2 Years)		After Spring 2003 (3 Years)	
	LPM (1)	Tobit (2)	LPM (3)	Tobit (4)	LPM (5)	Tobit (6)
Eligible for FSAG	0.901*	1.530**	2.077**	3.196***	2.893**	4.350***
	(0.486)	(0.700)	(0.917)	(1.195)	(1.317)	(1.660)
EFC (centered at the FSAG cutoff)	0.403***	0.634	1.185	1.853***	1.275	2.237
	(0.596)	(0.850)	(1.132)	(1.470)	(1.642)	(2.075)
FSAG × Centered EFC	0.472	0.911	0.442	0.823	1.263	1.289
	(0.753)	(1.071)	(1.387)	(1.807)	(1.967)	(2.486)
Eligible for Bright Futures	3.475***	4.497***	7.453***	8.976***	11.811***	14.053***
	(0.332)	(0.454)	(0.613)	(0.775)	(0.863)	(1.068)
N	7,553	7,553	7,553	7,553	7,553	7,553
R^2	0.18	0.18	0.18	0.18	0.21	0.21
EFC window	±$1,100	±$1,100	±$1,100	±$1,100	±$1,100	±$1,100
Sample mean of outcome	11.67	11.67	22.05	22.05	30.88	30.88

NOTES: Robust standard errors, clustered at the high school level, are shown in parentheses. The Florida K-20 Data Warehouse reports whether students were eligible for Bright Futures as of the end of their senior year in high school. Also included in the model are 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; and student age. All models also include high school fixed effects and a constant. We calculated the bandwidths using the Imbens-Kalyanaraman (2009) method for selecting optimal bandwidths. The time periods (e.g., "1 year") refer to the length of time assuming entry into college the immediate fall after on-time high school graduation in spring 2000. However, the estimates are not conditional on high school graduation or immediate college enrollment.

*$p < .10$. **$p < .05$. ***$p < .01$.

Table A.2

Quantile Regression Results of the Impact of FSAG Eligibility on Cumulative Credit Completion Within Four Years at Florida Public Colleges and Universities

	Cumulative College Credit Completion Within Three Years								
	$Q_{0.1}$	$Q_{0.2}$	$Q_{0.3}$	$Q_{0.4}$	$Q_{0.5}$	$Q_{0.6}$	$Q_{0.7}$	$Q_{0.8}$	$Q_{0.9}$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Eligible for FSAG	--	--	1.268	3.613**	6.340**	7.047**	4.563	2.313	3.000
			(0.802)	(1.665)	(2.521)	(3.076)	(2.900)	(2.848)	(2.691)
EFC (centered at the FSAG cutoff)	--	--	-0.372	0.326	1.632	0.850	-0.379	-3.833	-2.432
			(0.882)	(2.220)	(2.951)	(4.000)	(3.980)	(3.656)	(3.900)
FSAG × Centered EFC	--	--	2.229*	3.000	3.965	6.234	6.182	9.578**	13.548***
			(1.321)	(2.763)	(4.177)	(5.521)	(4.933)	(4.812)	(4.900)
Eligible for Bright Futures	--	--	24.311***	39.463***	43.819***	40.824***	32.264***	25.399***	17.508***
			(2.653)	(2.364)	(2.234)	(2.026)	(1.803)	(1.880)	(1.458)
Pseudo R^2	--	--	0.04	0.09	0.14	0.17	0.17	0.16	0.11

NOTES: $N = 6{,}917$. EFC window = ±$1,000. Sample mean of outcome = 35.42. Bootstrapped standard errors (500 repetitions per model) are shown in parentheses. Models for the first and second deciles failed to converge. The Florida K-20 Data Warehouse reports whether students were eligible for Bright Futures as of the end of their senior year in high school. Also included in the model are 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; and student age. All models also include high school fixed effects and a constant. The credit outcomes are inclusive of credits attempted and completed during summer terms. We include summer term credits within the total for the previous academic year. The time periods (e.g., "three years") refer to the length of time assuming entry into college the immediate fall after on-time high school graduation in spring 2000. However, the estimates are not conditional on high school graduation or immediate college enrollment.

*$p < .10$. **$p < .05$. ***$p < .01$.

Table A.3

Difference-in-Differences Estimates of the Impact of Changes in FSAG Award Amount on Enrollment at In-State Institutions

	1986	1988	1990	1996	1998 [a]
FSAG (2000 $)	4,498	6,139	4,972	1,011	1,585
Δ in FSAG from 2 years prior		1,641	-1,167		574
Proportion enrolled in-state					
Florida	0.83	0.80	0.83	0.85	0.87
Alabama	0.90	0.91	0.92	0.91	0.91
Georgia	0.83	0.82	0.83	0.86	0.85
South Carolina	0.87	0.87	0.89	0.89	0.89
Δ in-state enrollment, Florida		-0.03	0.03		0.02
Average Δ in-state enrollment, AL, GA, & SC		0.00	0.013		-0.003
Difference-in-differences		-0.03	0.017		0.023

SOURCE: Florida Office of Student Financial Assistance, *Annual Reports to the Commissioner*, 1997–1998 to 1998–1999; *Digest of Education Statistics*, 1988, 1990, 1992, 1998, 2000.

NOTES: Data on residency and migration patterns of college freshmen are only available for even years prior to 2000.

[a] This difference-in-differences estimate is confounded by the introduction of Bright Futures in 1997–98.