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Abstract

This paper examines the effect of a state-financed merit-aid scholarship—the Arkansas Academic Challenge Scholarship (ACS)—on post-secondary outcomes at a large university in Arkansas. Exploiting scholarship eligibility requirements, we implement a fuzzy regression discontinuity design to identify the scholarship's causal impacts on college outcomes. The analysis focuses on currently enrolled sophomores, juniors, and seniors who receive the scholarship to investigate the broad impacts of receiving money at nontraditional points in an individual's college trajectory. Findings indicate small, negative impacts of scholarship receipt on short-run outcomes such as GPA and credit accumulation, but large statistically significant declines in the likelihood of graduating within four, five, or six years of matriculation. The youngest cohort, who begin receiving funding during their sophomore year of enrollment, primarily drives these findings. However, cohort analysis also reveals that seniors who do not graduate on time are 54 percentage points more likely to graduate within 6 years of matriculation when they receive the scholarship. These results highlight the fact that the timing of receiving money may heavily influence student behavior and outcomes.

Introduction

Arkansas residents are half as likely to earn a postsecondary degree than the average American (U.S. Census Bureau, 2019).[3] To mitigate this attainment gap, state policymakers have pushed to increase the number of postsecondary credentials in several ways, including the implementation of numerous merit-aid programs (Arkansas Department of Education, 2015). Once such program, the Arkansas Academic Challenge Scholarship (ACS), underwent significant changes in the mid-2000s, providing a unique opportunity to study the effect of merit aid on student outcomes in new ways.

[3] While forty-five percent of Americans hold a postsecondary degree, only 22.6 percent of adults in Arkansas share this achievement (U.S. Census Bureau, 2019)

While a version of the ACS dates back to the 1990s, legislation passed in 2008 dramatically expanded the program by tying funding to the Arkansas Scholarship Lottery (Arkansas Department of Education, 2015). Students received the first round of lottery-funded ACS scholarships in the fall of 2010. Unlike the implementation of many merit-aid programs, which offer funding only to entering freshman, expansion of the Academic Challenge Scholarship program created three categories of students eligible for funding: Prior Recipients, Traditional Recipients, and Current Achievers. Prior Recipients are individuals who received the original ACS prior to its expansion in the fall of 2010 and remained eligible for the revised form of the program post-expansion. First-time freshmen who entered college after the program's expansion in the fall of 2010 or later are considered Traditional Recipients. The last group, Current Achievers, are students who became eligible for the scholarship while already enrolled at a college or university.

While prior merit-aid scholarship research has largely focused on recent high school graduates entering college for the first time (Bruce & Carruthers, 2014; Cornwell, Mustard, and Sridhar, 2006; Dynarski, 2003, & 2008; Goodman, 2008; Kane, 2003; Scott-Clayton, 2015), this study adds to the literature on the effects of merit-aid programs by focusing on postsecondary outcomes for Current Achievers who received the ACS in their sophomore, junior, or senior year of college.

While there is reason to expect positive outcomes for all merit-aid recipients, currently enrolled postsecondary students may respond differently to financial incentives compared to Traditional Recipients. Moreover, receiving funding at different points in an individual's postsecondary trajectory may impact progression through college and entry into the workforce.

Therefore, studying the influence of merit-aid on Current Achievers provides an opportunity to deepen the understanding of the benefits and drawbacks of merit-aid as a policy lever.

Following existing state-based merit aid research, we exploit variation in program eligibility to estimate the causal effect of qualifying for the ACS using a regression discontinuity approach. Using administrative data from one public Arkansas university, we determine the impact of the ACS on Current Achiever's persistence, college GPA, credit accumulation, and degree attainment four-, five-, and six-years post-matriculation. We also perform a secondary analysis separating our sample out by cohort, to independently investigate outcomes for Current Achievers who received aid during their sophomore, junior, and senior years. This analysis allows us to further examine the role that the timing of scholarship receipt may play in influencing student outcomes.

Our findings indicate that Current Achievers who receive the ACS earn lower cumulative GPAs, are less likely to persist, and accumulate fewer credits compared to non-recipients, although these results are imprecisely estimated. However, ACS recipients exhibit large, statistically significant, declines in the likelihood of graduating on-time, or at all, relative to the comparison group.[4] Based on our local average treatment effect estimates, scholarship recipients are over forty percentage points less likely to graduate in four, five, or six years compared to non-recipients.

Results of the cohort analysis show that students who received ACS scholarships during their sophomore year primarily drive the negative graduation effects observed in the pooled cohort model. Sophomore ACS recipients are between 50 and 60 percentage points less likely to

[4] We define on time graduation as graduating within 4 years of initial matriculation.

graduate in four, five, or six years relative to non-ACS recipient students in the same cohort. In contrast, junior recipients exhibit no difference in the likelihood of graduating, and students who received the ACS during their senior year of college are a statistically significant 52 percentage points more likely to graduate within six years compared to individuals who did not receive funding.

This study sheds light on the potential importance that the timing of receiving financial aid may play in influencing a student's postsecondary trajectory. The remainder of this paper proceeds as follows. We begin with a brief description of recent trends in financial aid, state-based merit aid, and the postsecondary outcomes attributed to these programs. We then describe the data and methodology used to estimate the impact of ACS on Current Achievers. After presenting our results and robustness checks, we conclude with a discussion of the implications and limitations of this work.

Background to the Arkansas Challenge Scholarship and Merit Aid Programs

The Arkansas Academic Challenge Scholarship

The goal of the Arkansas Academic Challenge Scholarship is "to provide meaningful financial help to those qualifying" (Arkansas Secretary of State, 2011). Given this loosely defined goal, the program provides merit-aid scholarships to students with relatively low eligibility criteria compared to other merit-aid programs, making it widely accessible to students in the state. The scholarship can be applied at both public and private, and 2- and 4-year colleges and universities within the state as long as students meet the eligibility criteria.

When the ACS was expanded in the fall of 2010, Current Achievers became automatically eligible for the scholarship if their GPA and credit enrollment met the ACS's eligibility criteria—earning at least a 2.5 GPA and completing at least 12 credit hours in the spring of 2010. In addition to these criteria, qualified applicants had to be in-state residents and complete both the Free Application for Federal Student Aid (FAFSA) and a one-page ACS application. Continued eligibility requires a minimum 2.5 GPA and enrollment in at least 15 credit hours. Aside from a few exceptions, eligible students can typically receive funding every semester of enrollment until they accrue 130 semester credit hours, at which point the scholarship becomes nonrenewable—although there are a few loopholes which may allow students to continue receiving funding past this threshold.

The ACS is a “last dollar” scholarship, designed to supplement, not supplant, existing financial aid a student receives.[5][6] Funding is provided at the beginning of each semester and is credited directly to the student’s university account. Our study examines the scholarship from 2010 to 2013. During that period, recipients were awarded $5,000 the first year of the scholarship, and $4,500 each subsequent year.[7] While the scholarship still exists, it was changed to a progressive pay structure in the 2013-14 school year and the program stopped accepting applications from new Current Achievers in June 2012.[8]

Existing Merit Aid Literature

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[5] Last dollar funding is applied after all other sources of financial aid, but before student loans.

[6] Scholarship money is credited directly to the student’s university account (50% each semester) after proof of enrollment is received by the State (Arkansas Department of Higher Education, 2010). Funding can be applied to both tuition and fees. Room and board cost are a grey area – the legislation does not explicitly state funding cannot be applied to room and board, thus individuals whose existing financial aid package already covers tuition and fees may have a portion of their room and board covered by the ACS. Therefore, students with differing financial aid packages may benefit from different amounts of actual ACS scholarship money. Our dataset is unable to account for these differences, therefore our analysis represents the result of receiving any money from the ACS.

[7] For comparison, the published tuition for the University of Arkansas-Fayetteville—the state’s flagship institution-was $5,010 in the 2010-11 school year (Source: National Center for Education Statistics, Integrated Postsecondary Education Data Systems (IPEDS): http://nces.ed.gov/ipeds/).

[8] Beginning with the 2013-14 cohort, the state decreased the initial award amount to $2,000 and progressively increased the amount received by $1,000 each subsequent year up to $5,000 during the fourth year (Kopotic, Mills, & Rhinesmith, 2019).

Several policies aim to improve both the rate at which individuals attend and successfully complete college, the most prevalent of which is financial aid. Financial aid generally works to improve college attendance by reducing the cost of college, which can be a substantial barrier to enrollment (Dynarski, 2008). Aid takes a variety of forms including grants, federal loans, education tax credits, and federal work-study funding (College Board, 2019). Grants represent funding provided directly to recipients with no expectation of repayment, whereas loans are awarded with repayment terms and accrue interest over time. Grant funding can either be need- or merit-based, awarded based on family income or academic achievement, respectively.

Eighteen different states currently offer some form of merit-based financial aid program (Education Commission of the States, 2020). There are generally three motivations for states to offer merit-aid programs: (1) increasing college enrollment by lowering the cost of attendance, (2) incentivizing high-performing high schoolers to stay in state, and (3) rewarding and promoting academic achievement and attainment (Cornwell, Lee & Mustard, 2005). Student outcomes may theoretically be improved by merit aid through two channels. First, the scholarship and its eligibility thresholds may incentivize students to maximize behaviors which are associated with college success (Scott-Clayton, 2012). Second, by reducing the cost of college access, merit scholarships may help minimize non-academic stress in students' lives, which could translate into higher achievement (Tinto, 2010).

Despite theoretical expectations, researchers have found mixed effects of such programs on student outcomes (Nguyen et al., 2019). Several studies show significant positive effects of merit-aid on college enrollment, persistence, cumulative GPA, total credits earned, the likelihood of graduation, graduate degree attainment and earnings (Angrist et al., 2014; Bettinger, 2004; Bettinger et al., 2019; Bruce & Carruthers, 2014; Cornwell, Mustard, and Sridhar, 2006; Henry, Rubenstein & Bugler, 2004; Dynarski, 2004; Dynarski, 2008; Goodman, 2008; Kane, 2003; Lee, 2018; Scott-Clayton, 2012, 2014, 2015; Scott-Clayton & Zafar, 2019; Sjoquist & Winter, 2015).

However, these positive findings appear to be highly context dependent, as results from other studies also demonstrate null to negative impacts on many of the same outcomes (Cornwell, Lee, and Mustard, 2005; Scott-Clayton, 2012; Cohodes & Goodman, 2014; Kopotic, Mills, & Hitt, 2019; Sjoquist & Winter, 2015). For example, in a 2015 meta-analysis of 25 state merit-aid programs implemented between 1991 and 2004, Sjoquist & Winter find overall null effects on degree completion. Similarly, Cornwell, Lee, and Mustard (2005), find a decreased likelihood of taking a full-time course load and an increased likelihood in enrollment in summer school classes, and Scott-Clayton (2012) finds no significant impacts on four-year college persistence. Cohodes & Goodman (2014), find that students provided tuition waivers through a Massachusetts merit aid program forgo college quality, demonstrate decreased year-to-year persistence, and have a lower college completion rate compared to students who did not receive a waiver. Partridge (2013) also finds that the Florida Bright Futures program also reduced year-to-year persistence by approximately four percentage points.

In the only experimental study of merit aid offers, Angrist and colleagues (2016) find that being randomly assigned to receive merit-aid increases both the probability of enrolling and persisting in college. They also demonstrate that students with relatively low academic achievement and those who enrolled in less-selective four-year institutions generated the largest gains in both outcomes. However, this study also indicates that students appear to delay graduation to a fifth year in order to maximize scholarship funding if the program is renewable beyond four years. A recent meta-analysis evaluating the effects of financial aid on persistence and graduation by Nguyen et al. (2019) shows that merit-aid only awards have smaller effects compared to needs-based awards, except for their positive findings on delayed graduation.

As these studies indicate, the relationship between merit-aid and student outcomes is complex. However, these papers focus exclusively on the impact of merit aid for individuals who qualify for funding in high school and must maintain good standing in college to continue receiving funds. Less is known about the role that these scholarships have on students who are already enrolled in college at the time they receive funding.

Theoretical Expectations

While prior studies help set expectations on the possible effects of the ACS, it is important to note that our research setting differs from most of the prior literature since we focus on currently enrolled college students rather than incoming freshmen. This distinction is important. Students who become eligible for financial aid while enrolled in college — and who may not have previously been receiving any financial aid in earlier years — differ from high school seniors and entering freshmen in significant ways that may influence their postsecondary outcomes. Entering freshmen, for example, have yet to prove if they are prepared for the demands of college and will be able to persist through their first year. On the other hand, current postsecondary students have already experienced the rigor of college courses, the challenge of autonomy, and the novelty of the college experience.

Differences in cognitive ability, aspirations, and other characteristics between all high school students and the subset that ultimately enroll and successfully complete at least one year of college also raise questions about effect heterogeneity across the two groups. Since effects may differ for these two groups, we inform our theoretical expectations for this study by broadly considering perspectives from existing merit aid research, as well as literature from sociology and economics.

There are several reasons to believe that merit aid will positively impact currently enrolled college students. Prior literature demonstrates that initial and continuing eligibility criteria can motivate students' productive behaviors. For example, Scott-Clayton (2012) shows that college students who are aware of eligibility criteria are more likely to meet renewal requirements and graduate compared to non-recipients. Similarly, Barrow & Rouse (2013) determine financial incentives promote academic effort for postsecondary students and show that students stop responding to incentives once they are no longer eligible to renew their scholarships. It is also possible that undergraduate sophomores, juniors, and seniors respond to these incentives in different ways. Such incentives, for instance, may be less salient for seniors who are nearer to completing postsecondary education than sophomores who must cover the costs of college for a few more years.

Beyond the possible incentives that eligibility thresholds provide, receiving money may also alter students' postsecondary experience in ways that can generate positive academic outcomes. Integration theory, for example, argues that student postsecondary outcomes result from their level of academic and social integration on campus (Spady, 1971; Tinto, 1988; Pascarella & Terenzini, 1983). Since monetary support removes the requirement to acquire outside work—thereby freeing up time for academics and socializing—receiving financial aid is hypothesized to increase student integration (Tinto, 2010). Students who are more highly integrated on campus are more likely to persist and thrive. Therefore, Current Achievers may experience higher levels of integration after receiving the ACS and subsequently demonstrate positive academic outcomes relative to their non-recipient peers. Moreover, the salience of receiving aid to better integrate into their college environment likely varies by cohort.

In contrast, it is feasible that providing funding to currently enrolled college students may unintentionally lead to non-productive outcomes. While integration theory feasibly posits that students who are more highly integrated into the campus experience are more likely to persist than poorly integrated peers, it also explains why individuals may choose to remain enrolled and delay labor market participation (Tinto, 2010). For example, students who are highly integrated in their academic and social lives may want to remain on campus longer, forgoing on time graduation. This desire to prolong enrollment may be especially true for financial aid recipients, for whom the opportunity cost of delayed graduation may be lower if scholarships are available beyond four years.

Research on scholarship aid programs provides some evidence in support of this theory suggesting that students will take advantage of all available years of scholarship funding, even if it means delaying graduation (Angrist, et al., 2016; Carlson et al., 2020). It is not out of the question, therefore, that ACS recipients may be motivated to delay graduation to maximize scholarship funding until they reach the 130-credit accumulation cutoff or find a way to circumvent it (which is possible in some circumstances). Among ACS recipients, sophomores may have more flexibility for delaying graduation relative to juniors and seniors who have already accumulated more credits. It is important to note, delaying graduation is not necessarily a negative outcome for students, especially if labor market prospects are not favorable or students need more time to accrue knowledge.

There are other reasons to believe currently enrolled students may engage in non-productive behavior after receiving merit aid. One theory from economics, the “house money effect," explains how individual risk-aversion changes when gamblers play with their own money versus "house" money (Thaler & Johnson, 1990). Thaler & Johnson (1990) show that individuals are less risk-averse with "house" money they unexpectedly receive from winning. Along these lines, students who move from paying for college out of pocket or via loans to receiving it at low or no cost, may be tempted to engage in riskier behavior. Therefore, Current Achievers may choose to decrease their focus on coursework to capitalize on the social benefits of college, detrimentally impacting their academic outcomes.

Despite ACS eligibility criteria designed to prevent delayed graduation and negative outcomes, there are several reasons why a student may be able to continue receiving money without maintaining eligibility criteria. For example, students may take a high number of credits (18-20) prior to receiving the scholarship and reduced their credit load upon receipt. In the absence of financial pressure, individuals may also elect to change majors, allowing them to meet the continued eligibility criteria but delaying graduation. For example, Sjoquist and Winters (2015) find that students receiving the Georgia HOPE scholarship were likely to switch from a STEM to a non-STEM major to maintain scholarship eligibility. Students could have enrolled in 15 or more credits to receive funding but dropped classes later in the semester. Unfortunately, we do not have data on attempted versus earned credits to answer this question. Finally, there were loopholes which allowed students to continue receiving the scholarship without meeting the eligibility criteria through voluntary literacy tutoring or institutional leeway on the number of credits they had to maintain.

While our research informs theories about the effect of money on students postsecondary outcomes, it is important to note that our estimated effects of the Academic Challenge Scholarship do not represent the influence of money alone on student outcomes. Rather, they capture the effect of treatment, which includes both the merit aid and the continued eligibility criteria. Moreover, since this paper estimates the impact of ACS on students at one particular university in Arkansas, our findings cannot be generalized to other student populations.

Materials and Methods

To estimate the impacts of receiving the ACS on postsecondary outcomes we leverage ACS's strict eligibility requirements for currently enrolled students to implement a regression discontinuity (RD) design. This allows us to estimate the impact of the program for students near the eligibility threshold without the confounding influence of unobservable factors (van der Klaauw, 2003; Kane, 2003; Dynarski, 2008; Scott-Clayton, 2012).

Data

We estimate the impacts of the ACS on college outcomes using detailed administrative data on students at a large public Arkansas university (LAU). These data include student level demographics, high school qualifications, information on credit accumulation, cumulative GPA, student major by semester, and family financial data. To study the program's impact on Current Achievers, we limit our sample to cohorts entering their sophomore, junior, and senior years when the ACS was expanded in the fall of 2010. We also restrict our analysis to in-state students who filled out a FAFSA at the time of their initial application to match ACS eligibility requirements.[9] After making these selections, we are left with an analytical sample comprising 385 students across three cohort years.[10]

[9] We identify students as having filled out a FAFSA if their record indicates an expected family contribution. LAU populates these data using FAFSA data. The analytic sample is further restricted to the chosen RD bandwidth, discussed later in this section.

[10] While this sample is limited in size, we leverage high powered robustness checks to determine the validity of our findings.

Table 1 provides descriptive statistics for our analytic sample. On average, our analytic sample is largely White, about half are male, half have parents who attended college, and half come from the youngest cohort (Sophomores). Students in the analytic sample also appear to be evenly distributed between expected family contribution quartiles.[11] These descriptive statistics are comparable on most characteristics to the general student population at the LAU.[12]

[Table 1 about here]

Analytic Strategy

Current Achievers became eligible for the ACS if they met both eligibility requirements in the spring of 2010: full-time enrollment in at least 12 credit hours and a minimum 2.5 cumulative GPA. While credit hours may appear to be a continuous variable, it is at best ordinal when restricted to a narrow band around the credit hour threshold. This ordinality violates the continuity requirement of assignment variables in regression discontinuity design (Imbens & Leimux, 2008). To address this issue, we conduct a frontier analysis, reducing the dual rating variables to a single rating variable by first conditioning on credit hours and then estimating the discontinuity around the GPA threshold (Reardon and Robinson, 2012; Porter, et al., 2014). This method allows us to estimate the effects of the ACS on college outcomes driven by a comparison of individuals meeting the ACS credit hours requirements with cumulative GPAs within a small range around 2.5 GPA points.[13]

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11 Financial resources are measured using the Expected Family Contribution amount generated from the student's administrative records. We divide this EFC into quartiles and control for each EFC level as a proxy for family income with the highest EFC corresponding to the highest income bracket, and so on.

12 See Appendix Table A1 for a comparison of descriptive statistics for the analytic sample and an expanded sample of all FAFSA-filing students at the LAU.

13 Previous RDD studies of the effects of financial aid on students have similarly examined impacts while conditioning on one or more assignment variables (Kane, 2003; Scott-Clayton, 2012).

The fuzzy regression discontinuity model

Figure 1 provides a scatter plot of our forcing variable (pre-ACS GPA) versus predicted scholarship receipt, which allows us to investigate how treatment assignment varies with GPA. Figure 1 shows a small degree of noncompliance with eligibility status is apparent in the data. While the program's eligibility requirements are technically strict in nature, we observe a compliance rate ranging between 30-40 percent in our dataset.

There are several reasons we may observe these low compliance rates. Students who were eligible for ACS still had to apply to receive the scholarship. This included filling out a Free Application for Federal Student Aid (FAFSA) as well as a one-page ACS-specific application. The complexity of the financial aid system, especially the various applications such as the FAFSA, has been shown to discourage eligible students from applying to receive funding (Dynarski & Scott-Clayton, 2006).

In addition, the scholarship was passed into law at the end of April 2010, the very end of the semester at the university. Therefore, eligible individuals may not have been well informed about the option to receive the scholarship, especially if it was not heavily advertised. Moreover, students in their sophomore, junior, and senior years are not typically seeking new scholarship opportunities as actively as entering freshman. It may have been the case that only students who had regular relationships with the financial aid office became aware of and applied for the scholarship. This would represent a small proportion of the overall pool of eligible students.

Beyond the information disruptions which may have caused noncompliance, this is a last-dollar scholarship, meaning that it is applied to tuition and fees only after all other financial aid has been exhausted, and is not eligible to cover room and board costs. Therefore, it is feasible that eligible students whose financial needs were already met through other first-dollar sources of aid (such as federal funding) may not have applied for the scholarship. This same logic applies to higher income students who were eligible but did not need the financial assistance.

Finally, while this take-up rate may seem alarming low, other papers, such as Goldhaber et al. (2019) find similarly low uptake by eligible students (39%). Moreover, low uptake may be especially likely in the initial years a program is implemented (Brooks, 2016). Regardless of the reason, we implement a fuzzy regression discontinuity design to address noncompliance and estimate the effect of the program on student outcomes.[14] Along with providing intent-to-treat estimates by comparing outcomes for students just above and below the eligibility threshold, we estimate the following two-stage least squares (2SLS) model using qualification as an instrumental variable (IV) to predict scholarship receipt:

$$R_i = a + bQualify_i + f(cGPA_i)'c + f(cGPA_i xQualify_i)'d + X_i'g + \gamma_i + e_i \qquad (1)$$

$$Y_i = \alpha + \beta\widehat{R_i} + f(cGPA_i)'\delta_1 + f(cGPA_i xQualify_i)'\delta_2 + X_i'\gamma + \gamma_i + \epsilon_i \qquad (2)$$

In these equations R_i indicates observed ACS receipt, $Qualify_i$ is a binary indictor which equals one if an individual qualified for the scholarship and zero otherwise, $f(.)$ is a first-order polynomial function of the centered pre-ACS GPA assignment variable (*cGPA*), X_i' is a vector of demographic control variables including student gender, ethnicity, and financial resources, and γ_i represents cohort fixed effects. All models first condition on having met the minimum

[14] This technique has been commonly used in papers examining the effects of financial aid on college enrollment (van der Klaauw, 2002; Kane, 2003; Scott-Clayton, 2012) and outcomes (Scott-Clayton, 2012).

initial credit hour requirement of 12 credits, as previously described.[15] If one's qualification status successfully predicts the probability of receiving a scholarship and our model sufficiently captures the underlying relationship between the assignment variable and our outcomes of interest, then β represents the causal effect of receiving an ACS for those individuals near the 2.5 GPA threshold.

Outcome variables of interest

Our aim is to estimate the impact of receiving the ACS on both short- and long-term college outcomes. These include cumulative GPA[16], persistence, and credit accumulation one year after receiving the scholarship. We also consider credit accumulation two years after receiving the scholarship[17], final observed GPA, and the likelihood that a student graduates in four-, five-, or six-years post-matriculation.[18] Continuous variables are estimated using linear IV, while binary variables are estimated using IV probit specifications.[19]

Figure 2 provides a first look at how ACS qualification is related to our outcome variables of interest. These graphs depict simple regressions of the eight outcome measures against cumulative GPA in the spring of 2010 (hereafter pre-ACS GPA), which has been centered at the ACS cutoff of 2.5 GPA points. All models condition on meeting the ACS credit

[15] We also control for students who may not meet the continuing eligibility requirements by including a dummy variable, which equals one if a student had less than 15 credit hours in any semester after the initial eligibility window, zero otherwise. This is captured in our model in the $X_i^{'}$ vector of student characteristics.

[16] Following Scott-Clayton (2012), we impute for missing values of GPA in this semester and final observed GPA using previously observed cumulative GPA values for the student. This procedure is repeated for missing credit hour values using credit hours accumulated in earlier semesters.

[17] Credit accumulation after one and two years are calculated as the difference between credit hours accumulated in the spring of 2010 and those accumulated by the end of the spring 2011 and spring 2012 semesters, respectively.

[18] Graduation indicators are binary variables collected from LAU's administrative data indicating if a student received a diploma by their 9th, 11th, or 13th semester, respectively.

[19] Results are robust to models which estimate binary outcomes using linear probability models, which can be found in Appendix Table A10.

hours requirement and control for the underlying relationship between outcomes and pre-ACS GPA using a local linear specification—the same specification that we employ in equations 1 and 2.[20] The graphs are restricted to a pre-ACS GPAs ranging between 2.166 and 2.834 points (or a band of 0.334 GPA points[21]). Because ACS qualification does not perfectly predict receipt, these graphs represent intent-to-treat estimates.[22] The graphs presented in Figure 2 provide evidence suggesting negative impacts across all outcomes of interest, especially credit accumulation after two years and all three graduation measures.

[Figure 2 about here]

Validation of the Regression Discontinuity

Density of pre-ACS GPA assignment variable

Figure 3 presents the density of the assignment variable at different GPA values ranging from 1.0 to 4.0, relative to the 2.5 GPA eligibility cutoff in two ways: (a) a histogram depicting individuals within 0.05 GPA point bins and (b) a polynomial regression line overlay which includes and excludes the 2.5 GPA bin grouping. Ideally, we would examine a relatively smooth density to the left and right of the cutoff — as a discontinuous density is suggestive of strategic manipulation of the assignment variable (Imbens & Lemieux, 2008; Scott-Clayton, 2012).

[Figure 3 about here]

The results presented in Figure 3 indicate a small increase in the grouping of individuals scoring at or slightly above a 2.5 in the spring of 2010. While this discontinuity potentially

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[20] We recreate these graphs using a quadratic specification for comparison but adhere to the local linear model for our main graphs and specifications (see Appendix Figure A1).

[21] Bandwidth has been determined using a combination of visual and mechanical selection [see Calconico, Cattaneo, & Titiunik (2014)] and by implementing the cross-validation procedures outlined in Imbens & Lemiux (2008).

[22] The difference between receipt and qualification suggests that we can get a good approximation of the treatment-on-treated impact estimates by dividing the intent-to-treat estimates by 0.35.

violates the smoothness assumption required for regression discontinuity designs, if individuals are unaware of the selection rule for treatment and do not have time to adjust their behavior, it is less likely that manipulation is present (McCrary, 2008). Luckily, ACS eligibility requirements were officially passed and made public in April 2010, leaving little opportunity for students to strategically manipulate their GPAs since the semester at the LAU ends around April 30th (Arkansas Department of Higher Education, 2010).

Results of a McCrary test (Figure 4) also indicate no statistically significant difference in the density of the assignment variable on either side of the GPA threshold.[23] Therefore, we believe the discontinuity observed in Figure 3 likely represents a random distortion in the data rather than strategic manipulation.

[Figure 4 about here]

Baseline equivalence

For regression discontinuity designs to be internally valid it is important to have baseline equivalence between groups above and below the cutoff (Imbens and Lemieux, 2008). Table 2 presents results of baseline equivalence tests for our analytic sample.[24] Our analytic sample is relatively well balanced on covariates apart from high school GPA and the proportion of juniors and sophomores in the sample. Students above the cutoff are more likely to have a higher GPA and be a sophomore in college relative to those below the cutoff. On the other hand, students

[23] McCrary test estimated a log difference in height of 0.399 on either side of the cutoff with a standard error of 0.330, which is not statistically significant. We repeat this test, dropping the 2.5 GPA bin grouping and find a log difference in height of -0.124 with a standard error or 0.411. Neither result indicates concern for gaming of the GPA cutoff.

[24] We also investigate the external validity of our sample by comparing the analytic sample to an expanded sample that includes all eligible in-state students regardless of whether they met the eligibility criteria. See Appendix Table A1 for details.

above the cutoff are less likely to be juniors or seniors. To address these imbalances, we control for these covariates in our regression to mitigate potential bias and perform specification checks, including a randomization inference exercise, to determine the ability of our controls to minimize potential confounding. We also conduct a separate cohort analysis to determine the effect that the timing of receiving financial aid has on postsecondary outcomes.

[Table 2 about here]

Results

Pooled Cohort Analysis

Table 3 presents the findings from our primary analysis using the pooled cohort of students. First stage point estimates suggest that ACS qualification is a relevant predictor of ACS receipt, with take-up probabilities ranging between 30 and 40 percentage points.[25] In addition, the first stage joint F-statistics are greater than 10 in all models presented, satisfying Staiger and Stock's (1997) recommended threshold for instrumental variable relevance.

The first two columns of Table 3 provide control group means and intent-to-treat estimates for each outcome variable, respectively. The remaining columns show the estimated local average treatment effect of the ACS on our continuous and binary outcomes of interest.[26] Column 3 lists results for our preferred pre-ACS GPA band of .334 GPA points without controls included. Column 4, our preferred specification, lists results with the same bandwidth but includes control variables for student background characteristics. Columns 5 and 6 present results from fully specified models employing larger and smaller pre-ACS GPA bands which are used to check the stability of our results.

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[25] A table of first stage regression results including F-statistics can be found in Appendix Table A2.
[26] Parameter estimates for binary outcome variables represent average marginal effects.

Our preferred model, in Column 4, which includes the full set of covariates, suggests that ACS recipients score on average 0.12 GPA points lower, are 8 percentage points less likely to persist, and accumulate about 8 fewer credits after one year, compared to their non-recipient counterparts. Similarly, two years after receiving the scholarship, recipients had accumulated approximately 18 fewer credits than their non-ACS peers. ACS recipients also experienced negative impacts on final observed GPA, earning about 0.30 GPA points lower relative to non-recipients. However, none of these results are statistically distinguishable from zero.

[Table 3 about here]

On the other hand, point estimates for graduation outcomes are large, negative, and statistically significant. ACS recipients are significantly less likely to graduate within four, five, or six years of matriculation. Local average treatment effect estimates suggest ACS recipients are 41 percentage points less likely to graduate within four years. Recipients do not catch up by years five or six and are about 54 and 46 percentage points less likely to graduate in five or six years relative to their peers, respectively.

Specification Checks

Our results are robust to several specification checks. First, we vary the bandwidth around the discontinuity – investigating whether our point estimates vary with wider and narrower bandwidths. The effect estimates—presented in Table 3, Columns 5 and 6—are not particularly susceptible to bandwidth alteration. We also test whether prior ACS Recipients bias our findings by dropping them from our data and re-running the model, finding no evidence that our results are sensitive to this change.[27]

[27] Results for models run excluding prior ACS recipients can be found in Appendix Table A4.

As an additional check, we estimate ACS effects on a "placebo" sample of students who matriculated at LAU in cohort years 2004-05, 2005-06, and 2006-07 and could not have been eligible for the scholarship. All students included in our placebo analysis meet the same requirements of our analytical sample. As expected, ACS qualification is not significantly related to any of the postsecondary outcomes.[28] More importantly, all estimated effects are substantively small; providing strong evidence that ACS qualification was not related to outcomes in these earlier cohorts.

To further investigate the validity of our findings, especially the large negative results for graduation, we conduct a randomization inference exercise. Randomization inference is helpful in settings with finite samples, such as ours, where large sample approximation approaches may not be valid (Cattaneo, Frandsen, and Titiunik, 2015). Following Cattaneo, Frandsen, and Titiunik (2015) and Cattaneo, Titiunik, and Vasquez-Bare (2016) we test Fisher's sharp null hypothesis of no treatment effect, running 10,000 iterations for each outcome of interest over a window selected for covariate balance to approximate random assignment. This test provides us the likelihood we would observe the results of our main two stage least squares analysis due only to chance. If we reject the sharp null hypothesis of no treatment effect in the randomization inference exercise it provides further evidence that the results of our main analysis are capturing the true program effect and are not spurious in nature.

When pooling cohorts, results of the randomization inference exercise indicate consistently negative and statistically significant results for all outcome variables except GPA

[28] The results of our placebo analysis are presented in Appendix Table A5. The placebo analysis estimates the intent-to-treat effect of ACS qualification since no individuals received a scholarship during these years.

one year after scholarship receipt.[29] These results are consistent in magnitude and direction with the point estimates from our main analysis. Graduate results are strongly negative and statistically significant at the 1% significance level. Unlike the LATE estimates from the main two stage least squares analysis, short-run outcomes are now statistically significant, indicating both negative short and long-run outcomes. These findings suggest our LATE estimates from the main analysis are accurately capturing program effect despite our limited sample size and mitigate the likelihood they are driven by model specification issues.

Cohort Analysis

To test for effect heterogeneity, we conduct a secondary analysis to separate effects out by cohort, using the same analytic approach outlined in Equations (1) and (2). Results of the cohort analysis, found in Table 4, demonstrate significant heterogeneity in the estimated effect of the ACS on our outcomes of interest. Column 1 depicts our local average treatment effects from the earlier pooled cohort analysis as a comparison. The remaining columns (2-4) show point estimates for the senior, junior, and sophomore cohorts, respectively. Point estimates vary in magnitude and direction for the three cohorts of students. Results are mixed for seniors and juniors, while point estimates for sophomores are consistently large and negative, however estimates for all short-run outcomes and final observed GPA are insignificant.

Graduation effects also vary by cohort. Senior ACS recipients appear to continue along their trajectory relatively uninterrupted, demonstrating small positive, but insignificant differences in the likelihood of graduating in four or five years. However, individuals who qualify for the ACS are 54 percentage points more likely to graduate within six years relative to

[29] Results for our randomization inference exercises can be found in Appendix Table A6 (pooled cohorts) and Appendix Table A7 (separate cohorts).

their peers who do not receive funding. Findings for the junior cohort are slightly negative but imprecisely estimated, indicating no detectible change in degree attainment for junior ACS recipients relative to the status quo.

Sophomores, however, display large, statistically significant declines in the likelihood of graduating within four, five, or six years. Results indicate that sophomores who qualify for the ACS are between 50 to 60 percentage points less likely to graduate on time or at all compared to their non-recipient counterparts.

[Table 3 about here.]

To inspect the validity of our cohort analysis we repeat the randomization inference exercise implemented for the main analysis with separate cohorts. Randomization results are similar in magnitude and direction for all outcomes of interest. However, randomization inference results show short-run outcomes are statistically significant for some cohorts, especially the sophomores who exhibit large, negative, and statistically significant declines in credit accumulation after one and two years, persistence, and final observed GPA.[30]

Discussion

This paper examines the effect of the Arkansas Academic Challenge Scholarship—a broad state-financed merit-aid scholarship—on college outcomes at a public university in Arkansas. Our results suggest that the scholarship had no statistically distinguishable impact on short- and long-run cumulative GPA, persistence after one year, and credit accumulation after both one and two years, despite consistently negative point estimates. On the other hand, ACS recipients appear to have a significantly lower likelihood of graduating within four, five, and six

[30] Appendix Table A7 provides results for the randomization exercise separated out by cohort.

years relative to non-recipients. Although we have a limited sample size, multiple robustness checks, including a randomization inference exercise, provide more confidence in the validity of these findings.

To investigate these results further and to understand more clearly the influence that the timing of merit-aid receipt may have on postsecondary outcomes, we conduct a second analysis separating effects out by cohort. Our findings indicate that the negative point estimates from the main analysis are primarily driven by the younger cohort, who began receiving funding during their sophomore year of enrollment. However, this analysis also reveals that seniors who do not graduate on time are 54 percentage points more likely to graduate within 6 years of matriculation when they receive the scholarship.

These results highlight the fact that the timing of receiving money may heavily influence student behavior and outcomes. Students who receive funding after their first year of college, but who can still dramatically alter their trajectory, may engage in non-productive decision-making. Moreover, these younger individuals appear to change their behavior immediately after receiving funding. Sophomores who received the ACS accumulated approximately 18 fewer credits within the first year after receiving the scholarship. While statistically insignificant, the decrease in credit hour enrollment is in line with the graduation declines we uncover for that same cohort. It is possible these changes reflect a newfound freedom of choice where students acquire the ability to experiment more with coursework or major options. We do not investigate these questions in this analysis and encourage future research to examine possible student behavioral changes upon receiving financial aid. Such research would be beneficial in understanding what underpins these negative results.

On the other hand, receiving the ACS appears to generate positive outcomes for older individuals in the dataset. While seniors who receive the funding during their fourth year of enrollment do not graduate at higher rates that same year, or the subsequent year, they are significantly more likely to graduate within six years. It is possible that students who would not have completed college due to funding constraints may have benefitted from receiving the ACS in their senior year. For example, a student who is lacking the credit hours required to graduate, but who may have exhausted other financial options, could benefit significantly from the added financial security that the scholarship provides late in their college trajectory. An analysis investigating the characteristics of seniors who do not graduate within 4 or 5 years but subsequently earn a degree in their sixth year would help uncover some of the driving factors influencing this result.

While our findings differ from many earlier analyses of state-financed merit-aid programs, there are understandable reasons for these divergent results. First, we examine a substantively different student population compared to prior studies. Our study is focused on students who were currently enrolled in college when they became eligible for the ACS (as opposed to entering freshmen), meeting relatively weak academic credential requirements. Second, our cohort analysis raises the possible influence that the timing of receiving money has on student behavior, which has not been previously studied in merit aid literature.

This work represents a case study of a small group of students at a public university in the state of Arkansas. As such, our findings have limited transferability to other settings. This study also employs a limited sample of students, which may make our findings susceptible to issues of finite sample bias. While our randomization inference exercise lends credibility to our findings, we still encourage readers to interpret these results with caution. Moreover, this study cannot disentangle the effect of money alone on student outcomes. Rather, it represents an analysis of ACS treatment, which includes completing the one-page application and FAFSA, receiving funding, and meeting the continuing eligibility criteria. Future work should continue investigating the link between merit-aid and college outcomes for unique student groups and further determine the extent to which the timing of receiving funding matters for student postsecondary decision-making. Investigating such heterogeneity will benefit the broader financial aid literature and help inform financial aid policymaking.

Nexus

Prior research on merit-aid has demonstrated that students will shift towards pro-academic behaviors in response to the incentives embedded in eligibility criteria (Hernandez-Julian, 2009; Scott-Clayton, 2011). If it is true that eligibility thresholds motivate students to engage in academically productive behavior, then perhaps the structure of the ACS did not provide adequate incentives to promote scholastic performance for students. This may be especially true when we consider the difference between students who are entering college for the first time versus those who have completed one or more years of postsecondary education.

Since currently enrolled students were already performing at the required levels, they may not have perceived future eligibility criteria as a hurdle to scholarship receipt. They may also have perceived the funding as a reward for prior performance. Therefore, they may be lacking motivation to improve their academic outcomes beyond prior levels or see their current performance as adequate.

On the other hand, receiving the ACS may have encouraged seniors who would otherwise not have graduated to persist to degree completion by alleviating financial burdens or providing a much-needed motivational boost. While this may not be the intended impact of the ACS, it nevertheless may help to explain why our findings differ from other studies.

The question of money and motivation has significant policy implications. Our findings indicate that eligibility-embedded incentives and the timing of scholarship receipt may play a significant role in driving student outcomes. However, to date, little research has taken place that specifically investigates this question. Understanding how money influences post-secondary outcomes in the absence of prior motivation or eligibility criteria may also help improve policies pertaining to the timing, quantity, and targeting of scholarship funds.

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Main Text Tables

Table 1: Descriptive statistics for analytic sample

	N	Mean	*s.d.*	Min	Max
	(1)	(2)	(3)	(4)	(5)
Male	385	0.52	0.50	0.00	1.00
Ethnicity					
Black	51	0.13	0.34	0.00	1.00
White	294	0.76	0.43	0.00	1.00
Hispanic	20	0.05	0.22	0.00	1.00
Other	21	0.05	0.23	0.00	1.00
Parent went to college	269	0.53	0.50	0.00	1.00
High School GPA	385	3.40	0.34	2.08	4.34
ACT Composite	384	23.73	3.13	16.00	33.00
EFC Percentile					
0-24	61	0.16	0.37	0.00	1.00
25-49	83	0.22	0.41	0.00	1.00
50-74	111	0.29	0.45	0.00	1.00
75-100	131	0.34	0.47	0.00	1.00
Cohort					
Senior	61	0.16	0.36	0.00	1.00
Junior	124	0.32	0.47	0.00	1.00
Sophomore	201	0.52	0.50	0.00	1.00

Note. Individuals included in the analytical sample have submitted a FAFSA, applied to LAU from within Arkansas, met the ACS credit hours requirement of 12 hours, and had a pre-ACS cumulative GPA between 2.166 and 2.834 GPA points. EFC refers to expected family contribution. *Source*. Authors' calculations.

Table 2: Baseline equivalency test for analytic sample

	Analytic Sample (N=383)		
	Above Cutoff	**Below Cutoff**	**Difference**
	(1)	(2)	(3)
Male	0.51	0.55	-0.04
Black	0.11	0.17	-0.06
White	0.78	0.73	0.06
Hispanic	0.06	0.04	0.02
Other	0.05	0.07	-0.02
First gen.	0.51	0.57	-0.06
HS GPA	3.41	3.35	0.07**
ACT	23.88	23.38	0.50
0-24	0.17	0.13	0.03
25-29	0.23	0.19	0.04
50-74	0.29	0.28	0.02
75-100	0.31	0.40	-0.09
Cohort			
Senior	0.12	0.17	-0.06*
Junior	0.24	0.36	-0.11**
Sophomore	0.64	0.47	0.17***

Note. Individuals included in the analytical sample have submitted a FAFSA, applied to LAU from within Arkansas, met the ACS credit hours requirement of 12 hours, and had a pre-ACS cumulative GPA between 2.166 and 2.834 GPA points. *, **, *** represent statistical significance at the 10%, 5%, and 1% significance level, respectively. EFC refers to expected family contribution. *Source*. Authors' calculations.

Table 3. Estimated ACS Effects on Student Postsecondary Outcomes, Pooled Cohorts

	Control Group Mean	ITT	Local Average Treatment Effect			
			Simple Model	Preferred Model	Wide Band	Narrow Band
	(1)	(2)	(3)	(4)	(5)	(6)
Probability of Persisting	0.79	-0.05	-0.10	-0.08	0.01	-0.19
		(0.08)	(0.26)	(0.22)	(0.17)	(0.23)
GPA (1 Year Later)	2.36	-0.03	-0.10	-0.11	-0.10	0.12
		(0.05)	(0.15)	(0.12)	(0.12)	(0.16)
Yr. 1 Credit Accumulation	27.59	-2.80	-8.37	-8.42	-6.76	-6.90
		(1.82)	(5.82)	(5.65)	(4.98)	(7.07)
Yr. 2 Credit Accumulation	54.00	-5.44	-17.43	-16.17	-4.23	-25.49
		(3.48)	(14.32)	(11.69)	(7.57)	(17.13)
Final Observed GPA	2.42	-0.07	-0.21	-0.25	-0.10	-0.04
		(0.06)	(0.21)	(0.16)	(0.14)	(0.19)
Probability of Graduating						
Within 4 Years	0.19	-0.16	-0.40**	-0.41***	-0.37***	-0.48***
		(0.10)	(0.16)	(0.13)	(0.12)	(0.14)
Within 5 Years	0.44	-0.30**	-0.51***	-0.52***	-0.41***	-0.54***
		(0.12)	(0.08)	(0.08)	(0.11)	(0.11)
Within 6 Years	0.56	-0.22**	-0.46***	-0.46***	-0.30*	-0.47***
		(0.11)	(0.12)	(0.12)	(0.17)	(0.16)
Controls						
Student demographics				X	X	X
Family income				X	X	X
Observations	254 - 386	254 - 386	254 - 386	254 - 385	356 - 530	178 - 269
Clusters (College Major)	69 - 75	69 - 75	69 - 75	69 - 75	71 - 79	57 - 65
ACS GPA Band	0.334	0.334	0.334	0.334	0.434	0.234

Note. Standard errors (parentheses) account for clustering of individuals in major. *** p<0.01, ** p<0.05, * p<0.1. All models also include controls for entering cohort year, credit hours below the 15 continued eligibility requirement, and local linear functions of the assignment variable, centered pre-ACS GPA. Binary outcomes are estimated using IV probit specifications, point estimates represent average marginal effects. *Source.* Authors' calculations.

Table 4. Estimated ACS Effects on Student Postsecondary Outcomes, Separated by Cohort

	Main Analysis	Senior Cohort	Junior Cohort	Sophomore Cohort
	(1)	(2)	(3)	(4)
Probability of Persisting 1 Year	-0.08	0.06	0.18	-0.33
	(0.22)	0.5119	0.2252	(0.31)
GPA (1 Year Later)	-0.11	0.18	0.10	-0.36
	(0.12)	0.2297	0.1321	(0.26)
Yr. 1 Credit Accumulation	-8.42	-4.19	2.82	-20.39
	(5.65)	10.8281	5.5825	(12.64)
Yr. 2 Credit Accumulation	-16.17	n/a	2.33	-27.47
	(11.69)	n/a	10.2735	(21.64)
Final Observed GPA	-0.25	0.01	0.06	-0.57
	(0.16)	0.2087	0.1533	(0.41)
Probability of Graduating				
Within 4 Years	-0.41***	0.05	-0.24	-0.51***
	(0.13)	0.7699	0.3719	(0.11)
Within 5 Years	-0.52***	0.22	-0.31	-0.60***
	(0.08)	0.6185	0.324	(0.04)
Within 6 Years	-0.46***	0.52***	-0.05	-0.59***
	(0.12)	(0.16)	(0.32)	(0.05)
Controls				
Student demographics	X	X	X	X
Family income	X	X	X	X
Observations	254 - 385	38 - 59	93 - 124	150 - 201
Clusters (College Major)	69 - 75	25 - 35	48 - 57	48 - 56
ACS GPA Band	0.334	0.334	0.334	0.334

Note. *** p<0.01, ** p<0.05, * p<0.1. Standard errors (parentheses) account for clustering of individuals in major. All models also include controls for entering cohort year, credit hours below the 15 continued eligibility requirement, and local linear functions of the assignment variable, centered pre-ACS GPA. Binary outcomes are estimated using probit specifications, point estimates represent average marginal effects. *Source.* Authors' calculations.

Figures

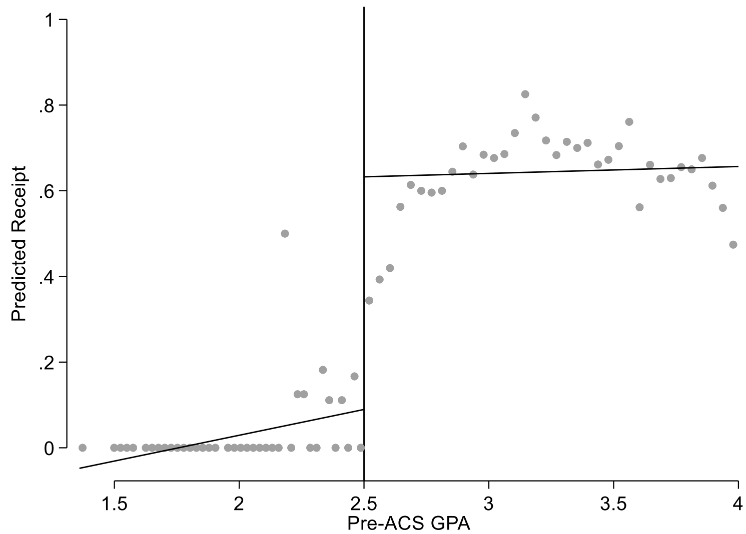

Figure 1. Scatter plot of rating (Pre-ACS GPA) versus predicted scholarship receipt. *Source*: Authors' calculations.

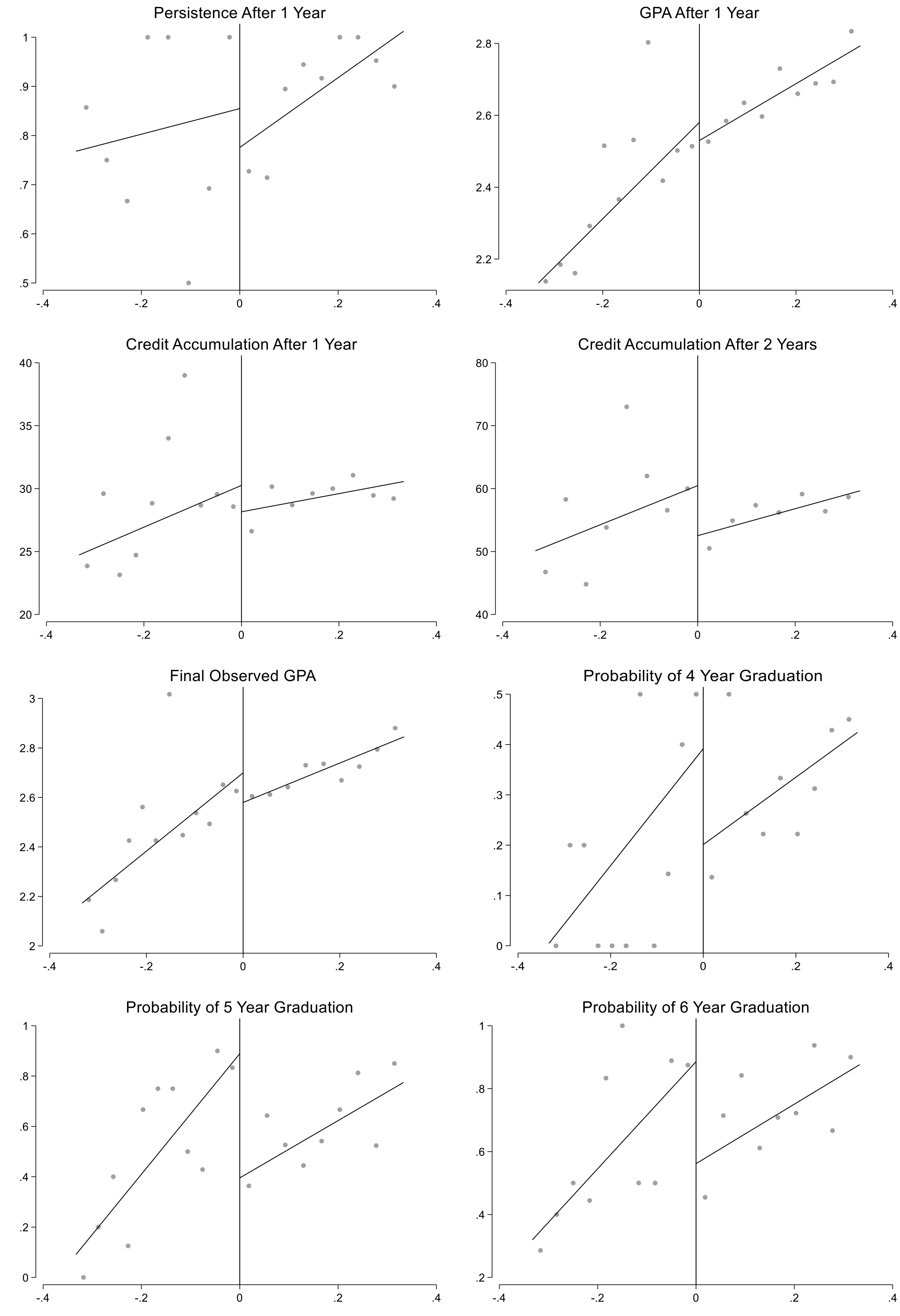
Persistence After 1 Year
GPA After 1 Year
Credit Accumulation After 1 Year
Credit Accumulation After 2 Years
Final Observed GPA
Probability of 4 Year Graduation
Probability of 5 Year Graduation
Probability of 6 Year Graduation

Figure 2. Scatterplots of each outcome variable by centered pre-ACS GPA assignment variable, conditional on meeting the ACS hours requirement. All graphs employ a local linear specification for the assignment variable and are restricted to our primary analytical range of 2.166 to 2.834 pre-ACS GPA points. *Source*: Authors' calculations.

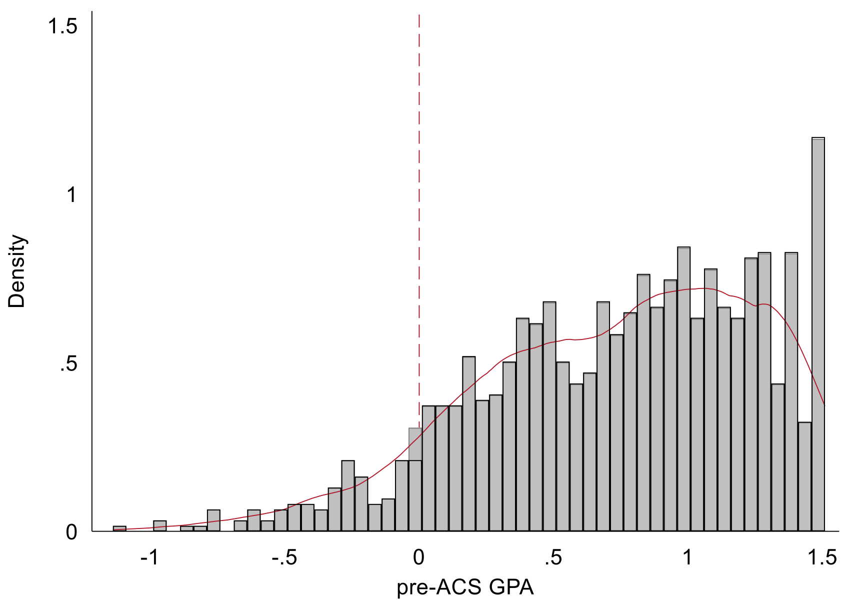

Figure 3. Graph of density by Centered pre-ACS GPA assignment variable with kernel density overlay. Bins represent .05 GPA point gaps. All individuals have met the ACS hours threshold. The two bars to the left of the threshold represent two superimposed graphs, one including and one excluding the 2.5 bin grouping. *Source.* Authors' calculations.

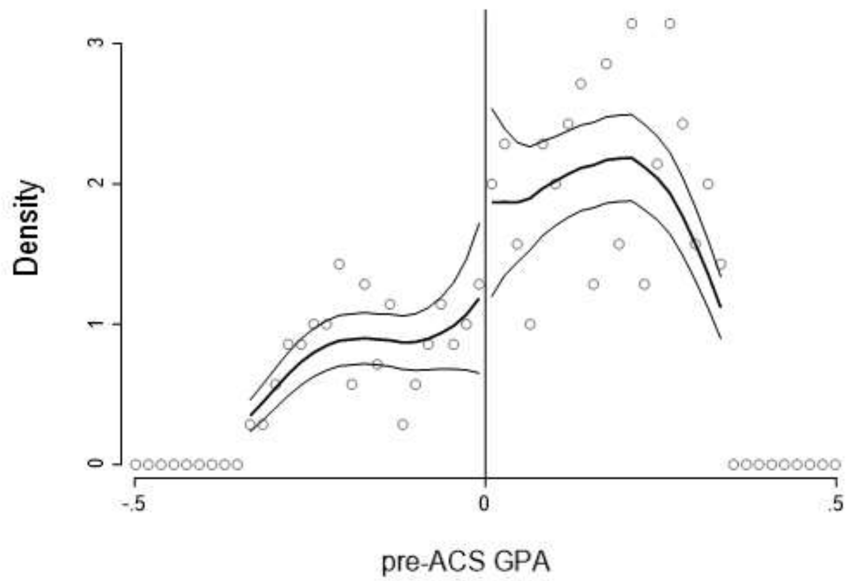

Figure 4. Graph of McCrary density test depicting density estimate by centered pre-ACS GPA assignment variable with kernel density overlay. Bins represent .05 GPA point gaps and the bandwidth is restricted to 0.334 GPA units above and below the cut-off. Log difference in height on either side of the cut-off is 0.339, standard error = 0.330. All individuals have met the ACS hours threshold. *Source.* Authors' calculations.

Figure Captions

- *Figure 1*. Scatter plot of rating (Pre-ACS GPA) versus predicted scholarship receipt. *Source*: Authors' calculations.
- *Figure 2.* Outcome variables by centered pre-ACS GPA assignment variable, conditional on meeting the ACS hours requirement. All graphs employ a local linear specification for the assignment variable and are restricted to our primary analytical range of 2.166 to 2.834 pre-ACS GPA points. *Source*: Authors' calculations.
- *Figure 3*. Graph of density by Centered pre-ACS GPA assignment variable with kernel density overlay. Bins represent .05 GPA point gaps. All individuals have met the ACS hours threshold. The two bars to the left of the threshold represent two superimposed graphs, one including and one excluding the 2.5 bin grouping. *Source.* Authors' calculations.
- *Figure 4*. Graph of McCrary density test depicting density estimate by centered pre-ACS GPA assignment variable with kernel density overlay. Bins represent .05 GPA point gaps and the bandwidth is restricted to 0.334 GPA units above and below the cutoff. Log difference in height on either side of the cutoff is 0.339, standard error = 0.330. All individuals have met the ACS hours threshold. *Source.* Authors' calculations.

Appendix

Table A1: Descriptive statistics for analytical sample and comparison groups.

	Analytic Sample (N=385)			Expanded Sample (N=1597)			Diff. in Diff.
	Above	Below	Diff.	Above	Below	Diff.	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Male	0.51	0.55	-0.04	0.44	0.50	-0.06	0.02
Black	0.11	0.17	-0.06	0.06	0.17	-0.11***	0.06
White	0.78	0.73	0.06	0.83	0.73	0.09	-0.03
Hispanic	0.06	0.04	0.02	0.05	0.06	-0.02	0.04
Other	0.05	0.07	-0.02	0.07	0.03	0.04*	-0.06*
First gen.	0.51	0.57	-0.06	0.63	0.56	0.07	-0.13*
HS GPA	3.41	3.35	0.07**	3.79	3.22	0.57***	-0.50***
ACT	23.88	23.38	0.50	27.07	22.84	4.23***	-3.72***
0-24	0.17	0.13	0.03	0.24	0.16	0.08*	-0.05
25-29	0.23	0.19	0.04	0.25	0.14	0.11***	-0.07
50-74	0.29	0.28	0.02	0.26	0.28	-0.02	0.03
75-100	0.31	0.40	-0.09	0.25	0.42	-0.18***	0.09
Senior	0.12	0.17	-0.06*	0.03	0.26	-0.23***	0.17***
Junior	0.24	0.36	-0.11**	0.11	0.34	-0.23***	0.34**
Sophomore	0.64	0.47	0.17***	0.86	0.40	0.46***	-0.29***

Note. Individuals included in the analytical sample have submitted a FAFSA, applied to LAU from within Arkansas, met the pre-ACS credit hours requirement of 12 hours, and had a pre-ACS cumulative GPA between 2.166 and 2.834 GPA points. *, **, *** represent statistical significance at the 10%, 5%, and 1% significance level, respectively. Diff. in. diff. column represents the different between the analytical sample and the sample of all in-state students in cohorts 2007-08, 2008-09, and 2009-10.
Source. Authors' calculations.

Table A2: First Stage Regression Results

	Simple Model	Preferred Model	Wide Band	Narrow Band
	(1)	(2)	(3)	(4)
Short Run Outcomes				
Probability of Persisting 1 Year	0.34***	0.34***	0.35***	0.31***
	(0.09)	(0.09)	(0.08)	(0.10)
Joint F-statistic	21.78	21.78	35.91	14.25
N	385	385	530	269
GPA (1 Year Later)	0.33***	0.38***	0.34***	0.38***
	(0.09)	(0.10)	(0.10)	(0.10)
Joint F-statistic	*22.90*	*28.38*	*14.37*	*22.97*
N	*343*	*342*	*483*	*235*
Yr. 1 Credit Accumulation	0.33***	0.38***	0.34***	0.38***
	(0.09)	(0.10)	(0.10)	(0.10)

Joint F-statistic	*22.26*	*27.10*	*13.86*	*21.77*
N	*342*	*341*	*482*	*235*
Yr. 2 Credit Accumulation	0.31***	0.37***	0.34***	0.38***
	(0.11)	(0.12)	(0.11)	(0.12)
Joint F-statistic	*15.91*	*18.58*	*11.47*	*18.59*
N	*254*	*254*	*356*	*178*
Final Observed GPA	0.30***	0.35***	0.30***	0.35***
	(0.08)	(0.09)	(0.09)	(0.09)
Joint F-statistic	*20.00*	*26.99*	*13.85*	*21.78*
N	*379*	*378*	*519*	*263*
Probability of Graduating				
Within 4 Years	0.34***	0.34***	0.34***	0.34***
	(0.09)	(0.09)	(0.09)	(0.09)
Joint F-statistic	*21.78*	*21.78*	*21.78*	*21.78*
N	*385*	*385*	*530*	*269*
Within 5 Years	0.34***	0.34***	0.34***	0.34***
	(0.09)	(0.09)	(0.09)	(0.09)
Joint F-statistic	*21.78*	*21.78*	*21.78*	*21.78*
N	*385*	*385*	*530*	*269*
Within 6 Years	0.34***	0.34***	0.34***	0.34***
	(0.09)	(0.09)	(0.09)	(0.09)
Joint F-statistic	*21.78*	*21.78*	*21.78*	*21.78*
N	*385*	*385*	*530*	*269*
Controls				
Student demographics		X	X	X
Family income		X	X	X
ACS GPA Band	0.334	0.334	0.434	0.234

Note. *** p<0.01, ** p<0.05, * p<0.1. Standard errors (parentheses) account for clustering of individuals in major. All models also include controls for entering cohort year, credit hours below the 15 continued eligibility requirement, and local linear functions of the assignment variable, centered pre-ACS GPA. Columns 1 & 2 represent results for our preferred bandwidth specification of 0.334 with increasing complexity moving left to right. Columns 3 & 4 display findings for wider and narrower bandwidths, respectively. *Source.* Authors' calculations.

Table A3. Estimated ACS Effects on Student Post-Secondary Outcomes, Pooled Cohorts, Quadratic Specification

	Control Group Mean	ITT	Local Average Treatment Effect			
			Simple Model	Preferred Model	Wide Band	Narrow Band
	(1)	(2)	(3)	(4)	(5)	(6)
Probability of Persisting 1 Year	0.79	-0.13	-0.37	-0.35*	-0.20	-0.26
		(0.08)	(0.23)	(0.20)	(0.27)	(0.19)
GPA (1 Year Later)	2.36	0.03	0.10	0.11	0.04	-0.08
		(0.07)	(0.25)	(0.18)	(0.16)	(0.17)
Yr. 1 Credit Accumulation	27.59	-3.16	-12.15	-9.90	-10.15	-6.14
		(2.90)	(12.95)	(10.27)	(8.64)	(8.30)
Yr. 2 Credit Accumulation	54.00	-10.87**	-35.97	-35.04	-29.02	-23.96
		(4.47)	(26.95)	(22.26)	(19.06)	(18.31)
Final Observed GPA	2.42	-0.05	-0.19	-0.20	-0.15	-0.66*
		(0.09)	(0.39)	(0.30)	(0.22)	(0.34)
Probability of Graduating						
Within 4 Years	0.19	-0.27*	-0.53***	-0.52***	-0.45***	-0.47**
		(0.16)	(0.11)	(0.12)	(0.16)	(0.20)
Within 5 Years	0.44	-0.27*	-0.52***	-0.51***	-0.53***	-0.50***
		(0.16)	(0.13)	(0.14)	(0.10)	(0.17)
Within 6 Years	0.56	-0.27**	-0.52***	-0.51***	-0.51***	-0.53***
		(0.14)	(0.12)	(0.14)	(0.12)	(0.12)
Controls						
Student demographics				X	X	X
Family income				X	X	X
Observations	254 - 386	254 - 386	254 - 386	254 - 385	356 - 530	178 - 269
Clusters (College Major)	69 - 75	69 - 75	69 - 75	69 - 75	71 - 79	57 - 65
ACS GPA Band	0.334	0.334	0.434	0.234	0.334	0.334

Note. Standard errors (parentheses) account for clustering of individuals in major. *** p<0.01, ** p<0.05, * p<0.1. All models also include controls for entering cohort year, credit hours below the 15 continued eligibility requirement, and local linear functions of the assignment variable, centered pre-ACS GPA. Binary outcomes are estimated using IV probit specifications, point estimates represent average marginal effects. *Source.* Authors' calculations.

Table A4: Estimated ACS Effects *Excluding Prior ACS Recipients*, Pooled Cohorts

	Simple Model	Preferred Model	Wide Band	Narrow Band
	(1)	(2)	(3)	(4)
Probability of Persisting	-0.08	-0.07	-0.06	-0.16*
	(0.08)	(0.07)	(0.07)	(0.09)
GPA (1 Year Later)	-0.10	-0.07	-0.13	0.04
	(0.14)	(0.14)	(0.14)	(0.16)
Yr. 1 Credit Accumulation	-4.54	-2.61	-1.19	-3.14
	(6.34)	(5.43)	(6.01)	(6.07)
Yr. 2 Credit Accumulation	-18.48	-18.95	-10.01	-21.13*
	(13.02)	(13.54)	(10.90)	(11.25)
Final Observed GPA	-0.28	-0.24	-0.23	-0.02
	(0.19)	(0.18)	(0.15)	(0.18)
Probability of Graduating				
Within 4 Years	-0.34*	-0.38**	-0.32*	-0.43***
	(0.17)	(0.17)	(0.17)	(0.16)
Within 5 Years	-0.55***	-0.56***	-0.51***	-0.61***
	(0.04)	(0.04)	(0.06)	(0.04)
Within 6 Years	-0.47***	-0.44***	-0.34*	-0.50***
	(0.11)	(0.15)	(0.19)	(0.13)
Controls				
Student demographics		X	X	X
Family income		X	X	X
Observations	236	229	321	161
Clusters (College Major)	65	65	71	55
ACS GPA Band	0.334	0.334	0.434	0.234

Note. Standard errors (parentheses) account for clustering of individuals in major (number of clusters ranges from 60-74). *** p<0.01, ** p<0.05, * p<0.1. All models also include controls for entering cohort year, credit hours below the 15 continued eligibility requirement, and local linear functions of the assignment variable, centered pre-ACS GPA. Binary outcomes are estimated using IV probit specifications, point estimates represent average marginal effects. *Source.* Authors' calculations.

Table A5: Estimated ACS Effects on Placebo Cohorts (2004-05, 2005-06, 2006-07)

	Simple Model	Preferred Model	Wide Band	Narrow Band
	(1)	(2)	(3)	(4)
Probability of Persisting	0.11	0.12	0.01	0.16
	(0.07)	(0.08)	(0.06)	(0.10)
GPA (1 Year Later)	0.09	0.04	0.03	0.01
	(0.09)	(0.10)	(0.08)	(0.11)
Yr. 1 Credit Accumulation	-0.21	-0.70	-0.14	-1.25
	(2.53)	(2.45)	(2.07)	(2.90)
Yr. 2 Credit Accumulation	-2.95	-4.69	-2.12	-5.48
	(4.61)	(4.27)	(3.23)	(4.77)
Final Observed GPA	-0.00	-0.10	-0.08	-0.13
	(0.10)	(0.10)	(0.10)	(0.10)
Probability of Graduating				
Within 4 Years	0.05	0.06	0.08	0.06
	(0.11)	(0.10)	(0.10)	(0.11)
Within 5 Years	-0.03	-0.02	0.03	0.15
	(0.12)	(0.12)	(0.11)	(0.13)
Within 6 Years	-0.15	-0.13	-0.08	0.03
	(0.11)	(0.10)	(0.09)	(0.12)
Controls				
Student demographics		X	X	X
Family income		X	X	X
Observations	327	303	422	208
Clusters (College Major)	67	66	72	59
ACS GPA Band	0.334	0.334	0.434	0.234

Note. Standard errors (parentheses) account for clustering of individuals in major (number of clusters ranges from 60-74). *** p<0.01, ** p<0.05, * p<0.1. All models also include controls for entering cohort year, credit hours below the 15 continued eligibility requirement, and local linear functions of the assignment variable, centered pre-ACS GPA. Binary outcomes are estimated using IV probit specifications, point estimates represent average marginal effects. *Source.* Authors' calculations.

Table A6: Randomization Inference Exercise, Pooled Cohorts

	Test Statistic	P-Value	Main Analysis Point Estimate
	(1)	(2)	(3)
Outcome			
Yr 1. GPA	-0.02	0.694	-0.12
Yr. 1 Credit Accumulation	-2.51	0.087 *	-7.92
Yr. 1 Persistence	-0.12	0.050 **	-0.08
Yr. 2 Credit Accumulation	-10.13	0.000 ***	-17.61
Final Observed GPA	-0.11	0.024 **	-0.29
Probability of Graduating			
Within 4 Years	-0.31	0.000 ***	-0.43***
Within 5 Years	-0.38	0.000 ***	-0.54***
Within 6 Years	-0.38	0.000 ***	-0.46***
N	30,833		254-385

Note. *** p<0.01, ** p<0.05, * p<0.1. All models include controls for entering cohort year, pre-ACS hours below 15 hours, and local linear functions of the assignment variable, centered pre-ACS GPA, and demographic information. Window size -0.14 to 0.14 GPA points. *Source.* Authors' calculations.

Table A7: Randomization Inference Exercise, Separated by Cohort

	Pooled Cohorts	Senior Cohort	Junior Cohort	Sophomore Cohort
	(1)	(2)	(3)	(4)
Yr. 1 GPA	-0.02	0.189***	0.31***	-0.08
Yr. 1 Credit Accumulation	-2.51*	4.79	3.07	-5.95***
Yr. 1 Persistence	-0.12**	0.06	0.36**	-0.26***
Yr. 2 Credit Accumulation	-10.13***	n/a	-13.87**	-9.82***
Final Observed GPA	-0.11**	0.13***	0.07	-0.22***
Probability of Graduating				
Within 4 Years	-0.31***	0.25	-0.14	-0.49***
Within 5 Years	-0.38***	0.18	0.05	-0.74***
Within 6 Years	-0.38***	0.23***	0.06	-0.76***
N	30,833	31,577	34,688	39,274

Note. *** p<0.01, ** p<0.05, * p<0.1. All models include controls for entering cohort year, pre-ACS hours below 15 hours, and local linear functions of the assignment variable, centered pre-ACS GPA, and demographic information. Window size -0.14 to 0.14 GPA points. *Source.* Authors' calculations.

Table A8: Continued ACS receipt rates among initial recipients

	Senior Cohort		Junior Cohort		Sophomore Cohort		Pooled Total	
	N	%	N	%	N	%	N	%
1 semester later								
No longer receiving ACS	3	2.1%	11	5.1%	14	5.5%	28	4.6%
Still receiving ACS	135	95.1%	203	94.9%	240	94.5%	578	94.8%
Graduated	4	2.8%	0	0.0%	0	0.0%	4	0.7%
2 semesters later								
No longer receiving ACS	19	13.4%	30	14.0%	40	15.8%	89	14.6%
Still receiving ACS	23	16.2%	181	84.6%	214	84.3%	418	68.5%
Graduated	100	70.4%	3	1.4%	0	0.0%	103	16.9%
3 semesters later								
No longer receiving ACS	14	9.9%	27	12.6%	39	15.4%	80	13.1%
Still receiving ACS	7	4.9%	177	82.7%	215	84.7%	399	65.4%
Graduated	121	85.2%	10	4.7%	0	0.0%	131	21.5%
4 semesters later								
No longer receiving ACS	8	5.6%	44	20.6%	58	22.8%	110	18.0%
Still receiving ACS	0	0.0%	35	16.4%	191	75.2%	226	37.0%
Graduated	134	94.4%	135	63.1%	5	2.0%	274	44.9%
5 semesters later								
No longer receiving ACS	8	5.6%	34	15.9%	59	23.2%	101	16.6%
Still receiving ACS	0	0.0%	15	7.0%	184	72.4%	199	32.6%
Graduated	134	94.4%	165	77.1%	11	4.3%	310	50.8%
6 semesters later								
No longer receiving ACS	4	2.8%	24	11.2%	66	26.0%	94	15.4%
Still receiving ACS	0	0.0%	1	0.5%	37	14.6%	38	6.2%
Graduated	138	97.2%	189	88.3%	151	59.5%	478	78.4%
7 semesters later								
No longer receiving ACS	n/a	n/a	18	8.4%	55	21.7%	73	15.6%
Still receiving ACS	n/a	n/a	0	0.0%	21	8.3%	21	4.5%
Graduated	n/a	n/a	196	91.6%	178	70.1%	374	79.9%
8 semesters later								
No longer receiving ACS	n/a	n/a	18	8.4%	50	19.7%	68	14.5%
Still receiving ACS	n/a	n/a	0	0.0%	0	0.0%	0	0.0%
Graduated	n/a	n/a	196	91.6%	204	80.3%	400	85.5%
9 semesters later								
No longer receiving ACS	n/a	n/a	n/a	n/a	42	16.5%	42	16.5%
Still receiving ACS	n/a	n/a	n/a	n/a	0	0.0%	0	0.0%
Graduated	n/a	n/a	n/a	n/a	212	83.5%	212	83.5%
10 semesters later								
No longer receiving ACS	n/a	n/a	n/a	n/a	39	15.4%	39	15.4%
Still receiving ACS	n/a	n/a	n/a	n/a	0	0.0%	0	0.0%
Graduated	n/a	n/a	n/a	n/a	215	84.7%	215	84.6%

Note: Sample includes all qualified ACS recipients in the 2007, 2008, and 2009 cohorts. Prior ACS recipients excluded from sample. Our data are restricted to 13 semesters after initial matriculation. "n/a" indicates no data are available for a given cohort

Table A9: Comparison of graduation rates and scholarship retention and loss across cohorts

Cohort	**By End of 4th Year Post-Matriculation**	**By End of 5th Year Post-Matriculation**	**By End of 6th Year Post-Matriculation**
2007	70.4% graduated 16.2% still receiving ACS 13.4% No longer receiving ACS	94.4% graduated 0.0% still receiving ACS 5.6% No longer receiving ACS	97.2% graduated 0.0% still receiving ACS 2.8% No longer receiving ACS
2008	63.1% graduated 16.4% still receiving ACS 20.6% No longer receiving ACS	88.3% graduated 0.5% still receiving ACS 11.2% No longer receiving ACS	91.6% graduated 0.0% still receiving ACS 8.4% No longer receiving ACS
2009	59.5% graduated 14.6% still receiving ACS 26.0% No longer receiving ACS	80.3% graduated 0.0% still receiving ACS 16.5% No longer receiving ACS	84.7% graduated 0.0% still receiving ACS 15.4% No longer receiving ACS
Average	*64.3% graduated* *15.7% still receiving ACS* *20% No longer receiving ACS*	*87.7% graduated* *0.2% still receiving ACS* *11.1% No longer receiving ACS*	*86.4% graduated* *0.0% still receiving ACS* *8.9% No longer receiving ACS*

Note: Sample includes all qualified ACS recipients in the 2007, 2008, and 2009 cohorts. Prior ACS recipients excluded from sample. Our data are restricted to 13 semesters after initial matriculation

Table A10: Estimated ACS Effects on Student Post-Secondary Outcomes, Pooled Cohorts, *Linear Probability Models for binary outcomes*

	Unqualified Mean	ITT	LATE				
			Simple Model	Preferred Model	Wide Band	Narrow Band	No Fafsa
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Probability of Persisting 1 Year	0.79	-0.06	-0.19	-0.18	-0.07	-0.30	-0.18
		(0.10)	(0.33)	(0.30)	(0.24)	(0.33)	(0.32)
GPA (1 Year Later)	2.36	-0.03	-0.10	-0.11	-0.10	0.12	-0.11
		(0.05)	(0.15)	(0.12)	(0.12)	(0.16)	(0.13)
Yr. 1 Credit Accumulation	27.59	-2.80	-8.37	-8.42	-6.76	-6.90	-8.28
		(1.82)	(5.82)	(5.65)	(4.98)	(7.07)	(5.84)
Yr. 2 Credit Accumulation	54.00	-5.44	-17.43	-16.17	-4.23	-25.49	-17.37
		(3.48)	(14.32)	(11.69)	(7.57)	(17.13)	(13.16)
Final Observed GPA	2.42	-0.07	-0.21	-0.25	-0.10	-0.04	-0.21
		(0.06)	(0.21)	(0.16)	(0.14)	(0.19)	(0.17)
Probability of Graduating							
Within 4 Years	0.19	-0.15	-0.49	-0.48	-0.39*	-0.62	-0.42
		(0.11)	(0.38)	(0.31)	(0.24)	(0.42)	(0.34)
Within 5 Years	0.44	-0.30**	-0.98*	-0.95**	-0.59**	-0.91*	-0.87**
		(0.12)	(0.51)	(0.41)	(0.27)	(0.54)	(0.44)
Within 6 Years	0.56	-0.25**	-0.80*	-0.79**	-0.44	-0.79	-0.73*
		(0.11)	(0.44)	(0.40)	(0.27)	(0.50)	(0.41)
Controls							
Student demographics				X	X	X	X
Family income				X	X	X	X
Observations	254 - 386	254 - 386	254 - 386	254 - 385	356 - 530	178 - 269	382 - 573
Clusters (College Major)	69-75	69-75	69 - 75	69 - 75	71 - 79	57 - 65	69 - 76
ACS GPA Band	0.334	0.334	0.334	0.334	0.434	0.234	0.334

Note. Standard errors (parentheses) account for clustering of individuals in major. *** p<0.01, ** p<0.05, * p<0.1. All models also include controls for entering cohort year, credit hours below the 15 continued eligibility requirement, and local linear functions of the assignment variable, centered pre-ACS GPA. Binary outcomes are estimated using IV probit specifications, point estimates represent average marginal effects. *Source.* Authors' calculations.

Figure A1. Outcome variables by centered pre-ACS GPA assignment variable, conditional on meeting the ACS hours requirement. All graphs employ a quadratic specification for the assignment variable and are restricted to our primary analytical range of 2.166 to 2.834 pre-ACS GPA points. *Source*: Authors' calculations.