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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 began 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 postsecondary outcomes.

INTRODUCTION

While forty-five percent of Americans hold a post-secondary degree, only 22.6 percent of adults in Arkansas share this achievement (U.S. Census Bureau, 2019). To mitigate this attainment gap, policymakers have pushed to increase the number of post-secondary credentials within the state (Arkansas Department of Education, 2015). One strategy commonly implemented by states to increase college enrollment and degree attainment is the use of state-financed merit aid (Dynarski & Scott-Clayton, 2013).

Arkansas has its own merit-aid program, the Arkansas Academic Challenge Scholarship (ACS). 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. Students received the first round of lottery-funded ACS scholarships in the fall of 2010.

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 (Bruce & Carruthers, 2014; Cornwell et al., 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 post-secondary 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 post-secondary students may respond differently to financial incentives compared to Traditional Recipients. Moreover, receiving funding at different points in an individual's post-secondary trajectory may impact his/her progression through college and entry into the workforce. Therefore, studying the influence of merit-aid on Current Achievers provides an opportunity to deepen our understanding of the potential 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 large Arkansas university, we determine the impact of the ACS on Current Achiever's 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 sophomore, junior, and senior recipients. This approach 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 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. On average, scholarship recipients are over forty percentage points less likely to graduate in four, five, or six years compared to non-recipients.

When separating the effects out by cohort, however, an interesting story emerges. It appears 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 53 and 62 percentage points less likely to 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 54 percentage points more likely to graduate within six years compared to individuals who did not receive funding.

These findings indicate that money alone may be insufficient to guarantee positive college outcomes. In addition, this study sheds light on the potential importance that timing may play in influencing a student's post-secondary trajectory. Providing money to students when they can still alter their college path may lead to non-productive decision making that delays graduation. On the other hand, seniors who might not otherwise graduate may benefit substantially from additional funding.

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 post-secondary outcomes attributed to these programs. We then describe the data and methodology we use 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.

The Arkansas Academic Challenge Scholarship

The Arkansas Academic Challenge Scholarship is a state-financed merit-aid program with relatively low eligibility requirements. Recent high school graduates are automatically eligible for the scholarship if they reside in Arkansas at least 12 months

prior to enrolling in college, graduate from an Arkansas high school, and have either a 2.5 high school GPA or score a 19 or above on the ACT exam (Arkansas Department of Higher Education, 2010). Once enrolled in college, students must maintain a minimum 2.5 GPA and enroll in at least 15 credits per semester after their first semester in which they can take as few as 12 credit hours (Arkansas Department of Higher Education, 2010).

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 strict 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 must be in-state residents and complete both the Free Application for Federal Student Aid (FAFSA) and a one-page ACS application. Individuals remain eligible for the program throughout college as long as they maintain a minimum 2.5 GPA and enroll in at least 15 credit hours. Eligible students can receive funding every semester of enrollment until they accrue 130 semester credit hours, at which point the scholarship becomes nonrenewable.

The scholarship is "last dollar" funding, designed to supplement, not supplant, existing financial aid a student may receive.[1][2] Funding is provided at the beginning of each semester and is credited directly to the student's university account. In the initial years of the program, recipients were awarded $5,000 the first year of the scholarship

[1] Last dollar funding is applied after all other financial aid, but before student loans.
[2] 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 have different "realized" amounts of 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.

(2010), and $4,500 each subsequent year (2011-2013).[3] 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.[4]

Existing Merit Aid Literature

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 et al., 2005). Student outcomes may theoretically be improved through two channels. First, the scholarship and its eligibility thresholds

[3] 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/).

[4] 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).

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. A large number of studies show significant positive effects of merit-aid on college enrollment (Bruce & Carruthers, 2014; Cornwell, Mustard, and Sridhar, 2006; Dynarski, 2004, 2008; Goodman, 2008; Kane, 2003; Scott-Clayton, 2015). Researchers have also found positive impacts on persistence, cumulative GPA, total credits earned, and the likelihood of graduation, (Angrist et al., 2014; Bettinger, 2004; Dynarski, 2008; Henry et al., 2004; Lee, 2018; Scott-Clayton, 2012, 2014; Sjoquist & Winter, 2015). Similarly, recent research has reported positive effects of merit aid on later life outcomes such as graduate degree attainment and earnings (Bettinger et al., 2019; Scott-Clayton & Zafar, 2019).

However, these positive findings appear to be highly context dependent, as results also demonstrate null to negative impacts on many of the same outcomes (Cornwell et al., 2005; Scott-Clayton, 2012; Cohodes & Goodman, 2014; Kopotic et al., 2019; Sjoquist & Winter, 2015). In a 2015 meta-analysis of 25 state merit-aid programs implemented between 1991 and 2004, Sjoquist & Winter report no significant positive effects on degree completion. Cornwell and colleagues (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 and

demonstrate a lower college completion rate compared to non-waiver students, indicating that college quality may moderate completion rates.

In the only study of randomly assigned aid offers, Angrist and colleagues (2016), find that being assigned to receive merit-aid increases both the probability of enrolling and persisting in college and demonstrates 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 same 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.

As these studies indicate, the relationship between merit-aid and student outcomes is complex. However, these studies 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 research helps 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 due to its focus on Current Achievers rather than Traditional Recipients. These distinctions are important. Students who become eligible while enrolled in college differ from high-school qualifiers in significant ways that may influence their post-secondary outcomes. High school students, for example, have yet to prove if they are prepared for the demands of college. On the other hand, current post-secondary students have already experienced the rigor of college courses, the challenge of autonomy, and the joy of the college experience. Differences between all high school students and the subset that

ultimately enroll and successfully complete at least one year of college in cognitive ability, aspirations, and other characteristics also raise questions about effect heterogeneity across the two groups. We inform our theoretical expectations for this study with 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), also determine that financial incentives promote academic effort for post-secondary students and show that students stop responding to incentives once they are no longer eligible to renew their scholarships.

Beyond the possible incentives that eligibility thresholds provide, receiving money may also alter students' post-secondary experience in ways that can generate positive academic outcomes. Integration theory, for example, argues that student post-secondary outcomes result from their level of academic and social integration on campus (Spady, 1971; Tinto, 1988; Pascarella & Terenzini, 1983). In this framework, students are more likely to remain enrolled if they experience a high level of connection between themselves and their college environment. 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). Therefore, Current Achievers may experience high levels of integration after receiving the ACS and subsequently demonstrate positive academic outcomes relative to their non-recipient peers.

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 in order to maximize scholarship funding until they reach the 130-credit accumulation cutoff. It is important to note, delaying graduation is not necessarily a poor outcome for students, especially if labor market prospects are not favorable or students need more time to accrue knowledge. Therefore, we characterize delayed graduation as a "non-productive" outcome, rather than a "negative" one, allowing room for unobserved individual preferences that may guide such decisions.

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 in order to capitalize on the social benefits of college, detrimentally impacting their academic outcomes.

However, 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

This study aims to estimate the impacts of receiving the ACS on post-secondary outcomes for a group of non-traditional recipients who became eligible for the scholarship while already enrolled in college. We leverage ACS's strict eligibility requirements for currently enrolled students to implement a regression discontinuity (RD) research design which 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). This section describes the data and analytical strategy used to estimate the scholarship's impact. In addition, we provide initial graphical and statistical analyses supporting our empirical approach.

DATA

We estimate the impacts of the ACS on college outcomes using detailed administrative data on students at a large 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 in order to match ACS eligibility requirements.[5] After making these selections, we are left with an analytical sample comprising 331 students from cohort year 2007-08, 464 from cohort year 2008-09, and 745 from cohort year 2009-10.

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. The dual nature of the ACS eligibility requirements suggests at least three potential comparison groups for ACS recipients: (1) students satisfying the GPA requirement but who failed to meet the credit hours requirement; (2) students satisfying the credit hours requirement but who did not meet the GPA requirement; and, (3) students who did not meet either requirement.[6]

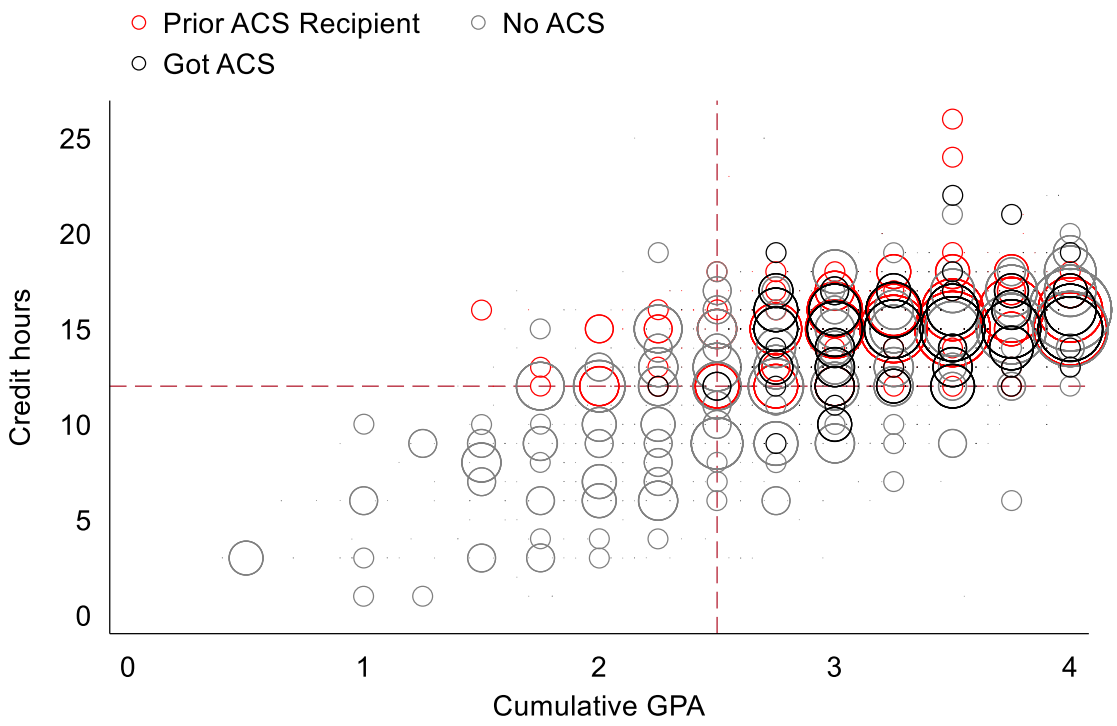
[5] We identify students as having filled out a FAFSA if their record indicates an expected family contribution. LAU populates these data using FAFSA data.

[6] As Reardon and Robinson (2012) note, one can accomplish the final comparison by combining the two continuous assignment variables into a single continuous variable using a Euclidean distance transformation. For the purposes of our analysis, we could use the variable $d_i = sign(cGPA_i)\sqrt{cGPA_i^2 + cHrs_i^2}$, where cGPA is the ACS GPA requirement centered at the cutoff score of 2.5 and cHrs is the credit hour requirement centered at 12 hours.

These potential comparison groups are displayed in Figure 1, which graphs individual credit hours earned in the spring semester of 2010[7]—the last semester before the expansion of the ACS—and cumulative GPA at the end of the spring semester. The sample is restricted to in-state enrollees who had completed a FAFSA and were continuously enrolled at the university since their initial matriculation. The figure presents individuals who did not receive the ACS (grey circles), individuals who received the ACS (black circles), and individuals who had received an earlier version of the ACS at any point in their college career (red circles).

[7] The ACS required Current Achievers to be continuously enrolled full-time (12 hours) in every semester prior to the fall of 2010. The sample presented in Figure 1 has first been restricted to only those individuals who have met the continual enrollment requirement in every semester before the spring of 2010. This approach allows us to effectively turn the continual enrollment requirement into a single continuous variable: credit hours earned in the spring of 2010.

Figure 1: Dual eligibility requirements for the ACS. Current Achievers qualifying for the ACS



Students had to have at least 12 credit hours and a cumulative GPA of 2.5 in the semester prior to the introduction of the ACS. This figure highlights the dual nature of the ACS eligibility requirements. The black box depicts the comparison under study in this analysis: individuals near the pre-ACS GPA threshold who have satisfied the credit hours requirement.

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 alleviate this issue, we reduce the dual rating variables to a single rating variable by first conditioning on credit hours and then estimating the discontinuity around the GPA threshold (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 points.[8] Our analytic sample, which is restricted to this small GPA range, is depicted in the black box in Figure 1.

The red circles in Figure 1 represent the prior ACS recipients in the analytic sample. We control for this small group of prior recipients in our analysis using a dummy variable indicating whether an individual ever received an ACS prior to the 2010 expansion. In addition, Figure 1 also shows a small number of individuals who received the ACS in the fall of 2010 (black circles) and appear to have only met one of the two eligibility requirements. While the fuzzy regression discontinuity design, explained below, will adjust for these individuals, it is important to note that they highlight potential issues with our current assignment variables.[9] As such, it is important to stress that the findings presented here are preliminary and should be taken with caution.

The fuzzy regression discontinuity model

While the program's eligibility requirements are strict in nature, eligible students still had to apply for scholarship receipt. In addition, as depicted in Figure 1, a small degree of noncompliance with eligibility status is apparent in the data. Therefore, we implement a fuzzy regression discontinuity design to estimate the effect of the program

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

[9] Only five individuals who do not meet both qualifications but nevertheless received an ACS scholarship make it into the final analytical sample. We have tested the extent to which these observations influence the results presented in Tables 4 through 6—our primary ACS effect estimates—by re-running the models while excluding these observations. In all cases, the estimated coefficients are in the same direction, but in a small number of cases, removal of these observations nudges the coefficients estimates over the statistically significant threshold. In general, however, the estimates are not substantially different, and we therefore conclude that inclusion of these observations is not problematic for our estimation.

on student outcomes.[10] We estimate the following two-stage least squares (2SLS) model using qualification as an instrumental variable (IV) to predict scholarship receipt.

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

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

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*), and X is a vector of demographic control variables capturing student gender, ethnicity, and financial resources. All models first condition on having met the minimum credit hour requirement of 12 credits, as previously described. 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

We are interested in estimating the impact of receiving the ACS on both short- and long-term college outcomes including cumulative GPA[11] and credit accumulation one year after receiving the scholarship, credit accumulation two years after receiving

[10] 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).

[11] 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.

the scholarship[12], final observed GPA, and the likelihood that a student graduates in four, five, or six years post-matriculation.[13] Continuous variables are estimated using linear IV, while binary variables are estimated using IV probit specifications.[14]

Figure 2 provides a first look at how ACS qualification is related to our outcome variables of interest. These graphs present simple regressions of the seven 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 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 our primary analytical models. 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[15]). Because ACS qualification does not perfectly predict receipt, these graphs represent intent-to-treat estimates.[16]

[12] 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.

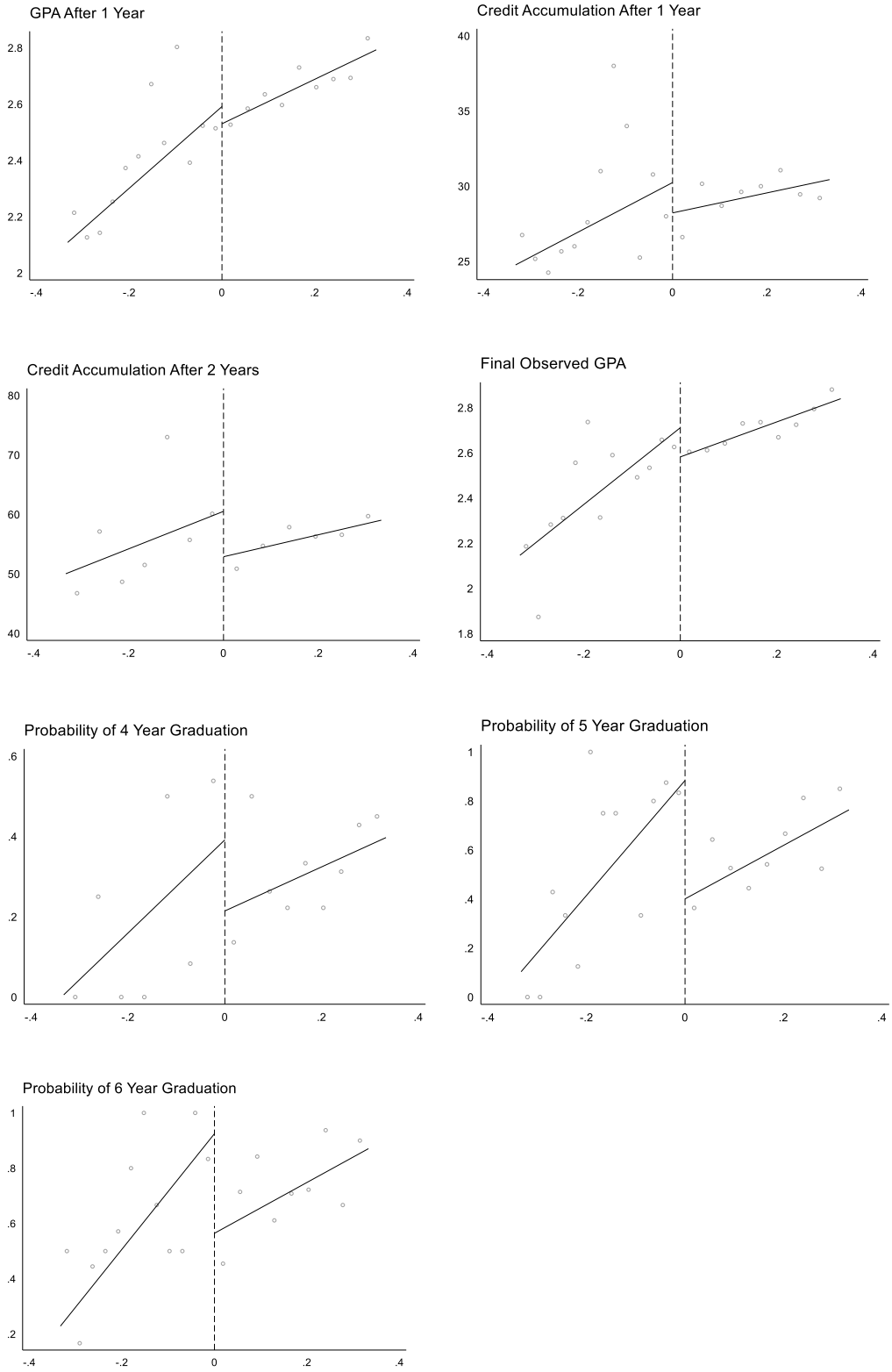
[13] Graduation indicators are binary variables collected from LAU's administrative data indicating if a student received a diploma by their 9th, 11th, or 13th semester, respectively.

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

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

[16] 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.

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.



The results presented in Figure 2 provide evidence suggesting negative impacts across all our outcomes of interest, especially credit accumulation after two years and all three graduation measures. It is important to note that the data presented in these graphs are quite noisy—especially for the binary outcomes of interest. This variation may make it difficult to separate signal from noise when it comes to our estimated program effect.

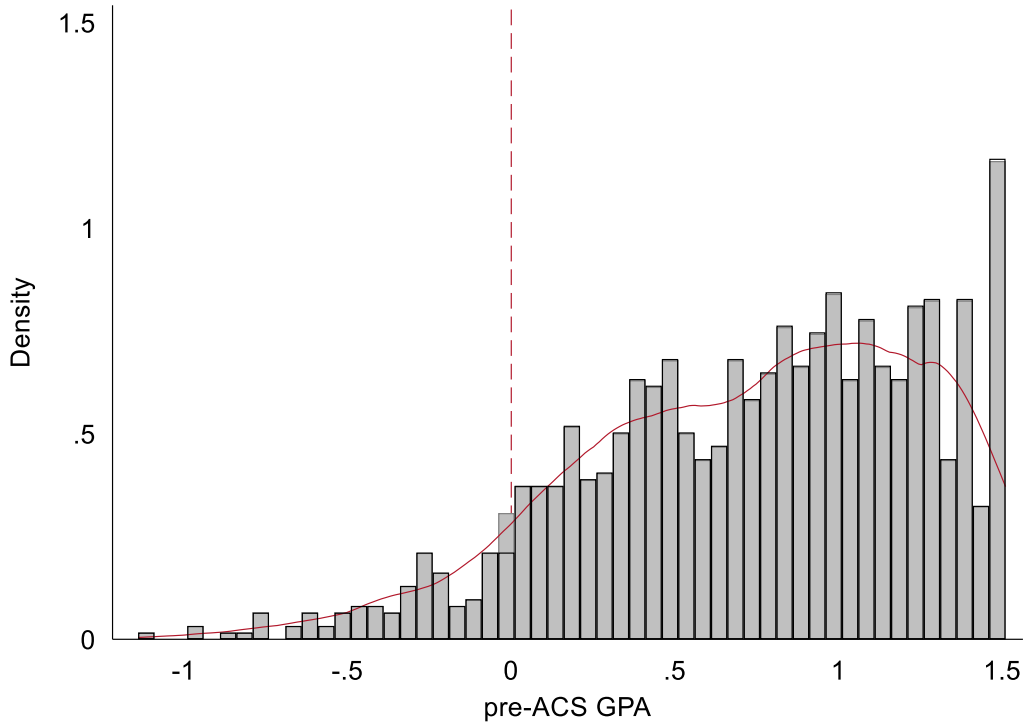
Density of pre-ACS GPA assignment variable

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: 1) a histogram depicting individuals within .05 GPA point bins and 2) a polynomial regression line overlay which excluded 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).

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 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 also indicate no statistically significant difference in the density of the assignment variable on either side

of the GPA threshold. Therefore, we believe the discontinuity observed in Figure 3 likely represents a random distortion in the data rather than strategic manipulation.

Figure 2: 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. Source. Authors' calculations.



Baseline equivalence

Table 1 presents descriptive statistics for our analytic sample and an expanded sample that includes all in-state applications regardless of whether or not they met eligibility criteria. The first three columns of Table 1 present data for our primary analytical sample: students entering the university in the 2007-08, 2008-09, and 2009-10 school years who applied from within the state of Arkansas, had submitted a FAFSA application, met the ACS credit hours requirement, and had pre-ACS GPAs ranging between 2.166 and 2.834 GPA points. The next three columns represent all in-state applicants in the 2007-08 through 2009-10 cohort years who submitted a FAFSA

application. The expanded sample is included to examine the extent to which our estimates are externally valid.

Table 1: Descriptive statistics for analytical sample and comparison groups.

	Analytical Sample			Expanded Sample			Diff. in Diff.
	Above GPA Cutoff (N=273)	Below GPA Cutoff (N=112)	Diff.	Above GPA Cutoff (N=1,533)	Below GPA Cutoff (N=64)	Diff.	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Student Demographics							
Male	0.51	0.55	-0.04	0.44	0.5	-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 generation	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***
Expected Family Contribution Percentile							
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	0.4	-0.09	0.25	0.42	-0.18***	0.09
Cohort							
Senior	0.17	0.12	0.06	0.26	0.03	0.23***	-0.17***
Junior	0.36	0.24	0.11***	0.34	0.11	0.23***	-0.12**
Sophomore	0.47	0.64	0.17***	0.40	0.86	0.46***	0.29***

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. 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.

Our analytic sample is relatively well balanced on covariates apart from high school GPA and the proportion of juniors and sophomores in the sample, all of which are higher for ACS recipients and lower for non-recipients. It is not particularly surprising that younger students represent a greater proportion of the analytic sample, as older individuals with lower GPAs are more likely to have dropped out by senior year. Nevertheless, we control for these variables in our regression to mitigate potential bias.

As expected, there are statistically significant differences between the analytic sample and the expanded sample from the university. Individuals in the analytic sample are less likely to be first generation college students or a race other than black, white, or Hispanic. They also have lower high school GPAs and ACT scores relative to the broader university population. Younger students are also more prevalent in the analytic sample. These differences serve to highlight our limited external validity.

RESULTS

In this section, we present the preliminary estimates of the effects of the Academic Challenge Scholarship on college outcomes for students near the program's GPA eligibility requirements. Our results suggest the scholarship had a slightly negative impact on short- and long-run cumulative GPA, persistence after one year, and credit accumulation after both one and two years. On the other hand, ACS recipients appear to have a significantly lower likelihood of graduating within four, five, and six years relative to non-recipients. In the following sections, we present the results from our preliminary analyses and show that our findings are robust to multiple specification checks.

Pooled Cohort Analysis

Table 2 presents the findings from our primary analysis using the pooled cohort of students and the result of first stage regressions using ACS qualification to predict scholarship receipt (Row 1). 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. 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.[17]

Rows 2 through 7 of Table 2 show the estimated local average treatment effect of the ACS on our continuous and binary outcomes of interest. Parameter estimates for binary outcome variables represent average marginal effects. Columns 1-4 present results for our preferred pre-ACS GPA band of .334 GPA points (or GPAs ranging between 2.166 and 2.834 points), with model specifications increasing in complexity as we move from left to right. 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. Column 7 displays results for an expanded sample of students which includes all in-state applicants in the 2007-08 through 2009-10 cohort years regardless of whether they filed a FAFSA. These specification checks are discussed in additional detail below.

Our preferred model, in Column 4, which includes full covariates, suggests that ACS recipients scored on average 0.12 GPA points lower and accumulated 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

[17] A full table of first stage regression results including F-statistics can be found in Appendix Table A1.

fewer credits than their non-ACS peers. ACS recipients also experienced negative impacts on final observed GPA, on average earning about 0.30 GPA points lower relative to non-recipients. However, none of these results are statistically distinguishable from zero.

Table 2: Estimated ACS Effects on Student Post-Secondary Outcomes, Pooled Cohorts

	Simple Model	Preferred Model	Wide Band	Narrow Band	No FAFSA
	(1)	(2)	(3)	(4)	(5)
First Stage	0.33***	0.35***	0.37***	0.33***	0.33**
	(0.08)	(0.09)	(0.07)	(0.11)	(0.09)
GPA (1 Year Later)	-0.10	-0.12	-0.11	0.10	-0.10
	(0.15)	(0.16)	(0.17)	(0.15)	(0.15)
Yr. 1 Credit Accumulation	-8.37	-7.92	-5.99	-6.10	-7.54
	(6.13)	(6.06)	(5.32)	(6.60)	(6.10)
Yr. 2 Credit Accumulation	-17.43	-17.61	-4.65	-27.07	-19.30
	(11.65)	(12.17)	(8.22)	(18.14)	(12.80)
Final Observed GPA	-0.21	-0.29	-0.12	-0.06	-0.23
	(0.19)	(0.20)	(0.17)	(0.18)	(0.19)
Probability of Graduating					
Within 4 Years	-0.40***	-0.43***	-0.39***	-0.49***	-0.45**
	(0.14)	(0.12)	(0.12)	(0.13)	(0.20)
Within 5 Years	-0.51***	-0.54***	-0.43***	-0.55***	-0.60***
	(0.07)	(0.07)	(0.10)	(0.09)	(0.12)
Within 6 Years	-0.45***	-0.46***	-0.29	-0.47***	-0.49***
	(0.11)	(0.12)	(0.19)	(0.16)	(0.18)
Controls					
Student demographics		X	X	X	X
Family income		X	X	X	X
Observations	386	383	528	268	570
Clusters (College Major)	77	77	83	68	80
R-squared	0.23	0.29	0.30	0.30	0.31
ACS GPA Band	0.334	0.334	0.434	0.234	0.334

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 include controls for entering cohort year, pre-ACS hours below 15 hours, and quadratic functions of the assignment variable, centered pre-ACS GPA. See Table A1 for remaining coefficient estimates. Binary outcomes are estimated using IVprobit specifications, point estimates represent average marginal effects. *Source.* Authors' calculations.

On the other hand, point estimates for end-of-college outcomes are large and statistically significant. ACS recipients are significantly less likely to graduate within four, five, or six years of matriculation. While the graduation estimates are particularly large—suggesting ACS recipients are 43 percentage points less likely to graduate within four years—they do align with the simple graphical analysis presented in Figure 2. Recipients do not catch up by years five or six and are about 54 and 46 percentage points less likely to graduate in 5 or 6 years relative to their peers, respectively.

In summary, the results presented in Table 2, Columns 1-4, suggest that Current Achievers receiving the ACS slightly underperform their peers in the initial years after receiving the funding, but are then significantly less likely to graduate compared to their counterparts. Our results are robust to several specification checks. In a first series of robustness checks, we vary the bandwidth around the discontinuity. The effect estimates – presented in Table 2, Columns 4 & 5 – are not particularly susceptible to bandwidth alteration. We also relax the FAFSA eligibility requirement for ACS qualification to increase the statistical power of our analysis. Results – shown in Table 2, Column 7 – are not sensitive to the inclusion or exclusion of these students.[18]

[18] We also test whether or not subsets of our sample drive the results of prior ACS Recipients and find no evidence that our results are sensitive to any of those subgroups. Results can be found in Appendix Table A4. As a final check, we estimate ACS effects in a cohort of students who could not receive the lottery scholarship financed ACS by examining a "placebo" sample of students who matriculated at LAU in cohort years 2004-05, 2005-06, and 2006-07. All students included in our analyses meet the same requirements of our analytical sample. The results of our placebo analysis are presented in Appendix Table A4. Models estimate the intent-to-treat effect of ACS qualification since no individuals received a scholarship during these years. As expected, ACS qualification is not significantly related to any of the postsecondary outcomes. More importantly, all estimated effects are substantively small; providing strong evidence that ACS qualification was not related to outcomes in these earlier cohorts.

Cohort Analysis

Our descriptive statistics demonstrated that all cohorts are not equally represented across the analytic sample. While we control cohort differences via fixed effects in our model, this modeling strategy does not guarantee certain cohorts are not driving the main specification results. In addition, there is reason to believe that receiving merit aid at different points in an individual's college trajectory may differentially influence his/her post-secondary outcomes. Therefore, we use the same analytic approach outline in Equations 1 & 2, but conduct a secondary analysis separating effects out by cohort.

Results of the cohort analysis, found in Table 5, demonstrate significant heterogeneity in the estimated effect of the ACS on our outcomes of interest. Column 1 depicts our findings from the main pooled cohort analysis (Table 2, Column 4). Columns 2 through 4 show point estimates for the senior, junior, and sophomore cohorts, respectively. Looking from left to right across the columns, for most outcome variables we see small negative impacts on senior ACS recipients, slightly positive impacts for junior scholars, and large negative outcomes for sophomore individuals—though these outcomes are statistically insignificant for all short-run outcomes and final observed GPA.

When separated out by cohort, the effect of the ACS on graduation, however, tells an interesting story. Senior ACS recipients appear to continue along their current trajectory, demonstrating small positive, but insignificant differences in the likelihood of graduating in four or five years. However, individuals who receive the ACS are 54 percentage points more likely to graduate within six years relative to 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 ACS recipients relative to the status quo.

Sophomores, however, seem to drive the negative findings from the main analysis, displaying large, statistically significant declines in the likelihood of graduating on time, within five years, or within six years. On average, sophomores who receive the ACS are between 53 and 62 percentage points less likely to graduate compared to their non-recipient counterparts.

Table 3: Estimated ACS Effects on Student Post-Secondary Outcomes, Separated by Cohort

	Main Analysis	Senior Cohort	Junior Cohort	Sophomore Cohort
	(1)	(2)	(3)	(4)
GPA (1 Year Later)	-0.12	0.13	0.10	-0.40
	(0.16)	(0.23)	(0.13)	(0.31)
Yr. 1 Credit Accumulation	-7.92	-1.92	2.85	-17.68
	(6.06)	(11.13)	(5.86)	(11.78)
Yr. 2 Credit Accumulation	-17.61	n/a	2.06	-23.25
	(12.17)	n/a	(12.11)	(18.88)
Final Observed GPA	-0.29	-0.06	0.08	-0.74
	(0.20)	(0.17)	(0.14)	(0.57)
Probability of Graduating				
Within 4 Years	-0.43***	0.27	-0.21	-0.53***
	(0.12)	(0.12)	(0.34)	(0.11)
Within 5 Years	-0.54***	0.22	-0.28	-0.62***
	(0.07)	(0.61)	(0.36)	(0.03)
Within 6 Years	-0.46***	0.54***	-0.02	-0.60***
	(0.12)	(0.14)	(0.39)	(0.04)
Controls	X	X	X	X
Observations	383	58	124	198
Clusters (College Major)	77	34	53	62

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 include controls for entering cohort year, pre-ACS hours below 12 hours, and local linear functions of the assignment variable, centered pre-ACS GPA. See Table A1 for remaining coefficient estimates. Binary outcomes are estimated using probit specifications, point estimates represent average marginal effects. *Source.* Authors' calculations.

DISCUSSION

This paper examines the effect of the Arkansas Academic Challenge Scholarship—a broad-based state-financed merit-aid scholarship—on college outcomes at a large Arkansas university (LAU). Our results indicate that currently enrolled university students who have received the ACS had lower cumulative GPAs and accumulated fewer credits relative to their peers. In addition, ACS recipients were significantly less likely to graduate within four, five, or six years. Taken along with the negative—but statistically insignificant—findings on short-run outcomes, our results may suggest that ACS recipients were more likely to delay graduation than students who did not receive funding. It also implies that scholarship recipients near the eligibility threshold were less likely to attain a degree compared to their peers.

To investigate these results further and to better understand the influence that the timing of merit-aid receipt may have on post-secondary outcomes, we conduct a secondary analysis separating effects out by cohort. Our findings indicate that the negative findings 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, however future studies which dig deeper into these student behavior changes would be beneficial in understanding what motivates 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. We believe that individuals who were unlikely to complete their degree without the additional funding that the ACS provides drive this positive finding. 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. A follow up 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 (enrolling for 15 hours a semester and earning a cumulative GPA of at least 2.5 points). Therefore, it should not be unexpected to find that these different student populations would have different experiences. Second, our cohort analysis uncovers the potential influence that the timing of receiving money has on student behavior, which has not been previously studied in merit aid literature.

It is important to highlight the preliminary nature of the research presented in this paper. This work represents a case study of a small group of students at one university in the state of Arkansas. As such, our findings have limited transferability to other settings, and we encourage readers to interpret these results with caution. This study also employs a limited sample of students, which may make our findings susceptible to issues of finite sample bias. 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, receiving funding, and meeting the continuing eligibility criteria.

Our future work plans to expand the current study to include all two- and four-year universities within Arkansas. This approach should alleviate any problems that arise due to small sample size and allow us to investigate whether the findings from this paper are replicable on a state-wide scale, or if these phenomena are unique to this particular university setting. In this way, we hope to continue investigating the link between merit-aid and college outcomes for this unique group of students and further determine the extent to which the timing of receiving funding matters for student post-secondary decision-making.

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APPENDIX

Table A1: First Stage Regression Results

	Simple Model	Full Model	Wide Band	Narrow Band	No FAFSA
	(1)	(2)	(3)	(4)	(5)
Qualify for ACS	0.33***	0.35***	0.37***	0.33***	0.33**
	(0.08)	(0.09)	(0.07)	(0.11)	(0.09)
Controls					
Demographics		X	X	X	X
Family income		X	X	X	
Observations	343	340	481	234	509
Joint F-Statistic	33.04	17.17	26.85	19.36	39.01
R-squared	0.23	0.29	0.30	0.30	0.41
ACS GPA Band	0.334	0.334	0.434	0.234	0.334

*** p<0.01, ** p<0.05, * p<0.1

Note. Standard errors (parentheses) account for clustering of individuals in major. 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. 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. Column 5 presents results for an expanded sample with relaxed FAFSA requirements. *Source.* Authors' calculations.

Table A2: Estimated ACS Effects Excluding Prior ACS Recipients, Pooled Cohorts

	Simple Model	Preferred Model	Wide Band	Narrow Band	No FAFSA
	(1)	(2)	(3)	(4)	(5)
GPA (1 Year Later)	-0.10	-0.07	-0.13	0.04	-0.09
	(0.14)	(0.14)	(0.14)	(0.16)	(0.15)
Yr. 1 Credit Accumulation	-4.54	-2.61	-1.19	-3.14	-3.48
	(6.34)	(5.43)	(6.01)	(6.07)	(6.07)
Yr. 2 Credit Accumulation	-18.48	-18.95	-10.01	-21.13*	-20.22
	(13.02)	(13.54)	(10.90)	(11.25)	(14.58)
Final Observed GPA	-0.28	-0.24	-0.23	-0.02	-0.27
	(0.19)	(0.18)	(0.15)	(0.18)	(0.20)
Probability of Graduating					
Within 4 Years	-0.34*	-0.38**	-0.32*	-0.43***	-0.46*
	(0.17)	(0.17)	(0.17)	(0.16)	(0.24)
Within 5 Years	-0.55***	-0.56***	-0.51***	-0.61***	-0.73***
	(0.04)	(0.04)	(0.06)	(0.04)	(0.10)
Within 6 Years	-0.47***	-0.44***	-0.34*	-0.50***	-0.55***
	(0.11)	(0.15)	(0.19)	(0.13)	(0.21)
Controls					
Student demographics		X	X	X	X
Family income		X	X	X	X
Observations	236	234	321	163	421
Clusters (College Major)	65	65	71	55	73
ACS GPA Band	0.334	0.334	0.434	0.234	0.334

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 include controls for entering cohort year, pre-ACS hours below 15 hours, and quadratic functions of the assignment variable, centered pre-ACS GPA. See Table A1 for remaining coefficient estimates. Binary outcomes are estimated using probit specifications, point estimates represent average marginal effects. *Source.* Authors' calculations.

Table A3: Estimated ACS Effects on Placebo Cohorts (2004-05, 2005-06, 2006-07), Excluding Prior ACS Recipients

	Simple Model	Preferred Model	Wide Band	Narrow Band	No FAFSA
	(1)	(2)	(3)	(4)	(5)
GPA (1 Year Later)	0.09	0.04	0.03	0.01	0.05
	(0.09)	(0.10)	(0.08)	(0.11)	(0.09)
Yr. 1 Credit Accumulation	-0.21	-0.70	-0.14	-1.25	-0.39
	(2.53)	(2.45)	(2.07)	(2.90)	(2.44)
Yr. 2 Credit Accumulation	-2.95	-4.69	-2.12	-5.48	-5.00
	(4.61)	(4.27)	(3.23)	(4.77)	(4.47)
Final Observed GPA	-0.00	-0.10	-0.08	-0.13	-0.08
	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)
Probability of Graduating					
Within 4 Years	0.05	0.06	0.08	0.06	0.06
	(0.11)	(0.10)	(0.10)	(0.11)	(0.12)
Within 5 Years	-0.03	-0.02	0.03	0.15	-0.05
	(0.12)	(0.12)	(0.11)	(0.13)	(0.34)
Within 6 Years	-0.15	-0.13	-0.08	0.03	-0.12
	(0.11)	(0.10)	(0.09)	(0.12)	(0.11)
Controls					
Student demographics		X	X	X	X
Family income		X	X	X	X
Observations	327	311	431	208	559
Clusters (College Major)	67	66	72	59	77
ACS GPA Band	0.334	0.334	0.434	0.234	0.334

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 include controls for entering cohort year, pre-ACS hours below 15 hours, and quadratic functions of the assignment variable, centered pre-ACS GPA. See Table A1 for remaining coefficient estimates. Binary outcomes are estimated using probit specifications, point estimates represent average marginal effects. *Source.* Authors' calculations.