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From Start to Finish: Predicting Enrollment and Attainment in Arkansas Postsecondary Education

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From Start to Finish: Predicting Enrollment and Attainment in Arkansas Postsecondary Education

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Abstract

Postsecondary education has become a popular option for students, as evidenced by increases in enrollment over the last two decades. However, while enrollment has increased, completion has not. It is therefore important to investigate the factors that could lead to students' enrollment, persistence, and completion of college. This dissertation examines two broad topics over three chapters. Chapters 1 and 2 focus examine the impact of a policy change that resulted in backloading the award disbursement of a state-wide merit-based scholarship program in Arkansas on college enrollment and success. Chapter 3 examines factors that influence the predictive nature of high school GPA and college admission exam score.

Chapter 1 finds that changing the award disbursement to a backloaded structure has no statistically significant impact on overall college enrollment in the state of Arkansas, compared to other similar southern states. While we find no statistically significant impact, the estimates trend negative; however we are not able to determine if this is due to the overall award reduction, or the backloaded structure. This suggests states should use caution when considering implementing a backloaded payout structure, as it has the potential for adverse effects.

In chapter 2, focusing examining the same award disbursement policy change, we find no significant change in outcomes for students qualifying for the scholarship after the award disbursement change, relative to those who qualified for the scholarship prior to the change. Simply, we do not find evidence that switching to a backloaded payout structure significantly impacted persistence, college GPA, or the likelihood of graduation within four years.

Finally, as high school GPA and score on college admission tests are used in college admission decisions, and qualification for scholarships, chapter 3 explores the predictive nature of these high school academics on college outcomes, and how they change by high school type. I

find that certain high school characteristics change the relationship between student high school academics, and college outcomes.

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Dedication

This dissertation is dedicated to my immediate family, chosen and blood: my soon-to-be husband, Benjamin Knuckles, sister, Taylor Jordan, mother, Donna Blackwell, and father, Michael Kopotic. I will always work to make you proud, and let us never forget the most fun we never want to have again.

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List of Published Papers

Kopotic, K., Mills, J. N., & Rhinesmith, E. (under review at *Higher Education Politics & Economics*). Altering expectations: How changing a merit scholarship program's payout structure affects student postsecondary enrollment choices (Chapter 1 of this dissertation).

Introduction

Postsecondary education is becoming increasingly prominent, both in the personal and political spheres. The positive financial and personal returns to postsecondary education such as increases in lifetime earnings (Oreopoulos & Petronijevic, 2013; Lawrence, 2017), potential to increase social mobility (Chetty et al., 2017), and lower likelihood of marriage leading to divorce (Wang, 2015), are well documented. As postsecondary education increases in popularity, so too does it generate political agenda items, in the form of financial aid, college remediation policies, and policies designed to address persistent gaps in the groups of students who attend college, to name a few. Much of the K-12 education system is geared towards college preparation as students are tasked with mastering academic content that will later be demonstrated in their high school GPAs and college admission exam scores. Many school districts track the percent of students who matriculate to college, and there are charter schools specifically focused on preparing students for a collegiate education (NSC Blog, 2019; KIPP, 2019). Additionally, there is a greater emphasis on Advanced Placement coursework, which allows students to earn college credit while still in high school, contingent on passing an annually administered exam (College Board, 2018).

While K-12 education places a strong emphasis on postsecondary education, and the individual personal benefits are salient, postsecondary education is not an obvious choice for some. There are large documented gaps between various groups of students who enroll in and persist through college. Would-be-first-generation college students are less likely to enroll in college, relative to students who have at least one college-educated parent (The Pell Institute, 2018). Additionally, students with less financial resources are less likely to pursue postsecondary education, compared to their more affluent peers (The Pell Institute, 2018). Various interventions at the federal, state, and local levels, have been designed and implemented in an attempt to address these barriers to college access. Efforts have been made to ensure students are well-prepared to tackle college-level work, have access to ample information about college options, and have adequate financial resources.

With many efforts being made to reduce barriers to entry for potential college-bound students, it should come as no surprise that postsecondary enrollment rate for 18-24 year-olds has increased steadily over the last two decades (National Center for Education Statistics, 2019). While students are enrolling in postsecondary institutions, however, not all are persisting through to attainment of their terminal degree. For example, approximately 70 percent of high school graduates in 2016 enrolled in college directly following their graduation from high school (U.S. Bureau of Labor Statistics, 2017), while nationally, only about 60 percent of students graduate within six years (National Center for Education Statistics, 2019). This dissertation seeks to explore some of the factors that possibly contribute to enrollment in, and persistence through postsecondary education in Arkansas. Specifically, I examine how a policy change in a merit-based financial aid disbursement impacts students' decisions to enroll in Arkansas postsecondary institutions, and how that same change to the merit-aid disbursement affects postsecondary success, as measured by persistence, college GPA, and the likelihood of graduating within four years. Finally, as there is documented literature on the predictive nature of high school GPA and student scores on college admissions exams such as the ACT or SAT on college outcomes, I explore how the relationship changes, given different high school environments.

Chapter 1 of this dissertation explores how changes in the disbursement of a merit-based financial aid award impact students' decisions to enroll in college in Arkansas. The Arkansas Academic Challenge Scholarship (ACS) was first introduced in the 1990s, but was not widely used. In 2008, Arkansas voters approved the first statewide lottery, with the proceeds to be used to expand the ACS. The new lottery-funded merit-based scholarship was first available to students enrolling in college during the 2010-11 school year. To qualify for the award, students are required to meet a series of residence, academic, and application requirements[1], but once awarded, the ACS covered a substantial part of the cost of attendance at Arkansas postsecondary institutions. The scholarship amount, however, was slightly reduced almost immediately. The major policy change occurred in 2013, when the ACS was again reduced in award amount, and, of interest to this study, the disbursement, or payout, was restructured to a reflect a backloaded, or gradual installment. Specifically, students would receive a small amount of money upon initial enrollment in college, and this amount would progressively increase each year for a total of four years as they persisted through to their terminal degree.

We[2] estimate the impact of the ACS award disbursement change in 2013 in Arkansas colleges using a difference-in-differences design applied to state-level panel data available through the Integrated Postsecondary Education Data System (IPEDS). We compared Arkansas enrollment trends to that of a group of similar southern states before and after the change to a backloaded award structure. Overall, our results suggest no significant impact on students' decisions to enroll in Arkansas colleges, overall, and at four-year institutions specifically. While not significant, our results do suggest negative estimates. While other research of merit-based aid generally finds increases in student enrollment, these studies focus on the overall impact of the

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[1] Students qualifying for the Academic Challenge Scholarship must be an Arkansas resident for at least 12 months prior to enrolling in college, graduate from an Arkansas high school through the SmartCore curriculum, earn either a 2.5 high school GPA or a 19 on the ACT (or concordant score on another approved admissions test), and must finally apply for the scholarship and FAFSA. See https://scholarships.adhe.edu/scholarships/detail/academic-challenge-scholarships.

[2] Chapter 1 and chapter 2 are co-authored with Jonathan Mills and Evan Rhinesmith.

program, whereas our findings suggest that major changes to how money is disbursed to students could have adverse impacts on postsecondary enrollment.

While backloading the award payout for students receiving merit-based financial aid potentially negatively impacts student decisions regarding enrollment, one could argue that increasing the financial aid to a student as they continue through college could incentivize students on the margin to persist. Chapter 2 of this dissertation specifically addresses this argument. Using the same policy change over time, we additionally take advantage of the academic requirements necessary to qualify for the scholarship to estimate the impact of the payout change on college attainment. The ACS has specific high school GPA and college admissions exam score thresholds that students are required to meet in order to qualify, so we are able to add a regression discontinuity element to our difference-in-differences design from the initial chapter. Using student-level administrative data for all first-time, full-time enrollees in Arkansas's public postsecondary institutions between 2010 and 2015, we utilize a hybrid model, differences-in-discontinuities, to estimate the causal effects of qualifying for the ACS, as well as the impacts of the shift in payout structure on student attainment outcomes. Overall, our findings indicate no evidence of changes in ACS qualified students' postsecondary attainment outcomes, as measured by persistence, college GPA, and the likelihood of graduating within four years. So while there is potentially evidence for a downward shift in enrollment as a result of changing the payout structure, there does not appear to be any change in postsecondary outcomes as result of the change.

As the ACS and college admission decisions rely on demonstrated student academic success, as measured by high school GPA and college admission exam score, Chapter 3 descriptively examines the predictive nature of these two student characteristics, and further explores the differential relationship these measures have with college success when students of similar academic ability experience different high school environments. Specifically, I[3] explore how the inclusion and interaction of the percent of students at the origin high school that are free and reduced price (FRL) eligible, the percent of minority students, and school size differentially impact the degree to which high school GPA and college admissions exam score predict persistence past the first year of college, college GPA at the end of the first year, and the likelihood of graduating within four years. Overall, I find that high school GPA and admissions exam score are always positively associated with college success outcomes. However, when the percent of FRL students at the high school is included and subsequently interacted with the student academic regressors, I find that the expected increases in college success differ. Specifically, the expected gains associated with increasing high school GPA are diminished slightly, while the expected gains associated with increasing college admission exam score increase. Overall, this pattern remains when high school percent minority is included and interacted with student academic regressors. There is, however, no discernible pattern when high school enrollment is included. While descriptive, this suggests that students with similar academic ability who experienced different high school environments could be expected to fare differently in college. Equipped with this information, colleges might better be able to identify students who could require additional support to achieve the anticipated success, and possibly increase the likelihood of college attainment.

The three chapters of this dissertation contribute to the education research community by providing a better understanding of potential factors influencing students' enrollment decisions, and subsequent collegiate attainment. Specifically, the results presented here suggest that

[3] Chapter 3 was authored independently.

financial considerations may be eclipsed by other barriers to college access, as major changes to the ACS payout structure did not have significant impacts on enrollment, or postsecondary success outcomes for students. The relationship between high school GPA and college outcomes appears to vary across high schools, specifically the gains associated with higher GPAs are reduced in magnitude in high schools with higher levels of disadvantage. In contrast, the gains associated with higher exam scores increase with higher levels of high school disadvantage. College administrators must be aware of these relationships, as they can be used to better identify students who may need additional supports to make it to and through college.

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Chapter 1: Altering Expectations: How Changing a Merit Scholarship Program's Payout Structure Affects Student Postsecondary Enrollment Choices

This paper was coauthored with Jonathan Mills and Evan Rhinesmith

Introduction

The popularity of state-financed merit scholarships, which provide grant aid to attend higher education institutions to students satisfying pre-specified academic requirements, has dramatically increased since their inception in the 1980s. These programs are expensive, however, especially as more students meet their qualifications. Several states have considered changes to program requirements or financial aid amounts to allow these popular programs to continue in light of budget shortfalls. While there is a robust empirical literature demonstrating the ability of these programs to improve college access and attainment when introduced, few studies, if any, examine how changes to these programs impact students. This study addresses this gap in the literature by determining if a shift from an equal installment payment plan to a backloaded payment structure that provides increasing amounts as students persist through college impacts college enrollment.

Strong empirical evidence indicates positive returns to postsecondary attainment. A college education is associated with higher salaries, improved health, and a decrease in the likelihood of getting divorced (Lawrence, 2017; Wang, 2015). Additionally, the returns to postsecondary education have steadily increased in the United States' skills-based economy (Oreopoulos & Petronijevic, 2013). Nevertheless, while the college enrollment rate for 18-24 year-olds has consistently increased over the last two decades (National Center for Education Statistics, 2019c), many students fail to complete their degrees. As of 2017, only 60 percent of students who enrolled in college seeking a four-year degree completed their Bachelor's degree within six years. Attainment also varies significantly by institution type, with nearly 90 percent of students graduating within six years from selective four-year institutions compared to only 31 percent of students graduating from open-admissions four-year institutions within six years (National Center for Education Statistics, 2019c).

Some attribute the weaker than expected link between enrollment and attainment to dramatically increasing costs of college. In constant 2016-17 dollars, from 2000-2017, the average cost of attendance at public four-year institutions has increased from $12,000 to $19,000. Private four-year institutions experienced an increase from $30,000 to $41,000, and two-year institutions saw an increase from almost $7,000 to $10,000 over the same time period (National Center for Education Statistics, 2019b). These increasing costs can pose an important barrier to accessing and enrolling in college, as well as persisting and completing college.

Financial aid, which seeks to reduce the upfront cost of college, is one of the most prevalent interventions used to increase both college access and attainment (Dynarski, 2008). Financial aid can take many forms, including loans - which provide funds upfront while requiring repayment at a later date--or grants and scholarships - which directly subsidize the cost of college for the student (College Board, 2019). With the passage of the Higher Education Act of 1965, aid per student has nearly tripled over the last 60 years (Dynarski & Scott-Clayton, 2013). Federal grants, such as the Pell Grant, account for 60 percent of distributed aid, while grants from institutions of higher education account for 19 percent of aid. In 2017, over 80 percent of students enrolled in four-year institutions reported having some type of financial aid (National Center for Education Statistics, 2019a).

While the majority of financial aid is federally awarded, individual states also offer financial aid, typically in the form of merit-based scholarships. State-financed merit-based scholarships are grant aid programs which tie eligibility to student performance on standardized college readiness assessments, such as the SAT or ACT, and high school performance, often measured by GPA. These programs can be contrasted with need-based grant aid, which typically bases eligibility on parental income. State-financed merit-based scholarships have become increasingly popular to both families and policymakers. State policymakers, for example, often promote these programs by arguing that they can increase college enrollment, incentivize high-performing students to stay within the state, and promote and reward academic achievement through merit-based eligibility (Cornwell, Lee, & Mustard, 2005). As of 2015, 29 states had such programs (Legislative Fiscal Office, 2017).

Evaluations of these state-financed merit-based scholarships suggest that these programs increase the likelihood of enrollment in postsecondary institutions and, in some cases, attainment. Rigorous quasi-experimental studies find such programs improve the likelihood of college attendance (Cornwell, Mustard, and Sridhar, 2006; Dynarski, 2003; Kane, 2003; Scott-Clayton, 2012), persistence past the first year of college (Bettinger, 2004), cumulative GPA (Scott-Clayton, 2012), and graduation (Dynarski, 2008; Scott-Clayton, 2012).

While the popularity of these programs has grown due to these positive effects, states have increasingly struggled to maintain funding as more students qualify for the awards. In Louisiana, for example, Governor John Bel Edwards attempted to eliminate $233 million in funding for the popular Taylor Opportunity Program for Students in 2018 in response to a budget shortfall (Crisp, 2018). Moreover, funds often run out before all qualified students receive their scholarships. A 2018 analysis by the Hechinger Report found that 900,000 eligible low-income applicants did not receive state-financed scholarships because states ran out of money (Kolodner, 2018).

States have attempted to modify their scholarships in response to constrained budgets in the hopes of maintaining their popular programs. For example, the Florida Legislature passed a bill that increased the minimum test score needed to qualify for the Bright Futures Scholarship Program, impacting graduating students beginning in 2021 (Mahoney, 2019). While some states have reduced award amounts or implemented more rigorous qualification requirements to shrink the pool of qualifiers, Arkansas decided to shift the award payout structure for its Academic Challenge Scholarship (ACS) from equal annual installments to a backloaded structure in 2013. This change awards students progressively higher amounts as they persist through college, incentivizing completion. In theory, the new payout structure would directly benefit the state by increasing its return on investment through more college graduates. On the other hand, Arkansas's move to a backloaded ACS payout structure could disincentivize college enrollment by unambiguously increasing the cost of enrolling at a four-year institution.[4] Our study's goal is to determine how college enrollment in Arkansas was affected by this switch to a backloaded payout structure.

We estimate the impact of the change to Arkansas's scholarship program using a difference-in-differences design applied to state-level panel data on college enrollment obtained from the Integrated Postsecondary Education Data System (IPEDS). In effect, we estimate the impact of the payout change by comparing trends in college enrollment in Arkansas to similar southern states before and after the switch to the backloaded structure

In general, our analysis indicates no statistically significant impact on overall college enrollment or enrollment in four-year institutions resulting from the 2013 switch to a backloaded payout structure. While our results are inconclusive on the overall impacts of the policy change

[4] The overall award amount decreased from $18,000 to $14,000 over four years under the backloaded payout structure. The following section provides more details on the ACS changes.

in Arkansas's merit scholarship, we do observe patterns that this change may have had negative impacts on students' willingness to enroll in college. Previous research on statewide merit scholarships in other settings has found that introducing programs similar to that in Arkansas can have a positive impact on students' postsecondary educational outcomes. However, our findings—while not statistically significant—suggest that dramatic changes in how funds are awarded and the amount of funding available can potentially adversely impact students. States should proceed with caution if considering similar changes.

The remainder of this paper is structured as follows. We begin with a detailed description of Arkansas's merit-based scholarship, the Academic Challenge Scholarship (ACS), and subsequent alterations to its payout structure in 2013. We then review the current literature examining the impacts of merit-scholarships on postsecondary enrollment and attainment. Next, we detail our empirical methodology and present our results. We conclude with a discussion about the implications of our findings and policy relevance.

Description of the Academic Challenge Scholarship Program

The Arkansas Academic Challenge Scholarship (ACS) Program is a state-wide, broad-based merit scholarship program with multiple qualification standards. The program was originally created in 1991; however, the scholarship was not widely used until it was dramatically expanded in 2010 thanks to funding from Arkansas's first statewide lottery.[5]

The ACS eligibility requirements have remained unchanged over the time period examined in this study. To receive a scholarship, students must be an Arkansas resident for at least 12 months prior to enrolling in college, graduate high school completing the standard

[5] Voters approved the Arkansas Lottery in November 2008, with the understanding that a portion of the proceeds would go to fund the ACS. Lottery tickets originally went on sale in the fall of 2009 and scholarships were awarded under the expanded program in fall 2010 (Mills, 2015).

curriculum[6], and must either have a 2.5 high school GPA or score a 19 or higher on the ACT (or concordant score on an equivalent test). Additionally, in order to receive the scholarship, students must fill out the FAFSA and complete an application.

The ACS additionally has requirements for on-going eligibility. Once awarded a scholarship, students must maintain at least a 2.5 GPA, enroll in at least 12 credit hours for their first semester, and 15 credit hours each semester thereafter, and must be continuously enrolled and working towards a terminal degree (Arkansas Division of Higher Education, 2018). The original ACS award was substantial. Qualified students enrolling in four-year institutions in 2010 received equal installments $5,000 per year, which roughly covered 95 percent of tuition at the state's flagship institution.[7]

To date, over 500,000 scholarships have been awarded, totaling over $965 million in financial aid (Arkansas Department of Higher Education). Once enrolled in college, ACS recipients must maintain a 2.5 GPA, enroll in at least 12 credit hours for their first semester and 15 credits in each subsequent semester, and must be continuously enrolled to work towards a terminal degree (Arkansas Division of Higher Education, 2018). Table 1 describes how the ACS payouts have changed during the time period examined by this study.

The program's scholarships for four-year institutions were substantial between the fall of 2010 and the spring of 2013. For the first cohort of recipients, students received up to $20,000

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[6] The standard curriculum in Arkansas is SmartCore and requires four English language arts credits, four mathematics credits, three science credits, three social studies credits and half of a credit in oral communication, physical education, health and safety, and fine arts. An additional six credits in career or other content is required for graduation. (See: http://dese.ade.arkansas.gov/divisions/learning-services/curriculum-support/arkansas-graduation-requirements)

[7] Based on average tuition amounts for the ten public universities in the state of Arkansas as reported for the 2010- 11 school year. For comparison: the published tuition for the Arkansas flagship university, the University of Arkansas-Fayetteville, 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/).

over a four-year period, covering roughly 90 percent of the cost of tuition at the state's flagship institution at the time (Mills, 2015). While the award amount decreased slightly for fall 2011 applicants, the overall payout of $18,000 still was sufficient to cover 75 percent of tuition. The first major change to the ACS payout structure occurred for the fall 2013 applicant cohort, due largely to increased numbers of qualified applicants and falling lottery revenue (Beherec, 2013). Unlike previous cohorts, the fall 2013 applicant cohort would receive a lower award amount in their first year and progressively increasing payouts throughout their college experience. The resulting total award amount decreased from $18,000 to $14,000 over a four- year period. While policymakers at the time argued that this change would incentivize enrollment and persistence, no previous empirical evidence exists which could support such claims. Our research addresses this gap in the literature.

Review of College Enrollment Literature

Tangible barriers to college access can be broadly grouped into three categories: lacking financial resources, lacking information on how to enroll in college, and lacking preparation for college (Page & Scott-Clayton, 2016). We begin by briefly discussing interventions designed to address the information and preparation barriers. We then turn to the focus of our study: interventions attempting to address the financial barrier.

Information, or a lack thereof, can deter students from pursuing a postsecondary education (Hoxby & Avery, 2013; Avery & Kane, 2014; Castleman & Page, 2014). Interventions aimed at providing students with information about the college application process can increase college application and enrollment rates (Barr & Turner, 2017; Hoxby & Turner, 2013; Page & Gehlbach, 2017). Furthermore, interventions with both informational and personal interaction have been shown to increase enrollment at selective institutions (Sanders, 2018).

In addition to informational barriers about the application process and pipeline between high school and college, students may face preparation barriers that prevent them from pursuing a postsecondary education (Avery & Kane, 2014; Gonzalez, Bozick, Tharp-Taylor, & Phillips, 2011). This could be particularly salient for would-be first-generation students, as they are less likely to take advanced placement courses compared to continuing generation students (Cataldi et al., 2018).

Policymakers and researchers have long considered financial constraints to be significant barriers to college access; and many financial aid programs attempt to reduce this burden. Since the passage of the Higher Education Act of 1965, aid amount per student has tripled (Dynarski & Scott-Clayton, 2013). This should come as no surprise, as the theory of action is that financial aid for education can work to improve college attendance by reducing the overall cost of college (Dynarski, 2008). Indeed, the availability of financial support led to 75 to 85 percent of students in four-year institutions between 2000 and 2017 reported receiving some type of financial aid (National Center for Education Statistics, 2019d).

Financial aid can take several forms including loans, grants, and scholarships. Most financial aid is federally distributed, followed by institutional and state awarded aid (Sarubbi, & Pingel, 2018). While many financial aid programs have a need-based component, several states have aid programs based primarily on merit. These programs link financial aid with performance on standardized tests and high school GPA. One such program is the ACS, funded by the Arkansas state lottery, which requires a high school GPA of 2.5 or ACT score of 19. Similarly, the Georgia HOPE Scholarship and Florida Bright Future Scholarship Program award financial aid based on merit. To qualify for the Georgia HOPE Scholarship, students must have at least a 3.0 high school GPA, and students qualifying for the Florida Bright Future Scholarship Program must demonstrate a 3.0-3.5 high school GPA depending on the qualification tier (Dynarski, 2000; Zhang et al., 2013).

The Georgia HOPE Scholarship began distributing scholarship funds gained from the state-run lottery in 1993. Similarly, the Florida Bright Futures Program began using funds from the state-run lottery in 1997. As these programs have become more established and these states have funneled greater amounts for students to use for college enrollment, researchers have used quantitative methods to analyze the impacts of these programs.

Research on the HOPE Scholarship Program has had a positive impact on college enrollment. Dynarski's (2000) analysis of the Georgia HOPE Scholarship uses a difference-in-differences approach to analyze the impact of the program's implementation on college attendance for middle- and upper-income students in Georgia, compared to their peers in surrounding states. Overall, this study finds that the HOPE scholarship increases college enrollment for Georgia students by seven to eight percentage points in comparison to surrounding states (Dynarski, 2000). The results suggest that for each additional $1,000 available in aid, the college matriculation rate in Georgia increases by three to four percentage points (Dynarski, 2000). However, the important caveat for these results is that the program may widen the gap in attendance rates for White and Black students (Dynarski, 2000).

In other studies of the HOPE program, Cornwell, Mustard, and Sridhar (2006), using a difference-in-differences design, find that the Georgia HOPE Program increased freshmen enrollment by nearly six percent, relative to other Southeastern states from 1988-97, with four-year colleges accounting for most of the gain. They conclude that the Georgia HOPE Program helped to keep students in state, and the reduction of students leaving the state for college accounted for over 60 percent of the increase in four-year enrollment.

Additionally, Cornwell, Lee, and Mustard (2005) estimate the effects of the program on the course-taking behavior of HOPE recipients. Comparing in-state, HOPE-eligible enrollees to out-of-state enrollees at the University of Georgia, Cornwell et al find that HOPE recipients enroll in fewer credit hours than their out-of-state peers who were ineligible for the scholarship. Henry and Rubinstein (2002) examine whether the implementation of the HOPE Scholarship has altered educational quality in high school graduates, finding that the percentage of students earning a B average or higher in high school—thereby qualifying for the Scholarship—increased from about 55 percent to 59 percent of graduates. Additionally, African American students qualifying have increased their average SAT scores by 20 points (Henry & Rubinstein, 2002).

Similar to the results of research on the HOPE Scholarship, the Florida Bright Futures Scholarship shows overall positive impacts on enrollment. Using a regression-discontinuity, Zhang et al (2016) find students who just meet the cut score, and are therefore awarded a Scholarship, were 3 to 10 percentage points more likely to enroll in a public four-year institution than their peers who fail to meet the eligibility requirement. The variation in the size of the impact is due to the program's varying award amount based on tier for which students qualify based on their achievement. Another study of the Bright Futures Scholarship from Zhang, Hu, and Sensenig (2013) finds that being awarded a Scholarship yields a 22-percentage point increase in enrollment at four-year institutions and a 19-percentage point increase in enrollment at two-year institutions in Florida.

Overall, the literature suggests that financial aid, specifically in the form of merit-aid can increase enrollment at postsecondary institutions, however, there is a gap in the literature on how the construction of the payout structure can influence student choices. Typically, aid programs provide a consistent dollar amount while students are enrolled. While this was true of the ACS at the time of its expansion, we have shown that Arkansas's program has undergone significant changes in both dollar amount and payout schedule since its inception. The research we present here seeks to fill this gap by first evaluating the impact of the ACS on postsecondary enrollment patterns in Arkansas, as well as the degree to which the shift in award payout structure affects subsequent student secondary enrollment behaviors in Arkansas. The results from Arkansas can serve as an example of how a state might provide aid to students, and whether initial dollar amounts and the payout schedule are important for students' postsecondary enrollment expectations.

Theoretical Expectations

While the literature generally suggests a positive effect of merit aid on postsecondary enrollment, we have reason to suppose that *changing* the nature of the payout structure in this backloaded way will in fact have negative effects on enrollment patterns in Arkansas. Although earning the merit-based scholarship awards students money for college above and beyond what they would have had originally, we are specifically interested in how changing the *way* that money is disbursed impacts enrollment decisions. Students face a substantial financial burden when deciding to enroll in college, especially at a four-year institution, where costs are generally higher than at two-year institutions[8], and it takes longer to earn one's degree (College Board, 2020). Furthermore, the switch to the backloaded payout structure largely affected students intending to attend four-year institutions, meaning that students attending the more expensive schools are the same students who would be impacted by the large reduction in financial aid at the beginning of their postsecondary education career. Coupled with the overall reduction of the

[8] Average cost of two-year college is $3,440 per year, the average cost of public four-year colleges (in-state) is $9,410 per year, out-of-state is $23,890 per year, and private four-year colleges are $32,410 per year. See College Board website at https://bigfuture.collegeboard.org/pay-for-college/college-costs/college-costs-faqs.
.

total award amount over four years, from $18,000 to $14,000, we speculate that we will see negative effects. It is possible that we see some students turning away from public-four year institutions in favor of two-year institutions or out-of-state colleges. The difference in premium may not be large enough to sway their decisions, as the price tag at Arkansas institutions is higher at the beginning, because much of the ACS award is delayed until the end of the students' postsecondary education career.

Methodology

We determine the impact of changing the award payout structure from an equal installment payment to a backloaded system on postsecondary enrollment patterns in Arkansas using a difference-in-differences (DD) design. The following sections detail our empirical strategy and the data used for this study.

Empirical Strategy

Ideally, we would estimate the impact of the ACS payout change in an experimental research setting by randomly assigning students to receive scholarship awards in either equal installments or via ACS's backloaded system. Comparisons between these two groups would accurately identify how disbursing money to students influences their decisions on where to enroll in college. Unfortunately, this ideal setting does not exist, as students must apply and qualify for the award and the state changed the policy for all students in a single year.

Using existing administrative data, we could attempt to estimate the enrollment impact of the ACS change by comparing the number of students enrolled in Arkansas postsecondary institutions before and after the 2013 change. Nevertheless, while this may provide an informative starting place, this naïve pre-post comparison would be misleading if college enrollments were increasing in all states over time due to a stronger college-going culture in the

U.S. generally. If this trend exists, college enrollments would likely increase regardless of how the ACS awards students money. What is needed, therefore, is a method that will allow us to differentiate changes in Arkansas enrollments due to the ACS payout change from general trends in college enrollment.

Our empirical strategy is modeled on Cornwell, Mustard, and Sridhar's (2006) study of the Georgia HOPE program's effects on college enrollment. Specifically, we use a difference-in-differences (DD) design to estimate the impact of the switch to a backloaded payout structure by comparing changes in enrollment patterns within the state of Arkansas before and after 2013 to that of enrollment patterns in similar states whose students did not experience such a change in payout structure. In effect, the college enrollment trends of the comparison group states serve as our estimate of the counterfactual, or what would have occurred in Arkansas had the ACS payments not switched to a backloaded payout structure.

Our empirical model takes the following form:

$$\ln(E_{it}) = \delta_1(AR_i \times After2010_t) + \delta_2(AR_i \times After2013_t) + X_{it}'\beta + \gamma_i + \theta_t + \epsilon_{it} \quad (1.1)$$

Where:

- E_{it} is enrollment in state i in year t.
- AR_i is an indicator taking on a value of 1 for Arkansas and 0 otherwise.
- $After2010_t$ identifies the period following the initial expansion of the ACS in 2010 by taking on a value of 1 when $t \geq 2010$ and 0 otherwise
- $After2013_t$ identifies when the backloaded payout structure went into effect (equal to 1 when $t \geq 2013$).
- X_{it} is a vector of covariates capturing state demographics and economic indicators.
- γ_i is a vector of state fixed effects.

- θ_t is a vector of year fixed effects.
- ϵ_{it} is an error term accounting for nesting within states (Bertrand, Duflo, & Mullainathan, 2003)

This model is a slightly augmented version of the standard DD model employed by Cornwell, Mustard, and Sridhar (2006). Specifically, we include two interactions involving the Arkansas state identifier: $AR_i \times After2010_t$ and $AR_i \times After2013_t$. The first interaction identifies the general impact of the ACS expansion in 2010 on college enrollment in Arkansas, which is represented by δ_1. The second interaction term, $AR_i \times After2013_t$, identifies the parameter of interest in our analysis, δ_2: the differential impact on enrollment that occurred following the ACS change to a backloaded payout structure in 2013. Finally, the sum of δ_1 and δ_2 represents the general difference in enrollment in Arkansas following the switch to the backloaded payout structure relative to the period before 2010 (i.e., the pre-ACS expansion period). If, for example, the expansion of ACS in 2010 generally increased college enrollment afterward, but the switch to a backloaded payout structure made college attendance less attractive to students by increasing the overall cost of attendance, we would expect to observe $\widehat{\delta_1} > 0$, $\widehat{\delta_2} < 0$, and $\widehat{\delta_1} > \left(\widehat{\delta_1} + \widehat{\delta_2}\right) > 0$.

Our preferred model controls for natural variation in enrollment trends explained by student demographics and economic conditions. Specifically, we account for changes in the population of potential college-going students by controlling for the number of high school graduates each year. We additionally control for state economic conditions, which have been found to influence the decision to attend college (Cornwell, Mustard, & Sridhar, 2006). These variables, along with state and year fixed effects, help us to isolate the specific effect of the

ACS's payout structure change on college enrollment from other confounding factors affecting college enrollment trends in general.

Data

The chief challenge facing any empirical analysis is the identification of an appropriate estimate for the counterfactual, or the way the world would have been in absence of the intervention. For our analysis, we use two groups of comparison states to proxy for Arkansas's counterfactual: the other member states of the Southern Regional Education Board (SREB)[9] and the six states bordering Arkansas[10]. These comparison groups mirror those used in Cornwell, Mustard, and Sridhar (2006), and for good reason: states in both groups share regional and economic similarities that make them suitable proxies for the Arkansas counterfactual.

The outcomes for this analysis—college enrollment data—are drawn from the National Center for Education Statistics' (NCES) Integrated Postsecondary Education Data System (IPEDS). Specifically, we collected state-level aggregate data on first-time resident enrollment for all postsecondary institutions as well as separately for public four-year, private four-year, and public two-year institutions for even years between 2004 and 2016. We limit our data to first-time, first-year residents to mirror ACS's residential requirement for eligibility. This requirement further limits our analysis to even years only, as NCES only requires institutions to report residential data in even years.[11]

[9] SREB States: Alabama, Arkansas, Delaware, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia (see https://www.sreb.org/)
[10] Border States: Louisiana, Mississippi, Missouri, Oklahoma, Tennessee, and Texas
[11] We replicated our analysis for both comparison groups (SREB and Border States) using enrollment counts including non-residents for students enrolled full-time only (Tables A1 and A2) and full- and part-time (Tables A3 and A4). This allows us to additionally include odd-numbered years. In general, results are consistent across enrollment specifications.

Our analysis includes two covariates to control for extraneous factors that may explain pre-existing trends in college enrollment. First, we control for state economic conditions using the Federal Reserve Bank of St. Louis's Coincident Economic Activity (CEA) Index, which captures the expansion and contraction of state economies using data on employment trends, real earnings, unemployment rate, and the average weekly hours worked in manufacturing. An increase in the CEA Index is interpreted to mean the state economy is expanding, while a decrease represents a contraction in the state's economy.

Second, we control for the size high school graduation cohorts as they represent the primary pool of potential first-time college enrollees. We collected these data each year for each state in our sample from NCES's Digest of Education Statistics. NCES reports the actual high school graduation total for 2004 through 2013 and the projected high school graduation totals for 2014 through 2016. While, we would prefer using actual counts of high school graduates in our analysis, we use projections when no other data are available. Fortunately, a comparison of the projections with a separate data set containing information on all Arkansas high school graduates suggests the projections are fairly accurate.[12]

Analytic Sample

Our analysis focuses on three time periods:

1. Pre-ACS Expansion: Years 2003-2009
2. Initial ACS Expansion: Years 2010-2012
3. Change to Backloaded Payouts: Years 2013-2016

Table 2 provides descriptive statistics for Arkansas and the two comparison group samples—SREB and border states—in the three time periods indicated. Specifically, Table 2

[12] The projected rates for Arkansas in 2010-11 was 28,440 high school graduates, the actual number of high school graduates for that year totaled 28,205.

displays the average enrollment figures for Arkansas and each group of comparison states for each of the specified time periods, as well as the average number of high school graduates and average values of the local economic condition as captured by the CEA index.

Table 2 indicates that college enrollments in Arkansas, the SREB states, and Arkansas's border states generally increased between the pre-ACS Expansion period (2003-2009) and the Initial ACS Expansion period (2010-2012). In contrast, we observe slight declines in average enrollment across all states in the time period following Arkansas's change to a backloaded payout structure (2013-2016). The number of high school graduates in Arkansas and both comparison groups, in contrast, progressively increases as we move forward from each time period. Finally, the economic conditions of Arkansas and each group of comparison states appear to be expanding, as evidenced by a generally increasing average CEA index value across all states over time.

An important requirement of any DD analysis is that the comparison group and treatment group share similar trends in the outcome of interest away from the discontinuity point (Bertrand, Duflo, & Mullainathan, 2003). Figure 1 below illustrates overall trends in the log of enrollment for even years in Arkansas and the SREB states from 2004 to 2016 for all institutions, public four-year, private four-year, and public two-year institutions. The vertical lines at 2010 and 2013 show the implementation of the ACS and the change to the award payout structure, respectively. While the SREB states consistently have higher numbers of enrollees on average, their enrollment trends largely track those of Arkansas across all institution types. Figure 2 shows the same analysis, after enrollment figures are first indexed against the enrollment count in 2010. In this way, Arkansas and the comparison group of SREB states have equivalent enrollment indices of 100 for the year 2010, and therefore we are able to lay the trend lines on top of each other to better identify any variations. With the exception of private four year institutions, Figure 2 shows similar trends prior to 2010, with any major deviation occurring after the initial expansion of 2010, and later, the award payout change of 2013. Together, this provides some assurance for using the SREB states as a comparison group for Arkansas in the DD analysis. Figures 3 and 4 present the same enrollment trends, using the states that border Arkansas as the comparison group. Overall, we conclude that there is visual evidence supporting the use of SREB or border states as the comparison group of states in our analysis.

Results

This section presents the results of our primary analysis. While we find that the expansion of the ACS in 2010 is associated with an initial increase in postsecondary enrollment in Arkansas, we generally do not identify statistically significant impacts of the 2013 shift to a backloaded payout structure on enrollment. The notable exception is for two-year institutions, which experienced significant declines in enrollment following the 2013 ACS payout change.

Table 3[13] presents the estimated impacts of both the implementation of the ACS lottery scholarship in 2010 and the change to the award payout structure in 2013 using the SREB comparison sample. Odd numbered columns present simple models that do not control for additional covariates and even-numbered columns include controls for state economic conditions and high school graduation cohorts. Each model includes state and year fixed effects. Estimated impacts of expanding the scholarship in Arkansas using lottery funds in 2010 relative to the pre-time period are presented in row 1 (Arkansas x After 2010). Row 2 (Arkansas x After 2013) is the focus of our study: the estimated impacts backloading the ACS award payout structure above

[13] Tables A1 and A3 at the end of this chapter show the results for the same analysis comparing to SREB states when the sample includes residents and non-residents (A1), and both full- and part-time students (A3). Overall, the results do not change.

and beyond the impact of expanding the scholarship. Adding the two coefficients together, we are also able to see the impact of back-loading the payout structure relative to the Pre-Expansion period in 2010.

Our results indicate that the expansion of the ACS in 2010 is associated with a statistically significant five percent increase in enrollment in all Arkansas postsecondary institutions relative to the time period prior to the expansion. In contrast, there is no conclusive evidence to suggest that the subsequent change from equal annual installments to a backloaded award payout structure produced a significant change in enrollment rates in all postsecondary institutions throughout Arkansas. In general, the coefficient estimates suggest enrollment declined 6 percent compared to pre-ACS expansion levels following the switch to a backloaded structure; however, these estimates are not statistically significant at conventional levels. Combining the estimated effects of expanding the scholarship in 2010 and changing the award payout structure in 2013, we see that the backloaded award payout structure is associated with a non-significant one percent overall decrease in enrollment in Arkansas postsecondary institutions relative to the time period prior to the scholarship expansion.

Table 3 also presents estimated effects by institution type: public four-year, private four-year, and public two-year institutions. In general, the results for public four-year institutions in Arkansas mirror the results for total enrollment. Expanding the scholarship in 2010 is associated with a four percent increase in enrollment in public four-year institutions while backloading the payout structure is associated with a non-significant six percent decrease in postsecondary enrollment in Arkansas. The results for private four-year institutions indicate that the initial expansion of the ACS in 2010 yielded a sizeable jump in enrollment (23 percent), yet no noticeable change in enrollment due to the 2013 switch to backloaded payouts. Interestingly, the only case in which we observe that the 2013 payout change significantly impacted enrollment is for public two-year institutions. Specifically, our models indicate that the 2013 switch led to between 11 and 16 percent declines in enrollment at public two-year institutions. Combining the estimated effects, we see that the 2013 change to award payout structure, which only decreased the award amount by $500 per year at two-year institutions, is associated with an overall 10 percent decrease in enrollment in Arkansas public two-year institutions, compared to the time period prior to the ACS expansion.

Table 4[14] presents our analysis using the states that border Arkansas as the comparison group rather than the SREB states. Generally, we find similar results when comparing Arkansas to border states rather than SREB states, non-significant, negative impacts following the 2013 payout change. Because of this, we cannot say conclusively whether the post-2013 payout shift had a measurable impact on overall college enrollment decisions in Arkansas.

Conclusion

While the popularity of state-financed merit-based scholarships has increased since their creation in the 1980s, state policymakers struggle to maintain these programs in the face of growing costs. Some states have tried to manage this tradeoff through changes to program eligibility or award amounts; however, little empirical research exists that can speak to the effectiveness of these changes. This study adds to the financial aid literature by examining how one state's changes to the payout structure of its merit-scholarship program affects college enrollment.

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[14] Tables A2 and A4 at the end of this chapter show the results for the same analysis comparing to Border states when the sample includes residents and non-residents (A1), and both full- and part-time students (A3). Overall, the results do not change.

Using a difference-in-differences (DD) design comparing Arkansas to other southern states, we determine if college enrollment responded to a 2013 restructuring of Arkansas's Academic Achievement Scholarship (ACS) from equal annual awards to a backloaded system, which provided progressively higher payouts to students who continued to persist in college. To our knowledge, this is the first study to examine if moving to a backloaded payout structure affects college enrollment.

While we observe statistically significant increases in enrollment following the initial expansion of the ACS in 2010, our results do not indicate the 2013 payout change significantly impacted college enrollment. Specifically, we fail to identify statistically significant impacts to enrollment across all institutions as well as for both public and private four-year institutions following the 2013 payout change.

Despite the general finding of null effects, several findings are worth highlighting. First, we note a striking 23 percent increase in enrollment in Arkansas four-year private school institutions relative to other states following the initial expansion of the ACS in 2010. When comparing with results for other institutions, it appears that the results for private schools is the primary driver behind the observed significant impact of the ACS expansion on overall enrollment. It is possible that the initial scholarship award—which could be used at Arkansas private institutions—was sufficiently large enough to encourage students who otherwise were considering private schools outside the state to remain in Arkansas, as is intended by the state aid program. In contrast, we observe no discernable impact following the 2013 payout change as the estimate is both nonsignificant and trivial in magnitude. The backloaded payout structure—which represented only a $4,000 drop in total payout over four years—may have represented a small deterrent to Arkansas students already intending to attend an in-state private institution because they were confident that they would complete their education in four years, as private non-profit institutions tend to have the highest four-year graduation rates among post-secondary institutions (National Center for Education Statistics, 2019c). This is only a speculation, however, as our study cannot definitively answer this question. In addition, it should be noted that private school enrollment in Arkansas is generally quite low and thus more susceptible to fluctuations.

Second, we observe consistent evidence of a negative and statistically significant impact on enrollment for public two-year institutions in Arkansas relative to comparison states following the change in payout structure. While this finding is surprising given the payouts decreased only slightly for two-year institutions, it is important to note the U.S. Department of Education altered Pell Grant eligibility requirements that reduced the number of eligible students in 2012 (Mabel, 2019). If, as prior research suggests (Katsinas et. al, 2013), community college students in Arkansas were more adversely impacted by this policy change, students may be losing more than just the slight decrease in ACS dollars. While all students nationwide would be impacted by the Pell Grant change, this may have intensified the slight decrease in the ACS award experienced by community college students by decreasing the total aid available.

Finally, we caution that, while our findings generally do not indicate statistically significant impacts on college enrollment associated with the 2013 switch to a backloaded payout structure, the results suggest the potential for negative impacts. Specifically, the coefficient estimates are negative across most models and institution types. Moreover, there is evidence suggesting noticeable statistical noise in these estimations, as the reported standard errors are quite large. We therefore recommend that any state looking to implement a similar change to their merit-scholarship program should do so with caution.

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Figures

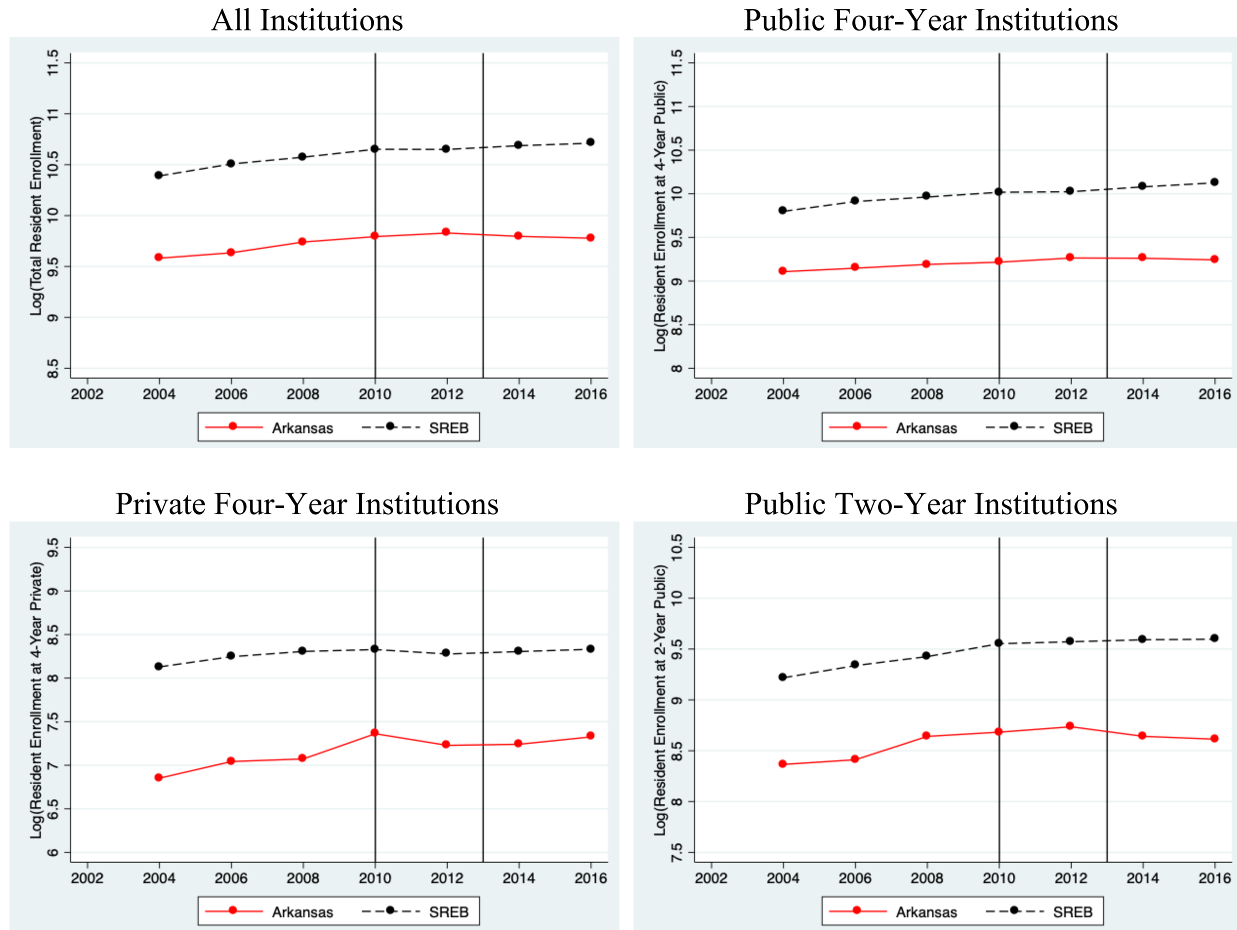

Figure 1: *Log of Enrollment Trends for Arkansas and Comparison Group of SREB States.*
Notes: Resident first-time undergraduates (FTUG) are restricted to students who graduated from high school in the previous 12 months. Resident FTUG available for even-numbered years only.

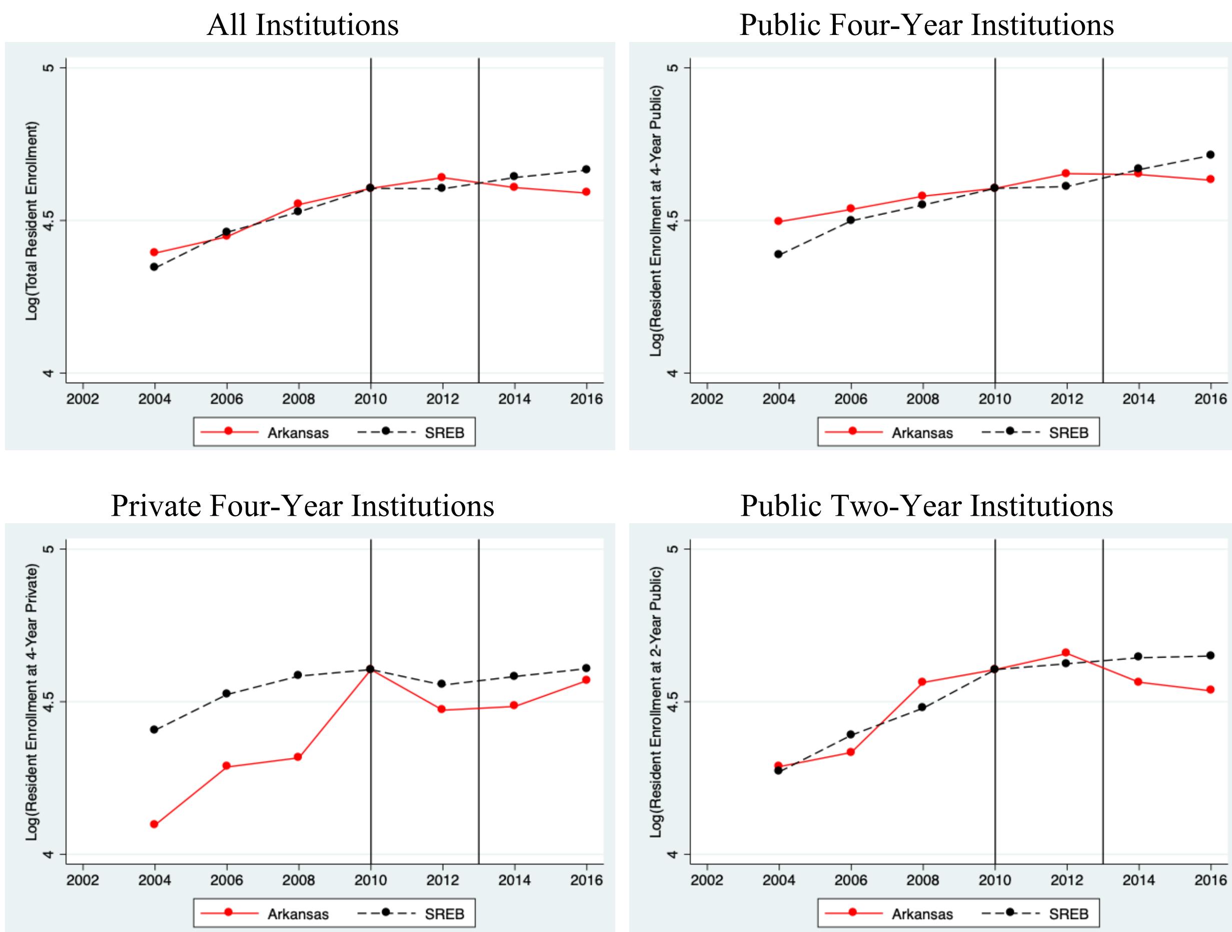

Figure 2: *Log of Enrollment Trends for Arkansas and Comparison Group of SREB States, Indexed to 2010 Enrollment Number*

Notes: Resident first-time undergraduates (FTUG) are restricted to students who graduated from high school in the previous 12 months. Resident FTUG available for even-numbered years only. Enrollment trends were indexed to 2010 enrollment numbers by dividing each enrollment count by the average number of enrollees in Arkansas, and comparison group of states respectively. In this way, the enrollments of both groups have an equivalent index of 100 in 2010, and trends before and after are easily identified.

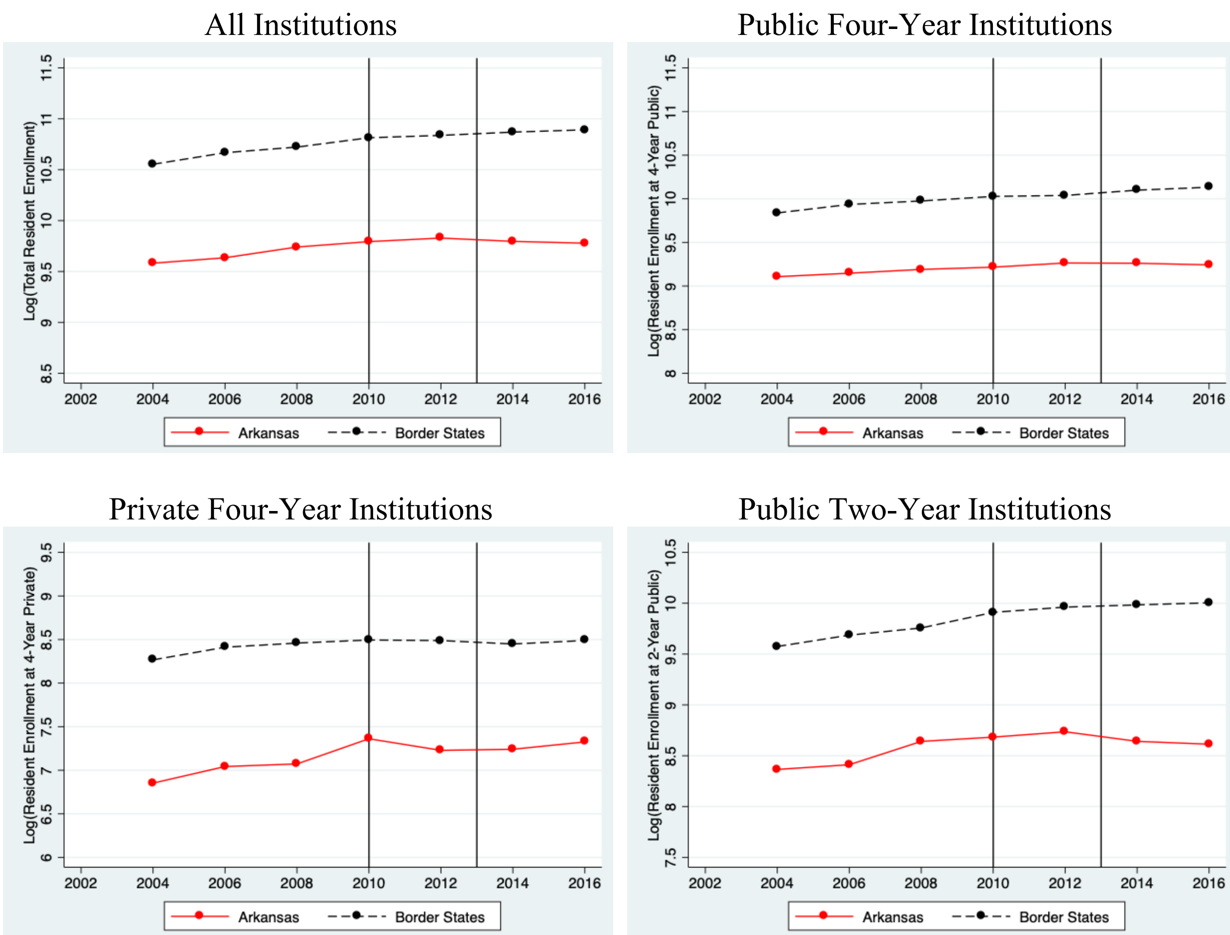

Figure 3: *Log of Enrollment Trends for Arkansas and Comparison Group of Border States.* Notes: Resident first-time undergraduates (FTUG) are restricted to students who graduated from high school in the previous 12 months. Resident FTUG available for even-numbered years only.

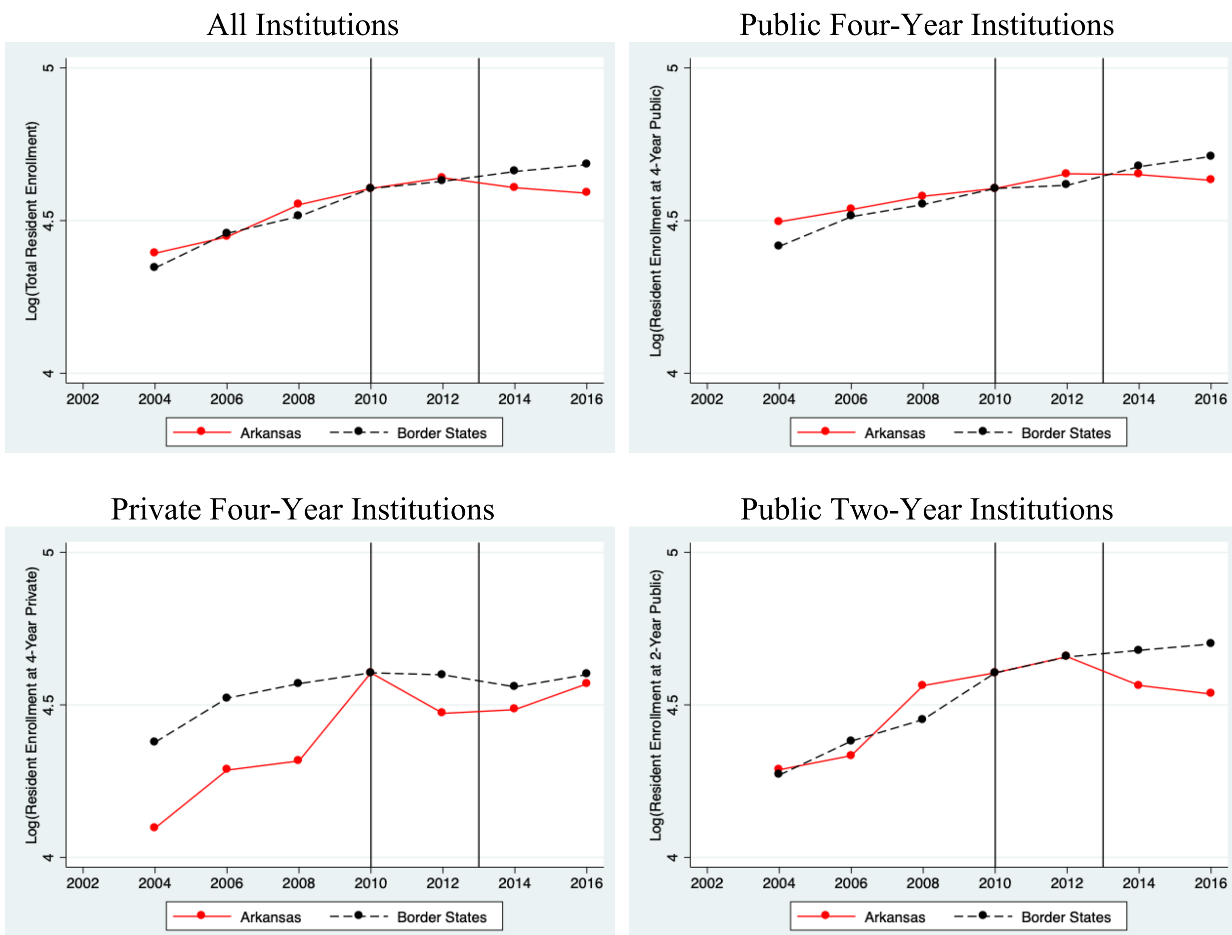

Figure 4: *Log of Enrollment Trends for Arkansas and Comparison Group of Border States, Indexed to 2010 Enrollment Number*

Notes: Resident first-time undergraduates (FTUG) are restricted to students who graduated from high school in the previous 12 months. Resident FTUG available for even-numbered years only. Enrollment trends were indexed to 2010 enrollment numbers by dividing each enrollment count by the average number of enrollees in Arkansas, and comparison group of states respectively. In this way, the enrollments of both groups have an equivalent index of 100 in 2010, and trends before and after are easily identified.

Tables

Table 1: *ACS Award Amounts by Year*

Year (Fall)	Amount by Year	Four-Year School	Two-Year School
2010	All Years	$5,000	$2,500
2011-2012	All Years	$4,500	$2,250
2013-2015	Year 1	$2,000	$2,000
	Year 2	$3,000	
	Year 3	$4,000	
	Year 4	$5,000	

Source: Arkansas Department of Higher Education (https://scholarships.adhe.edu/scholarships/detail/academic- challenge-scholarships)
Notes. "All Years" indicates that awards were paid out in equal installments to students attending four-year institutions for all four years

Table 2: *Means and standard deviations of variables*

	2003-2009			2010-2012			2013-2016		
	Arkansas	SREB states	Border states	Arkansas	SREB states	Border states	Arkansas	SREB states	Border states
Full-time, first time freshmen									
All institutions	22,382	49,564	53,966	26,082	56,480	61,548	25,027	55,973	61,866
	(1,420)	(34,811)	(39,917)	(168)	(42,087)	(48,854)	(220)	(42,490)	(51,423)
4-year institutions	15,277	31,591	32,411	17,873	36,907	36,245	18,011	38,559	38,023
	(765)	(21,181)	(22,760)	(261)	(28,129)	(27,387)	(421)	(29,863)	(30,849)
2-year institutions	7,105	17,973	21,556	8,209	19,573	25,303	7,016	17,414	23,842
	(857)	(14,658)	(18,248)	(224)	(16,261)	(22,040)	(586)	(15,293)	(21,000)
Resident first-time undergraduates*									
All institutions	15,589	36,077	42,187	18,235	42,215	50,288	17,799	44,307	53,132
	(1,275)	(29,947)	(38,037)	(452)	(37,046)	(47,791)	(226)	(40,622)	(54,117)
4-year public	9,400	19,802	20,282	10,304	22,485	22,758	10,424	24,406	24,726
	(393)	(18,294)	(18,480)	(351)	(22,676)	(22,039)	(137)	(25,044)	(26,712)
4-year private	1,090	3,751	4,370	1,476	4,034	4,873	1,457	4,096	4,765
	(126)	(3,393)	(4,401)	(139)	(3,542)	(4,837)	(87)	(3,659)	(4,823)
2-year public	4,817	11,279	15,917	6,061	14,217	20,663	5,583	14,679	21,892
	(736)	(11,662)	(15,295)	(226)	(15,172)	(20,337)	(112)	(16,138)	(21,463)
High School graduates (prior Spring)	27,757	64,043	75,976	28,300	72,217	85,585	30,092	75,837	90,061
	(902)	(58,601)	(78,598)	(109)	(68,457)	(94,182)	(818)	(74,461)	(102,537)
Coincident Economic Activity Index	141.44	145.68	140.35	152.2	152.78	148.84	166.25	174.77	167.68
	(6.11)	(13.43)	(14.99)	(3.40)	(17.75)	(20.98)	(6.59)	(24.15)	(28.34)

Note. Resident first-time undergraduates (FTUG) are restricted to students who graduated from high school in the previous 12 months. Resident FTUG available for even-numbered years only. *SREB States*: Alabama, Arkansas, Delaware, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia. *Border States*: Louisiana, Mississippi, Missouri, Oklahoma, Tennessee, and Texas.

Table 3: *Difference-in-Difference Estimates of the Impact of the ACS Expansion and Award Payout Change on Arkansas In-State Resident Enrollment, Compared to SREB States*

	All Institutions		4 Year Public		4 Year Private		2 Year Public	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Arkansas x After 2010 (δ_1)	0.018	0.049**	0.019	0.042	0.138***	0.226***	-0.055	0.055
	(0.026)	(0.023)	(0.040)	(0.025)	(0.040)	(0.047)	(0.059)	(0.044)
Arkansas x After 2013 (δ_2)	-0.082*	-0.060	-0.086	-0.059	0.006	-0.008	-0.111**	-0.155*
	(0.043)	(0.046)	(0.062)	(0.051)	(0.037)	(0.045)	(0.049)	(0.080)
Covariates		Yes		Yes		Yes		Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	128	112	128	112	128	112	117	103
R-squared	0.985	0.987	0.978	0.979	0.985	0.986	0.992	0.994

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

Note. Unit of analysis is state-by-year. The dependent variable in all analyses is the natural log of resident first-time undergraduates (FTUG) who graduated from high school in the previous 12 months. Resident FTUG are only available for even-numbered years. *After 2010* takes on a value of 1 for the fall of 2010 and thereafter. *After 2013* takes on a value of 1 for the fall of 2013 and thereafter. *Covariates* include the CEA index (which captures state economic conditions) and the natural log of high school graduates in the previous spring. *SREB States* include Alabama, Arkansas, Delaware, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia. Standard errors account for nesting within states.

Table 4: *Difference-in-Difference Estimates of the Impact of the ACS Expansion and Award Payout Change on Arkansas In-State Resident Enrollment, Compared to Border States*

	All Institutions		4 Year Public		4 Year Private		2 Year Public	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Arkansas x After 2010 (δ_1)	-0.000	0.030	-0.007	0.051	0.161*	0.214**	-0.081	-0.038
	(0.052)	(0.053)	(0.059)	(0.044)	(0.070)	(0.059)	(0.116)	(0.092)
Arkansas x After 2013 (δ_2)	-0.043	-0.033	-0.010	-0.004	-0.001	0.011	-0.175	-0.196
	(0.051)	(0.063)	(0.036)	(0.017)	(0.047)	(0.053)	(0.094)	(0.138)
Covariates		Yes		Yes		Yes		Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	56	49	56	49	56	49	56	49
R-squared	0.980	0.986	0.985	0.990	0.989	0.994	0.953	0.958

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

Note. Unit of analysis is state-by-year. The dependent variable in all analyses is the natural log of resident first-time undergraduates (FTUG) who graduated from high school in the previous 12 months. Resident FTUG are only available for even-numbered years. *After 2010* takes on a value of 1 for the fall of 2010 and thereafter. *After 2013* takes on a value of 1 for the fall of 2013 and thereafter. *Covariates* include the CEA index (which captures state economic conditions) and the natural log of high school graduates in the previous spring. *Border States* include Louisiana, Mississippi, Missouri, Oklahoma, Tennessee, and Texas. Standard errors account for nesting within states.

Table A1: *Difference-in-Difference Estimates of the Impact of the ACS Expansion and Award Payout Change on Arkansas Enrollment, Compared to SREB States*

	All Institutions		4 Year Institutions		2 Year Institutions	
	(1)	(2)	(3)	(4)	(5)	(6)
Arkansas x After 2010 (δ_1)	0.042***	0.058***	0.036	0.051*	0.030	0.106*
	(0.014)	(0.014)	(0.033)	(0.029)	(0.050)	(0.057)
Arkansas x After 2013 (δ_2)	-0.029*	-0.018	-0.028	-0.008	-0.020	-0.067**
	(0.015)	(0.014)	(0.016)	(0.020)	(0.028)	(0.028)
Covariates		Yes		Yes		Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	256	208	256	208	256	208
R-squared	0.994	0.997	0.986	0.993	0.966	0.968

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

Note. Unit of analysis is state-by-year. The dependent variable in all analyses is the natural log of post-secondary enrollment for both residents and non-residents who were enrolled full-time. *After 2010* takes on a value of 1 for the fall of 2010 and thereafter. *After 2013* takes on a value of 1 for the fall of 2013 and thereafter. *Covariates* include the CEA index (which captures state economic conditions) and the natural log of high school graduates in the previous spring. *SREB States* include Alabama, Arkansas, Delaware, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia. Standard errors account for nesting within states.

Table A2: *Difference-in-Difference Estimates of the Impact of the ACS Expansion and Award Payout Change on Arkansas Enrollment, Compared to Border States*

	All Institutions		4 Year Institutions		2 Year Institutions	
	(1)	(2)	(3)	(4)	(5)	(6)
Arkansas x After 2010 (δ_1)	0.054*	0.064**	0.064	0.083***	-0.011	0.003
	(0.026)	(0.018)	(0.039)	(0.019)	(0.080)	(0.083)
Arkansas x After 2013 (δ_2)	-0.024	-0.021	-0.022	-0.020	-0.087**	-0.096*
	(0.017)	(0.014)	(0.026)	(0.027)	(0.035)	(0.040)
Covariates		Yes		Yes		Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	112	91	112	91	112	91
R-squared	0.991	0.996	0.990	0.995	0.973	0.977

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

Note. Unit of analysis is state-by-year. The dependent variable in all analyses is the natural log of post-secondary enrollment for both residents and non-residents who were enrolled full-time. *After 2010* takes on a value of 1 for the fall of 2010 and thereafter. *After 2013* takes on a value of 1 for the fall of 2013 and thereafter. *Covariates* include the CEA index (which captures state economic conditions) and the natural log of high school graduates in the previous spring. *Border States* include Louisiana, Mississippi, Missouri, Oklahoma, Tennessee, and Texas. Standard errors account for nesting within states.

Table A3: *Difference-in-Difference Estimates of the Impact of the ACS Expansion and Award Payout Change on Full- and Part-Time Arkansas Enrollment, Compared to SREB States*

	All Institutions		4 Year Institutions		2 Year Institutions	
	(1)	(2)	(3)	(4)	(5)	(6)
Arkansas x After 2010 (δ_1)	0.006	0.019	-0.003	0.013	0.014	0.089
	(0.018)	(0.024)	(0.042)	(0.042)	(0.058)	(0.074)
Arkansas x After 2013 (δ_2)	-0.029	-0.024	-0.023	-0.001	-0.030	-0.088**
	(0.020)	(0.020)	(0.020)	(0.022)	(0.029)	(0.040)
Covariates		Yes		Yes		Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	256	208	256	208	256	208
R-squared	0.993	0.995	0.981	0.988	0.963	0.964

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

Note. Unit of analysis is state-by-year. The dependent variable in all analyses is the natural log of total post-secondary enrollment (i.e., full and part time, not limited to residents). *After 2010* takes on a value of 1 for the fall of 2010 and thereafter. *After 2013* takes on a value of 1 for the fall of 2013 and thereafter. *Covariates* include the CEA index (which captures state economic conditions) and the natural log of high school graduates in the previous spring. *SREB States* include Alabama, Arkansas, Delaware, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia. Standard errors account for nesting within states.

Table A4: *Difference-in-Difference Estimates of the Impact of the ACS Expansion and Award Payout Change on Full- and Part-Time Arkansas Enrollment, Compared to Border States*

	All Institutions		4 Year Institutions		2 Year Institutions	
	(1)	(2)	(3)	(4)	(5)	(6)
Arkansas x After 2010 (δ_1)	0.025	0.038	0.048	0.069**	-0.058	-0.039
	(0.029)	(0.022)	(0.042)	(0.020)	(0.080)	(0.082)
Arkansas x After 2013 (δ_2)	-0.022	-0.024	-0.021	-0.018	-0.085*	-0.104
	(0.020)	(0.024)	(0.027)	(0.027)	(0.035)	(0.056)
Covariates		Yes		Yes		Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	112	91	112	91	112	91
R-squared	0.991	0.995	0.989	0.995	0.975	0.979

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

Note. Unit of analysis is state-by-year. The dependent variable in all analyses is the natural log of total post-secondary enrollment (i.e., full and part time, not limited to residents). *After 2010* takes on a value of 1 for the fall of 2010 and thereafter. *After 2013* takes on a value of 1 for the fall of 2013 and thereafter. *Covariates* include the CEA index (which captures state economic conditions) and the natural log of high school graduates in the previous spring. *Border States* include Louisiana, Mississippi, Missouri, Oklahoma, Tennessee, and Texas.. Standard errors account for nesting within states.

Chapter 2: How a Change in the Award Payout Structure of a Broad-Based Scholarship Program Affects Student Postsecondary Outcomes

This paper was coauthored with Jonathan Mills and Evan Rhinesmith

Introduction

State-based merit financial aid for postsecondary education has increased in popularity since its inception in the 1980s. This type of aid is awarded to students based on their achievement characteristics, generally a combination of their high school GPA and score on a college readiness exam, such as the SAT or ACT. While states have an incentive to offer this financial aid to keep high-achieving students in the state for college, presumably with the hopes of retaining these students for the future workforce, these financial aid programs increase in expense as more students meet the stated achievement thresholds and qualify for the award.

This chapter focuses on one such program in Arkansas, the Academic Challenge Scholarship (ACS), introduced in Chapter 1. As discussed in there, the ACS was introduced in the 1990s, expanded in 2010, as a result of Arkansas voters approving the first state-wide lottery, and the payout structure was dramatically changed from equal installments to a backloaded system in 2013. Students must meet several residential and academic requirements to qualify for the ACS; of particular interest for this study, students must earn a 2.5 high school GPA, or score a 19 on the ACT or concordant score on another approved exam.

There is a robust literature evaluating merit-based financial aid programs, finding positive impacts on the decision to enroll in college (Cornwell, Mustard, and Sridhar, 2006; Dynarski, 2003; Kane, 2003; Scott- Clayton, 2012), the likelihood of persisting past the first year of college (Bettinger, 2004), GPA (Scott-Clayton, 2012), and likelihood of graduation (Dynarski, 2008; Scott-Clayton, 2012). While previous research studies take advantage of initial abrupt policy changes to assess the effect of getting an award after program *introduction*, we expand the body of research by instead assessing the effect of program *changes* following the ACS's 2013 policy shift from an equal installment payout program to a progressive payout structure on students' college outcomes. Using administrative data for all first-time, full-time enrollees in Arkansas' public, four-year postsecondary institutions between 2010 and 2015, we utilize a difference-in-discontinuities approach to identify the causal effects of qualifying for the ACS as well as the impacts of the shift in payout structure in 2013 in order to compare student outcomes. Specifically, our research question of interest is how did the change in the Academic Challenge Scholarship payout structure in 2013 affected students' college success outcomes, including term GPA, persistence, and attainment. We limit our sample of students to those who earned less than a 19 on the ACT, and therefore would not qualify for the ACS without meeting the other academic requirement of a 2.5 high school GPA. We then conduct our analysis over students who never qualify for the ACS, as they do not meet either academic requirement, compared to students who qualify for the ACS by meeting the high school GPA threshold, but not the ACT threshold. In this way, this analysis is conducted over a subsample of students enrolled in Arkansas institutions. Overall, our findings indicate no evidence of changes in ACS qualified students' postsecondary outcomes measured by persistence, GPA and likelihood of graduating within four years following the 2013 payout change compared to students receiving the scholarship under the initial regime of equal installments prior to 2013.

In this chapter, we describe financial aid in higher education before providing specific details of the ACS and the subsequent changes to the award payout structure. We then describe our data and methodology, exploring why we choose to use a difference-in-discontinuities approach rather than a standard regression discontinuity or difference-in-differences. We then present our empirical model and results, before discussing the implications of our findings and policy relevance.

Review of Financial Aid

Access to higher education in the United States has dramatically increased over the past three decades. Specifically, fall enrollment in degree-granting institutions has increased by 23 percent from 1995 to 2005, with an additional 14 percent increase from 2005 to 2015 (National Center for Education Statistics, 2019a). Additionally, the percentage of American individuals ages 25-29 holding a bachelor's degree has increased from 29 percent in 2000 to 36 percent in 2017 (National Center for Education Statistics, 2019c). However, these national percentages can mask trends in individual states. For example, in 2019, only 22 percent of Arkansas individuals ages 25-29 hold a bachelor's degree or higher (United States Census Bureau). The shortage of college graduates has been a concern in Arkansas for years, leading former Governor Mike Beebe to establish the statewide goal of 60 percent of state residents holding at least some postsecondary credential by 2025 through programs that will improve college affordability and increase access to postsecondary education (Arkansas Division of Higher Education, 2019). While there are many potential barriers to postsecondary access, financial barriers are the ones most commonly addressed by the program.

Financial aid for higher education can work to improve college attendance by reducing the cost of college (Dynarski, 2008). In constant 2016-17 dollars, the average price for tuition, room, and board at public four-year institutions increased from $12,000 to $19,000 from 2000 to 2016, and the price for private four-year institutions rose from an average of $30,000 to $40,000 over the same period (National Center for Education Statistics, 2019b). Given these increases, it is perhaps unsurprising that between 75 and 85 percent of students in four-year institutions between 2000 and 2017 reported receiving some type of financial aid (National Center for Education Statistics, 2019d).

Financial aid can take several forms, but the most prevalent are loans and grants (College Board, 2013). Loans provide funds upfront for future payments, while grant aid represents a direct financial subsidy from the perspective of the recipient. Since the passage of the Higher Education Act of 1965, total aid amount per student has nearly tripled (Dynarski & Scott-Clayton, 2013). Federal grants—largely the Pell Grant program—constitute the lion's share, accounting for 61percent of total aid received or distributed in 2012-13. Institutional grants constituted another 19 percent of total aid received. State grants, in contrast, represent a small fraction of the total aid distributed, just five percent in 2013 (College Board, 2013). While over 70 percent of grant aid has a need-based component, several states have grant aid programs based primarily on *merit*, with eligibility requirements largely linked to student performance on standardized college readiness assessments, such as the SAT or ACT, and high school performance, typically measured by GPA. One such state merit aid program is Arkansas' ACS.

Description of the Academic Challenge Scholarship

As was described in Chapter 1, the Arkansas Academic Challenge Scholarship Program (ACS) is a state merit-based aid program for students enrolling in Arkansas postsecondary institutions with relatively lax eligibility rules. Recipients of the award must meet various residential, academic, and application requirements[15]. Of specific interest to this study, students

[15] To qualify for the ACS, students must be an Arkansas resident for at least 12 months prior to enrolling in college, must graduate from an Arkansas high school through the SmartCore curriculum, must earn either a 2.5 high school GPA or a score of a 19 on the ACT (or concordant score on another approved admissions tests), and must apply for both the scholarship and FAFSA. See the Arkansas Division of Education Scholarship website at https://scholarships.adhe.edu/scholarships/detail/academic-challenge-scholarships.

must have *either* a 2.5 high school GPA or a score of a 19 on the ACT to qualify[16], which we will leverage in our empirical model.

While the scholarship has been available since the 1990s, it was dramatically expanded in 2010 after Arkansas voters approved the first state-wide lottery, with revenue being used to fund the scholarship. For the first cohort of students enrolling in a public four-year institution in Arkansas after the program's initial expansion, the flat-rate $5,000 scholarship covered over 90 percent of tuition at the state' flagship university for in-state residents.[17]

While the program initially offered a substantial financial support, it has undergone multiple alterations since its expansion in 2010. The first change came in 2011, when the flat-rate amount decreased to $4,500 annually. While the cut was by no means trivial, even with this $500 reduction, the scholarship still covered over three-quarters of tuition[18]. Growing concerns that more students were qualifying for the scholarship than originally anticipated and the lottery revenues were failing to meet projections, however, led to a major shift in the award payout structure (Beherec, 2013). Beginning with the 2013-14 cohort of students, the state decreased the initial award amount to $2,000 and altered the payout structure to progressively increase by $1,000 each year to $5,000 during the fourth (senior) year. As a result of this progressive award payout structure, the total award amount decreased in 2013 from $18,000 to $14,000 over a four-year period. This tiered, or backloaded, payout structure stayed in place until the 2016 cohort, when the policy changed again to provide $1,000 to students in their first year, $4,000 in their

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[16] As of 2016, the high school GPA requirement was removed, and students must only score a 19 on the ACT to qualify.
[17]University of Arkansas tuition was $5,211 for academic year 2010-11. See (https://oir.uark.edu/quickfacts/tuition.php). These figures only include tuition, and do not include additional expenses.
[18] For reference, University of Arkansas tuition was $5,888 for academic year 2011-12. See (https://oir.uark.edu/quickfacts/tuition.php). According to footnote 4 on the 2011-12 academic year, the large increase in tuition is a result of incorporating several mandatory fees into base tuition.

second and third years, and $5,000 in their fourth year. This 400 percent increase in aid between the first and second year is designed to incentivize persistence beyond the first year, a time when most college enrollees are at greatest risk of exiting postsecondary education (NSC Research Center, 2019; Marcus, 2018). An important element of the ACS is that it must comply with the Arkansas Stacking Law. This law states that the award package for an individual student must not exceed the calculated cost of attendance. In the event that a student has multiple scholarships and awards, the ACS must be the first to be reduced as to not exceed the cost of attendance (Arkansas Department of Higher Education). Therefore, it is possible that students with multiple awards would never see the full award disbursement, regardless of payout structure.

As can be seen in Table 1, the ACS can also be used at two-year institutions. However, funding and payouts to students attending two-year institutions have not undergone the same alterations that have occurred at four-year institutions. Prior to the change in 2013, students attending a two-year institution received two equal installments of $2,500 ($2,250 in 2011-12), and following the change, they receive two equal installments of $2,000. Taken together, the total funding a student attending a two-year institution receives decreased by $1,000. Additionally, students attending a two-year institution do not experience a backloaded payout structure. Because the change in payout structure is the element of interest in this study, we focus on four-year institutions.

Review of College Attainment Literature

In chapter 1, we reviewed the ways financial assistance can impact college enrollment. Here, we focus on the impacts of aid on the college experience of the recipients. There is a large and growing body of literature examining the impacts of merit-based financial assistance programs on student outcomes. Often, these studies use large, administrative datasets to estimate how the program alters individuals' behavior by examining students' specific choices before and after the implementation of various financial assistance programs. These studies typically examine the impacts such programs have on altering students' postsecondary enrollment decisions (Cornwell, Mustard, & Sridhar, 2006; Dynarski, 2000; Dynarski, 2003; Goodman, 2008; Kane, 2003). Cornwell et al. (2006) and Dynarski (2000) both examine the Georgia HOPE Scholarship's impacts on attendance patterns using similar difference-in-difference approaches, finding that the program positively influenced postsecondary enrollment in the state of Georgia by a measure of six to eight percent, respectively. Dynarski additionally estimates that for every $1,000 in financial aid, there is a three to four percent increase in the likelihood of postsecondary enrollment (Dynarski, 2000; 2003).

Studies examining the impacts of merit-aid programs on postsecondary achievement and attainment are far less common than those examining enrollment. Dynarski's (2008) study of large-scale merit-aid programs in Georgia and Arkansas finds that both programs improved the persistence rates of aid recipients compared to states that do not implement similar merit-aid programs. However, the program in Georgia may have extended students' timelines for graduation, as evidenced by a study from Cornwell, Lee, and Mustard (2005). Specifically, they find the Georgia HOPE program reduced the portion of freshmen at that state's flagship institution completing a full course load in a given year. A similar study of a merit-based aid program for low-income community college students authored by Brock and Richburg-Hayes (2006) finds that a scholarship worth up to $2,000 influenced more students to enroll full-time and to accumulate more credits over their first three semesters of study.

Scott-Clayton's (2014) study examines the impacts of the state-wide West Virginia PROMISE Scholarship on student outcomes five years after enrollment, including semester-level

GPA and credit accumulation. The West Virginia PROMISE is similar to the ACS in that it is a statewide aid program with student-based merit components. It is also similar in its requirements to the ACS, since West Virginia students must have a 3.0 high school GPA and score at least a 21 on the ACT to qualify. Students receiving the PROMISE must also meet minimum requirements to renew their scholarships in subsequent years of postsecondary education. Scott-Clayton's study finds the program has no significant impact on persistence over the four year period students are eligible to renew their scholarship but it does have substantial impacts on credits earned (4.6 more credits over four years), cumulative GPA (0.10 after four years), and the likelihood of completing a BA in four years (9.4 percentage point increase).

Overall, the literature shows that state-wide merit-aid programs can positively influence enrollment in postsecondary institutions and can vary in their impact on student achievement. However, these studies assess the program as a whole rather than specific elements of the financial intervention. Changes in the dollar amount, or the design of the program can also have implications on the effectiveness of the aid. Indeed, a study from Bettinger (2015) examines how the expansion of the Ohio College Opportunity Grant's funding amount impacted students' postsecondary enrollment and achievement. While the program in Ohio was only an *increase* in the dollar amount of a pre-existing program and not a shift to a backloaded funding mechanism like the ACS, students in Ohio enrolling in college after the expansion could conceivably receive an award 60% higher than students enrolling prior to the expansion. Bettinger's study found that increasing the dollar amount of the Ohio College Opportunity Grant led to a 2 percent decrease in the dropout rate among grant recipients, along with increasing students' first-year GPA.

Taken together, the results of prior literature suggest merit-aid scholarship programs positively influence enrollment, reduce dropouts, and can both increase credits earned as well as increase cumulative GPA. However, these positive results are far from consistent. Cornwell, Lee, and Mustard (2006) find students in Georgia were likely to switch to easier courses to maintain eligibility for their scholarship. Similarly, Scott-Clayton's (2014) study of the West Virginia PROMISE finds the effects of the program are largely concentrated around the performance thresholds for students to maintain eligibility and that the results on enrollment, credits and GPA fade out in the final year of eligibility when they can no longer renew their scholarship.

The lack of consistency in program effectiveness indicates that perhaps not all merit-aid programs are created equally. Specifically, the design of the program seems to matter. Indeed, Bettinger et al. (2012), suggests in their experimental study, that program complexity in the financial aid application progress can deter students from accessing college. Low-income families receiving personalized information and FAFSA assistance showed higher rates of college enrollment, and were more likely to receive the Pell Grant, when compared to the control group who only received personalized information about financial aid, but no FAFSA assistance (Bettinger et al., 2012).

Furthermore, a recent study of changes to the Pell Grant eligibility rules that reduced the lifetime availability of the aid finds that "aid exhaustion" caused students to borrow more money, attempt and complete more credits, and graduate sooner, but it did not have an impact on degree attainment overall (Mabel, 2019). This result suggests that when students lose aid over time, they have an incentive to complete degree programs more quickly. These studies suggest that the design and implementation of a financial aid program may influence its effectiveness.

Unlike previous examinations of merit-aid programs which evaluate the impacts of programs themselves that provide financial assistance to students, our study looks to examine how the expansion and subsequent revisions to the funding structure of a statewide merit-aid program (ACS) impact the academic outcomes of first-time college enrollees. We seek to contribute to the literature by investigating how the design of the ACS payout structure, which differs from other programs, impacts postsecondary outcomes for students. To our knowledge, no other statewide merit-aid programs have undergone such extensive alterations and there are therefore, there are no such evaluations present in the current literature.

Theoretical Expectations

Our goal is to estimate how the ACS's change from an equal installment payout structure to a progressive payout structure in 2013 impacted student college outcomes. It is not clear, *a priori*, how the progressive payout structure could impact student college experiences. In particular, this change could conceivably produce negative, positive, or null impacts.

Possible Negative Impacts

The switch to a backloaded payout structure could negatively impact students, especially those attending four-year institutions, as it unambiguously increases the price of four-year institutions. Under the prior payout structure, a student could receive up to $18,000 in total to attend a four-year institution over a four-year time period. However, the progressive payout structure, in contrast, only allows for a maximum of $14,000 over the same four-year period. This decrease in scholarship support may negatively impact student outcomes through increased psychological stress associated with the pressure to find a job to supplement for subsequent increases in the total cost of college. This change, in turn, likely leaves students with fewer hours per week to study, which is in direct conflict with the original purpose of the ACS: to decrease the need for students to work while in school to defray the costs of tuition and instead focus on academics.

The progressive payout structure could also produce negative impacts if the performance incentives embedded within the ACS's continuing eligibility requirements may be less meaningful to students under the new regime because the stakes are smaller. As Scott-Clayton (2012) notes, the performance requirements of merit-scholarships potentially play an important role in improving college outcomes by directly incentivizing students to maximize behaviors that are associated with college success. If, however, this incentive is reduced due to the smaller initial payments in the ACS progressive payout structure, we could see a decline in student performance relative to prior cohorts.

Possible Positive Impacts

On the other hand, the policy change could improve college persistence and graduation rates by back loading payments. This outcome represents the operational hypothesis of Arkansas lawmakers who initially proposed the ACS payout change. Students must persist and continue meeting the ACS eligibly requirements in order to receive the maximum payout. In effect, the progressive payout structure may represent the "carrot or stick" and work to "pull" students through the college experience. Additionally, a backloaded structure may incentivize students to graduate on time by keeping them on track by tying requirements for renewal to increasingly larger monetary awards. Nevertheless, while policymakers may hope for this outcome, it is not clear if such pull effects were sufficient enough to offset the unambiguous increase in the cost of attending four-year institutions.

Possible Null Impacts

Finally, it is possible that the ACS payout change could have no overall impact on student outcomes. While financial constraints represent important barriers on the path to college success, they are not the sole barrier. For example, the psychological and sociological literature note the important role of cultural capital—or knowledge of social assets and cultural institutions (Bourdieu, 1977)—in successfully navigating post-secondary institution formal and informal processes (Collier & Morgan, 2008 ; Hamilton, Roksa, & Nielsen, 2018 ; Lareau , 1989; Swidler, 1986). If these additional barriers largely dominate the financial constraints barrier, it is possible that the change in ACS funding may only minimally impact student outcomes.

In addition, it is important to remember that the 2013 payout structure change only minimally affected students attending two-year institutions. It would therefore be reasonable to assume the change to have negligible impacts on students who had been planning on attending two-year institutions. Finally, it is also possible that students are unaware of where the majority of their financial aid comes from, and therefore any changes to the total award amount, or payout structure may go unnoticed by students, and will not be detectable in college success outcomes.

In general, the 2013 ACS change to a progressive payout structure could, in theory, produce positive, negative, or null impacts on student college outcomes. In the following section, we describe the methodology used to attempt to determine which of the possibilities played out in reality.

Methodology

In this section, we outline the data used for this project, as well as relevant descriptive characteristics. We then discuss the characteristics of the regression discontinuity and difference-in-differences designs, and why each one independently will not satisfy our research objective. Thus, we use a hybrid method known as the difference-in-discontinuities (DDisc). We provide details on the design features of the DDisc including how we address dual rating variable, and error variance. Finally, as our method includes components of an RD, we explore the optimal bandwidth of our analysis.

Data

The Arkansas Department of Higher Education (ADHE) provided the data for this paper. Specifically, we have access to administrative data for over 300,000 first-time college enrollees at Arkansas public universities and community colleges between 2004 and 2018. Our data include information on student demographics, high school academics, family financial information for Free Application for Federal Student Aid (FAFSA) filers, specifically, Pell Grant eligibility and expected family contribution (EFC), as well as information on college enrollment, progress (semester GPA, credits, and persistence), and graduation status. Key to our analysis, the data include information we can use to identify ACS qualification, namely, high school GPA and ACT (or equivalent) score.

Analytic Strategy

Our goal is to determine if the 2013 change to the ACS payout structure impacted student college outcomes, which presents an empirically daunting task, because the ACS is not awarded randomly. In a random assignment situation, assignment to treatment, in this case receiving the ACS is determined by chance. Therefore, the only differences between two comparable groups of students, is that one group is awarded the ACS, while the other one is not. In that way, we are able to attribute any differences in outcomes to the treatment since it is the only differing factor. However, receipt of the ACS is not random, and therefore a randomized experiment is not an option for evaluation.

Students must qualify for the ACS on one of two benchmarks, either a 2.5 high school GPA, or a score of 19 on the ACT. Additionally, students must fill out the FAFSA and scholarship application in order to receive the award. Therefore, differences in college success outcomes such as GPA, persistence and graduation rate can be attributed to differences in student ability or motivation, rather than financial differences due to the scholarship. In our analysis, we explore differences in student college outcomes between students who *qualify* for the ACS, and therefore are eligible for the award if they fill out the necessary paperwork, and those who just miss the eligibility requirements, and therefore are not eligible to receive the award, regardless of paperwork.

Previous analyses of merit-aid programs primarily utilize either a regression discontinuity (RD) or difference-in-differences approach (DD). The regression discontinuity design compares individuals just above and just below an exogenous cutoff, whereby on one side individuals are assigned to the treatment condition, and on the other side, they are not. In this way, researchers are able to analyze the impact of being awarded a scholarship relative to not being awarded a scholarship on various outcomes, by exploiting differences in treatment status based on the cut score.

Alternatively, as policies change over time, researchers rely on a difference-in-differences approach to compare outcomes in a post policy change time period to those same outcomes in a pre-change time period. Key to the difference-in-differences approach is a counterfactual to serve as the "what if" comparison of what the trends would be in the absence of a policy change.

In our case, we are unable to use either method individually to address our question of the impact of *changing* the payout structure in 2013 on student outcomes. Since we are looking at a policy change over time rather than simply the program effect in a given year, the RD does not satisfy our needs. Additionally, the policy change occurred at the state level, meaning all students were impacted at the same time, eliminating an appropriate counterfactual group for a difference-in-differences design. We therefore turn to a hybrid model, the *difference-in-*

discontinuities approach, formalized by Grembi, Nannicini, and Troiana (2016) to identify the causal impacts of changing the payout structure of the ACS on student outcomes.

Why We Cannot Use a Regression Discontinuity Design

The fact that ACS qualifications were determined by the value of one of two continuous variables—having a high school GPA at or above 2.5 or a composite ACT score (or SAT equivalent) of 19 or above—suggests an ideal situation for the regression discontinuity design (RDD) (Imbens & Lemieux, 2007). The hallmark of the RDD is the "rating" or "forcing" variable: a continuous variable whose value determines if an individual qualifies or does not qualify for a specific treatment. As opposed to a random control trial, in which random assignment is used to allocate treatment and control status, it is the value of an individual's rating variable—or more specifically whether a value is above or below a pre-specified threshold or "cut point"—that determines if he/she does or does not qualify for treatment. Conceptually, the RDD estimates the impact of the intervention on a given outcome variable by comparing individuals scoring just above the policy cutoff with those scoring just below the cutoff. While it is true that individuals scoring above and below the cutoff may differ, these differences should be negligible within a sufficiently small range of values of the rating variable around the cut point. For example, one of the possible rating variables in determining eligibility for the ACS is high school GPA. High school GPA is determined over the course of four years, and it is therefore unlikely that students with a 2.49 GPA compared to students with a 2.5 GPA differ in observable or unobservable characteristics, such as academic ability. However, the first student would not be eligible to receive the ACS, while the second student would be.

RDD studies are common among evaluations of college scholarships. In West Virginia, for example, students with overall and core-specific high school GPAs at or above 3.0 *and* an

ACT score or concordant SAT score of over 21 qualified for a renewable scholarship to in-state higher education institutions worth up to $10,000 over four years. Taking advantage of the dual rating variables (high school GPA and ACT), Scott-Clayton (2012) estimates the impact of just barely qualifying for the program using an RDD framework. She reports an improved likelihood of college attendance, cumulative GPA, as well as the likelihood of graduation.

Our research scenario has many elements similar to Scott-Clayton's (2012). Qualification for ACS scholarships is largely determined either by students' high school GPA (at or above 2.5) or ACT score (at or above 19). However, we cannot use an RDD because we are interested in the *change* in potential ACS effects associated with the 2013 introduction of the progressive payout structure rather than determining the effect of receiving an ACS on college outcomes. While we could use the RDD to estimate the effect of qualifying for an ACS scholarship in either time period (before or after the payout structure change), we cannot determine if and how these two time periods differ using a conventional RDD.

Why We Cannot Use a Difference-in-Differences Design

Our interest in estimating the impact of a policy change suggests instead that we should turn to the difference-in-differences (DD) design. Here too our research scenario impedes our ability to use the DD method to answer our research question of interest. Specifically, as the following paragraphs describe, we are estimating a policy change that occurred within Arkansas and is limited by the available data we can use to create a valid comparison group.

A DD estimates the effect of a change in policy by comparing a treated group to a comparison group that is similar in pre-treatment trends (Angrist & Pischke, 2015, pp 178-208). Presuming the comparison group provides an adequate counterfactual for what the treatment group would look like in the absence of treatment, the DD treats any shift in outcomes above or below the predicted trend as evidence of the program's impact.

Several studies have used DD models to examine the impact of financial aid programs on student and institutional outcomes. Cornwell et al. (2006), for example, use a DD model to estimate the impact of Georgia's HOPE scholarship on college enrollment by comparing enrollment in Georgia post-secondary institutions before and after the program's creation with post-secondary enrollments in similar states comprising two comparison groups[19]. Their findings indicate the HOPE scholarship increased freshman enrollment by 5.9 percent, with four-year institutions capturing most of this enrollment increase.

As with the RDD, our research setting restricts our ability to use a conventional DD to estimate the impact of the ACS's change to a progressive payout structure on student college outcomes due to our focus on student outcomes in college. While we have access to detailed data on college experiences for all students enrolled in public post-secondary institutions in Arkansas, we do not have access to similar data for students outside Arkansas. A lack of data outside of the state is problematic because the policy change—switching to a progressive payout structure in 2013—impacted all students within Arkansas at the same time. As such, the DD strategy would require that we look outside the state for a suitable comparison group. While certain federal datasets provide some aggregate data on post-secondary institutions across the states, we cannot access outcome data with the level of data required for our analysis—most certainly not student-level data—outside Arkansas. Thus, we cannot estimate the effect of the payout structure's change on student outcomes via DD.

[19] Cornwell et al. (2006) consider two comparison groups: states that border Georgia and states that, like Georgia, are members of the Southern Regional Educational Board (SREB)

The Difference-in-Discontinuities: A Hybrid

While features of our research scenario lend themselves to either RDD or DD research designs, neither method will work in our specific case. Instead, we use the difference-in-discontinuity design (DDisc), which Grembi et al. (2016) formalized to determine how the change in the ACS funding scheme impacted student college experiences and outcomes.

Grembi et al. (2016) use the DDisc to study the impacts of a change in fiscal discipline regulations in Italy on municipality debt. In 1999, Italy introduced a policy placing regulations on municipalities in order to enforce fiscal discipline. In 2001, the regulations were relaxed for municipalities with fewer than 5,000 residents. The goal of Grembi et al. (2016) is to understand how relaxing these requirements affected districts.

Similar to our research setting, the authors first consider taking advantage of the fact that qualification for the relaxed fiscal rules is determined by a continuous variable to estimate the program's impact via RDD. They note, however, that they cannot employ an RDD because Italy has another policy at the population cutoff: mayors in cities with over 5,000 people receive higher salaries. A simple RDD would not be able to separate this confounding factor.

Next Grembi et al. consider using a DD model to determine if the relaxed fiscal rules impacted municipality finances. The situation would, in theory, be ideal for a DD as there was a sharp discontinuity in policy environment over time that differed for municipalities of various sizes. Assuming larger municipalities experienced trends similar to qualifying municipalities, one could estimate the program's impact by looking for a jump in revenues among qualified municipalities relative to non-qualified municipalities after 2001. Unfortunately, Grembi et al. note they cannot use a DD in their specific setting because small and large municipalities have different trends in other public policies.

They instead propose as a solution to their analytic conundrum a hybrid model combining the features of both the RDD and DD methods: the difference-in-discontinuities (DDisc) design. In short, the DDisc estimates two RDD effects, one in the period prior to 2001 and one after the fiscal rules relaxation policy was in place in 2001. The relaxation effect is then estimated by differencing the two RDD estimates via a DD model.

Similar to Grembi et al. (2016), we are interested in estimating two RDD effects: the first on the impact of receiving the ACS in the period of greater payouts prior to 2013 and a similar effect after the ACS funding was changed to a progressive payout structure after 2013. The payment structure's effect is then estimated by differencing the two RDD estimates via a DD model. Specifically, we estimate models of the following form:

$$y_{its} = \alpha_0 + \delta(Q_i x Post_{it}) + \alpha_1 Q_i + \alpha_2 Post_{\mathrm{it}} + \alpha_3 CR_i + \alpha_4(CR_i x Q_i) + \alpha_5(CR_i x Post_{it}) + \alpha_6(CR_i x Q_i x Post_{it}) + X_{its}\beta + u_{its} \quad (2.1)$$

Where y_{its} is one of four outcome categories of interest: student year-to-year persistence, GPA after the first year, final observed GPA[20], and the likelihood of graduation within four years[21]. Persistence and graduation are binary variables. Persistence is measured by fall-to-fall enrollment, and takes a value of one if the student is enrolled in a postsecondary institution one, two, three, and four years after initial enrollment, and zero otherwise[22]. In the same way, the graduation variable takes the value one if a student who could graduate within four years has done so, and zero otherwise. For example, a student enrolling in college in 2016 would not be

[20] Our data allow us to observe the final GPA recorded by a given institution. This variable, which effectively imputes GPA for all college dropouts their final GPA, has been used in prior studies of merit scholarships (see, for example, Scott-Clayton, 2012). Unfortunately, this suggests our findings for final GPA may be biased, as we cannot observe what a student's GPA would have been if they drop out of school; thereby implying a form of attrition bias.
[21] Ideally, we would estimate the impact of the payout change on six year graduation rates. Unfortunately, our data are restricted to school years 2010 through 2017 and, as such, we cannot estimate six year graduation rates for all students. We instead examine the impact of the payout change on four year graduation rates.
[22] We measure persistence after one, two, three, and four years, individually, rather than combining all metrics together.

expected to have graduated at the time of this analysis, and therefore would be excluded; however, a student enrolling in 2010 would have been able to graduate within four years, and therefore would be included. College GPA after the first year and final reported GPA are both continuous variables, and take the value reported by ADHE.

The variable Q_i identifies if a student met the ACS qualifications for his/her first year of college, $Post_{it}$ identifies being in the post-payout structure time period (2013 or later), and CR_i is the student's rating score variable value, centered at the cut point for the particular rating score. For ACT, CR_i is a student's ACT score minus 19. For high school GPA, CR_i is a student's GPA score minus 2.5. Therefore, CR_i takes on negative values for students with rating scores that do not meet the ACS threshold for the specific rating score and positive values for students who do qualify for the ACS. Finally, X_{its} is a vector of student demographics including gender, race/ethnicity, Pell Grant eligibility, and expected family contribution, reported prior to their arrival at a post-secondary institution, and u_{its} is a composite error term that allows for clustering of students within a school.

Provided our research scenario meets key assumptions for the DD and RDD estimators, the coefficients in our DDisc model have the following interpretations. The value of δ is our estimate of interest. It is the coefficient on an interaction of variables identifying if a student qualified for ACS during the post-payout structure change period, and therefore represents the effect of the change in ACS funding. The estimated α_1 represents the average ACS effect in pre-change years, and α_2 represents the effect for students who do not qualify for the ACS in the post-time period. The estimated α_3 represents the general relationship between the rating variable and the outcome of interest for students who do not qualify for the ACS in the pre-time period, whereas α_4 estimates the same relationship for students who do qualify for the ACS in the same time period. It is necessary to include the associated variable—CR_i—in an RDD model to account for underlying relationships between the rating variable and the dependent variable of interest. The value of α_5 represents the difference in the relationship between the rating variable and the outcome of interest for ACS non-qualifiers in the post-payout change period, and α_6 represents the difference in the relationship between the rating variable and the outcome of interest for ACS qualifiers in the post-payout change period. Finally, β represents any extraneous differences in the outcome measures associated with other control variables.

Additional Design Considerations

Due to the nature of our research scenario, additional design features of the DDisc method must also be addressed. The ACS has two qualification requirements, and therefore we have two rating variables. Additionally, the combination of two methodologies requires that more thought is given to that of the error terms structure.

Addressing Multiple Rating Variables

Grembi et al. (2016) develop the DDisc model for a setting with a single rating variable—municipality population. In our research scenario, we have two rating variables through which students can qualify for the ACS: a high school GPA at or above 2.5 or an ACT score or concordant SAT score at or above 19. Fortunately, the fact that ACS qualification is determined by two rating variables does not overly complicate our model.

There are several methods available for estimating RDD effects in situations of two or more rating variables (Porter, Reardon, Unlu, Bloom, & Robinson, 2014; Reardon & Robinson, 2012). Reardon and Robinson (2012), for example, demonstrate that in scenarios with two rating variables, one can estimate effects via threshold methods (which condition the sample using one of the rating scores while estimating programmatic effects using variation about the threshold of the other rating variable) or the binding score method (in which the two variables are combined into one by taking either the maximum or minimum value of the two).

In this analysis, we will focus on estimating the impact of the 2013 change in ACS payout structure by conducting a frontier analysis along a single rating variable threshold. For example, we condition our sample to students with ACT or concordant SAT scores below 19 and then estimate threshold effects by comparing students with high school GPAs just above 2.5 with those just below. Using this method, we are able to generate a group of students who are eligible for the award (treatment condition), and a group of students who are never eligible for the award (control). In this way, we are only focusing on a subsample of students, and therefore the results are not generalizable to the entire population of postsecondary enrollees. However, because we are limiting our sample to students who score below a 19 on the ACT, and making comparisons across a small range of high school GPAs, we can be confident that our treatment and control groups are similar on observable and unobservable characteristics and that our estimated effect is reliably identifying the causal impact of the change in payout structure on student postsecondary outcomes.

Assumed Dimensions of Error Clustering

Our standard errors account for clustering of students within postsecondary institutions. In their introduction to the DDisc model, Grembi et al. (2016) follow the lead of prior difference-in-difference models by clustering their standard errors at the analytical unit-level: municipality. Our research scenario requires that we adjust this portion of the Grembi et al. model, as our unit of analysis—students—varies across cohorts. We instead account for clustering of students at the higher level of within postsecondary institutions to account for important college-experience and regional correlations among individual errors.

Bandwidth Selection

Our analysis is based on local linear regressions conducted on samples of students within a specified bandwidth about the rating variable's cut point. Following Grembi et al. (2016), we estimate models using optimal bandwidth computation algorithms developed by two groups of researchers: Calonico, Cattaneo, and Titiunik (2014a,b) and Ludwig and Miller (2007). Using these methods, when conducting the frontier analysis in which our sample is limited to students scoring below a 19 on the ACS, the optimal high school GPA bandwidth is approximately 2.0 to 3.0, meaning students who score less than a 19 on the ACT, but have a high school GPA between 2.0 and 3.0 are included in the analysis. We present results for models using Calonico, Cattaneo, and Titiunik's method (2014a,b) and result sensitivity by comparing these with estimates using Ludwig and Miller's (2007) method. Overall, results do not differ substantively.

Analytic Sample

We apply several restrictions to our analytical sample. Specifically, sample inclusion is restricted to students graduating from Arkansas high schools, with valid data on ACT or SAT performance[23] applying to public Arkansas institutions for initial post-secondary enrollment in the fall of 2010 through the fall of 2015. The ACS was originally expanded in 2010, and the change from an equal installment to a progressive award payout structure, occurred in 2013. Over the six year timeframe, females consistently comprise over half of the sample, ranging from approximately 55 to 56 percent. The sample gets younger over time, with an average age of 19.5

[23] Arkansas allows for an alternative path to students who are not on the traditional core curriculum (the Smart Core curriculum) to qualify for an ACS without taking an ACT or SAT. Such students can substitute their performance on the state's Compass and Accuplacer tests for the ACS's ACT requirement. These students are much more likely to attend 2-year, as opposed to 4-year institutions because the Smart Core curriculum is Arkansas's college preparatory curriculum. Unfortunately, we do not currently have access to composite scores for students who do not take the Smart Core curriculum and, as such, these students are not present in our analysis. While we will have access to these data in the future, such students do not currently inform our results.

in academic year 2010-11, dropping to approximately 18.6 in 2015-16. The sample is primarily white, although the share of Hispanic students increases over time, while the share of black students increases in 2012-13, but drops as we near 2016. The average exam score increases modestly over time, from an average of just under 22 to an average of 22.3, as well as the average high school GPA increasing from 2010-11 and 2015-16, from 3.005 to 3.186. Finally, the share of students who qualify for the ACS is consistently well above 80 percent, reaching nearly 90 percent in 2015-16, as students can qualify by meeting *either* the high school GPA or ACT benchmark. However, as students must additionally apply and fill out the FAFSA, the share of students who are actually awarded the ACS is significantly lower.

As the ACS is available to students who graduate from an Arkansas high school, we felt it was appropriate to limit our analytic sample to in-state students. However, it is also important to note that, descriptively, the composition of students enrolled in Arkansas postsecondary institutions overall, and broken down by two- and four-year institutions is the same if we include out-of-state students in our sample. The overall composition of female, races, exam scores and high school GPA remains about the same.

Females consistently comprise over half of the sample, regardless of whether the student is attending a two-or four-year institution. However, there are some noticeable differences between the compositions of students at each type of institution. Specifically, students enrolling in two-year institutions are on average older than those enrolling in four-year institutions, with student ages averaging around 20 years old and 18 years old respectively. Additionally, the average entrance exam score and high school GPA are notably lower in the sample of students attending two-year institutions compared to that of those attending four-year institutions. Specifically, for two-year institutions, overall, students have an average ACT score of just under a 21 and a reported high school GPA ranging from about 2.7-3, whereas for four-year institutions, that increases to an average ACT score of 22-23, and an average reported high school GPA of 3.1-3.4. Therefore, it is unsurprising that a larger percentage of students at four-year institutions qualify for the ACS compared with students at two-year institutions, as ACT score and high school GPA are the metrics for qualification. However, it is also important to note that a significant portion of students qualify at both types of institutions, ranging from 75-83 percent at two-year institutions, and 90-94 percent at four-year institutions. Finally between the two institution types, on average, a slightly higher proportion of students enrolled at two-year institutions are Hispanic or identify as another race, while at four-year institutions, there is a higher percentage of white and black students.

Our research interest is in the *change* in the award payout structure that occurred in 2013, so therefore we use elements of the RD and DD designs to utilize the hybrid, differences-in-discontinuities. Because our design combines elements of both, we will use the following sections to demonstrate that our data satisfy the conditions for both an RD and a DD.

Rating Variable Densities

We begin by examining the distribution of our rating variables: exam score[24] and high school GPA. Ideally, we would see a relatively smooth density to the left and right of the cutoff; as a discontinuous density is suggestive of gaming of the assignment variable (Imbens & Lemieux, 2008; Scott-Clayton, 2012).

Figure 1 presents the distribution of ACT or concordant SAT scores for our analytic sample of interest, pooled over all time periods. The vertical line illustrates the ACT or concordant SAT score cut point determining ACS qualification: 19. The histogram suggests

[24] Exam score includes reported ACT score and SAT converted scores.

some potential for manipulation around the cutoff, as there is a dip in the number of students scoring an 18, or immediately below the ACS cutoff. This discontinuity could reflect students retaking the ACT until they pass the ACS threshold of 19, therefore violating the RD assumption that students just below and just above the cutoff are the same, as there are unobservable characteristics that would plausibly differ between students who choose to retake ACT, and those who do not.

Following our empirical strategy, we limit our sample to students who have less than a 2.5 high school GPA, and therefore can only qualify for the ACT by earning a 19 on the ACT. When we make that limitation, we do not see the obvious dip in students scoring an 18 on the ACT compared to those who just make it over the threshold by scoring a 19 on the ACT.

However, while we do not see the obvious dip in ACT scores just below the threshold when we limit our sample to those students earning less than a 2.5 high school GPA, there are additional complicating factors with using a students' ACT score as a rating variable for an RD. First, ACT scale scores are not truly continuous variables, as they range from 1-36[25], and only produce whole number scores. Additionally, a student earning an 18 on each section of the ACT could have answered only 103[26] total questions correct, whereas a student earning a 19 on each section, could have answered 114[27] total questions correct (The Princeton Review, 2020). Therefore, it is reasonable to believe that students scoring an 18 versus a 19 are not truly similar on observables and unobservables, as a difference of 11 questions correct may not be due to random chance.

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[25] ACT ranges from 1-36 as a scaled composite score resulting from a total of 75 English questions, 60 math questions, 40 reading questions, and 40 science questions.

[26] A scaled ACT score of 18 can be derived from correctly answering 40-41 English questions, 27-28 math questions, 20-21 reading questions, and 16 science questions.

[27] A scaled ACT score of 19 can be derived from correctly answering 42-44 English questions, 29-30 math questions, 22 reading questions, and 17-18 science questions.

Finally, in Arkansas, the cutoff for avoiding remediation is also a 19 on the ACT. That is to say that students earning a 19 on the ACT would both qualify for the ACT and avoid remediation coursework, and that students earning an 18 on the ACT, would not qualify for the ACS, and they would be assigned to remediation. There is a well-documented literature on the negative effects of remedial coursework in postsecondary education (Valentine et al., 2017). If we believe that qualifying for the scholarship should have positive impacts on college outcomes, and not qualifying has negative impacts, then there is no way to untangle the negative impacts of remediation and not having the ACT, as the assignment variable is the same for both. For these reasons, we instead limit our sample of students to those who score less than a 19 on the ACT, and instead use high school GPA as our preferred rating variable to determine which students qualify for the ACS.

Figure 2 presents the distribution of high school GPA for our sample of interest, again pooled across all time periods. The vertical line illustrates ACS high school GPA cut point of 2.5. Unlike Figure 1, this histogram does not show evidence of GPA inflation in order to obtain an ACS scholarship. Much to the contrary, we actually see a slightly higher percentage of students scoring just below a 2.5 than expected. High school GPA is calculated over four years, and is the reflection of multiple classes, teachers, and possibly schools, so it is likely a metric that is harder for a student to manipulate as they seek to qualify for a scholarship. Moreover, since it is a calculated average over four years, high school GPA is a continuous variable that allows for decimal calculations. It is possible for two individual students to earn a 2.49 and a 2.5 respectively. The first would fail to qualify for the ACS, whereas the second would meet the threshold. Because of the construction of GPA, we can be reasonably confident that these two students would in fact be similar on observable and unobservable characteristics, as the difference between 2.49 and 2.5 is minuscule, and could be the result of a single class in ninth grade, well before students were thinking about qualifying for a scholarship.

Again, following our empirical strategy of limiting our sample on one of the rating variables to exploit the variation in the other, we limit our sample of students to those scoring less than a 19 on the ACT. When we make this restriction, we no longer see an uptick of students scoring just below a 2.5, however, we also do not see a concerning dip just before the cutoff. Visually, this gives us confidence in using high school GPA as our rating variable in the context of an RD. Additionally, the continuous nature of high school GPA, and the fact that it is not conflated with assignment to postsecondary remediation, makes high school GPA the only acceptable rating variable for our study.

Rating Variable and Student Covariates

Next, we look to see if any discontinuities exist in the relationship between our rating variable of interest—high school GPA—and several independent variables around the high school GPA cut point of 2.5 (see Figures 5 - 12). Such discontinuities would be concerning as they would make it hard to determine if any changes in outcomes were the result of the ACS payout change or these pre-existing discontinuities. Fortunately, the graphs presented in Figures 5 -12, which include student age, gender, race/ethnicity, expected family contribution, and Pell Grant status, do not contain concerning jumps at the cut score on observable characteristics.

Descriptive Characteristics for Analytical Sample by ACS Qualification

Table 5 presents descriptive information for in-state residents applying to Arkansas public institutions between the fall of 2010 and the fall of 2015. The sample is further restricted to mimic our RDD scenario by focusing on students with ACT or concordant SAT scores below 19 and high school GPAs between 2.0 and 3.0. Table 5 is divided into two broad sections. Time

2 represents the cohort of students who enroll in college after the payout structure change in 2013-14, and Time 1 represents the cohort of students who enrolled in college between the years 2010-2012, and therefore did not experience the progressive payout structure. Columns 2 and 6 present descriptive information for students qualifying for the ACS in their respective time periods and columns 3 and 7 present information for students who did not qualify for the ACS. Columns 4 and 8 present the average difference between qualifiers and non-qualifiers in their respective time periods.

Column 9 is of primary interest in this table, as it presents the estimated difference in characteristics between non-qualifiers in each time period. A key assumption of our analytical strategy is that the experience of non-qualifiers in Time 1 (the pre-ACS payout change period) can serve as an adequate counterfactual for the experience of non-qualifiers in Time 2 had the payout change not occurred. One would hope, therefore, that these two groups are largely similar.

We observe few statistically significant and sizeable differences between the two groups. Specifically, non-qualifiers in Time 2 are approximately eight percent less likely to be White than in Time 1, and about 8.5 percent more likely to be Black. They are also about two percent less likely to identify as eligible for Pell Grants, and have an expected family contribution of about $340 less than in Time 1. The existence of these statistically significant differences raises slight concerns for our analytical strategy, as there is evidence that the composition of non-qualifiers changes slightly over time, leading us to believe that it is possible that the composition of those students who qualify for the ACS might also change over time. While our preferred analytical models control for these variables, we caution the reader to take these statistically significant differences into account when interpreting our results.

Results

In this section, we present the results of changing the ACS award payout structure from an equal installment regime to a backloaded structure for students enrolled in all institutions for which we have data available (both two- and four-year institutions), as well as by institution type. We begin with a model in which students are identified simply as being in a cohort before the change, and therefore experiencing the equal installment payments, or after the change, and therefore experiencing the backloaded structure. However, as we progress, we increase the model flexibility by including year fixed effects to account for potential differences unique to each year. It is important to note, that across models, we do not see any sustainable differences in our results.

Difference-in-Discontinuities Results using a Simple Before/After Model

Tables 6 and 7 contain the intent to treat (ITT) results from our main DDisc specification for all postsecondary institutions for which we have data available. The ITT estimates the effect of students *qualifying* for the ACS by meeting the GPA threshold, and therefore being eligible to receive the award, compared to those students who do not qualify and are thus unable to receive and are not affected by the change in the payout structure. We estimated the impact of *changing* the ACS payout structure to a backloaded system in 2013 relative to the equal installment structure that existed prior. Our empirical model follows equation (1) and is essentially differencing the RDD results in the post time period (after 2013), from the RDD results in the pre-time period (prior to 2013).

Specifically, our analysis contains students who score less than a 19 on the ACT, and differ only in their ability to qualify for the ACS by meeting the high school GPA threshold of a 2.5. We estimate the effect of students who qualify for the ACS by having a 2.5 high school

GPA or above, to those students who do not qualify because they met neither the ACT score nor GPA thresholds. Our model then differences these two estimated impacts over the two time periods. Our outcomes of interest include the likelihood of persisting past the first year of college, first year GPA, final reported GPA, and the likelihood of graduating within four years. Our estimated impact is captured by the variable indicating that students with less than a 19 on the ACT could qualify for the ACS by having a 2.5 high school GPA in 2013 or later.

Overall, across all postsecondary institution types, we find little evidence that qualifying for the ACS between 2010-2012 (pre-change time period) has any significant impact on the likelihood of persisting past the first year of college. This result corresponds with previous evidence indicating null effects for students currently enrolled at the time of ACS passage (Mills 2015). Additionally, we find little evidence that changing the payout structure to a backloaded system in 2013 has any impact on the likelihood of persistence, college GPA, or the likelihood of graduating within four years. Specifically, we find that qualifying for the ACS in the post-change time period is associated with a not significant one percentage point increase in the likelihood of persisting past the first year of college relative to those who qualified prior to 2013 under the equal installment payout regime. Furthermore, we find that qualifying for the ACS in the post-time period is associated with a two to four percentage point increase in the likelihood of persisting two, three, or four years. The lack of statistical significance, as well as the lack of practical significance provides evidence that changing the award payout structure from equal installments to a backloaded system has no impact on the likelihood of persistence past the first year of college. Our results also indicate that qualifying for the ACS in the post time period has no significant impact on college GPA after the first year, or the final reported GPA. We do see marginally significant effects on the likelihood of graduating within four years. Students qualifying for the ACS in the post time period and therefore being exposed to the backloaded award payout structure are associated with a marginally significant six percentage point increase in the likelihood of graduating within four years, compared to students who qualified in the pre-time period and thus experienced the equal installment payout structure. It is important to note, that in the overall analysis, both two- and four-year institutions are included. In this way, students attending a two-year institution may be more likely to graduate within four years, as the expected time to their degree is necessarily less than for students attending a four-year institution. This marginally significant finding may be driven by students enrolled in two-year institutions, who do in fact graduate within two years. We include students enrolled in both two- and four-year institutions to ensure statistical power results from a large enough sample size. The analysis is conducted separately for four- and two-year institutions, presented below, and the results do *not* show any significant findings for the outcome of graduation.[28]

Overall we find little evidence that qualifying for the ACS significantly impacts the likelihood of persistence, GPA, or graduation in either time period, under either payout structure. Additionally, we do not see any significant estimated effects on persistence, GPA, or likelihood of graduating within four years for students who failed to qualify for the ACS in the post period. As we showed earlier, the composition of the two groups of students who fail to qualify for the ACS in the pre and post time periods varied on some demographics. If we saw significant estimated impacts on persistence, GPA, and the likelihood of graduating within four years for students who failed to qualify after the change, we would be concerned that the counterfactual group of non-qualifiers, indeed changes over time. As we use students who never qualify for the ACS in either time period as our counterfactual group, the lack of significant estimates for

[28] It is also possible that this result is driven by the scholarship requirements, as it is only renewable for up to four years, which may incentivize students to graduate within that time frame.

students who fail to qualify in the post time period relative to those who fail to qualify in the pre time period gives us confidence in our counterfactual group.

Tables 8 and 9 contain the results from the DDisc specification for four year institutions only, as the payout change primarily impacted students enrolled in these schools. Here, we find no evidence of the payout structure change impacting the likelihood of persistence, or graduation within four years, nor GPA. For students enrolled in four year institutions, we see that qualifying for the ACS in the post period and being exposed to the backloaded payout structure is not associated with any change in the likelihood of persisting in college for one to four years, compared to students who qualified for the ACS in the pre-time period and were therefore exposed to the equal installment payout structure. We further find no significant effects on first year GPA, final GPA or the likelihood of graduating within four years for students who qualify for the ACS in the post period relative to those who qualify in the pre-time period. Additionally, when looking at students enrolled in four-year institutions, we do not see evidence that there are changes over time in the outcomes of students who do not qualify for the ACS, with the exception of marginally significant positive estimates final reported GPA. Taken together, these results further illustrate that changing the award payout structure has no detectable impact on the students' likelihood of persistence, or graduation within four years, nor college GPA in four-year institutions.

Finally, Tables 10 and 11 contain the results from the DDisc specification for students enrolled in two-year institutions only. We see that students enrolled in two-year institutions who qualify for the ACS in the post-time period are therefore exposed to the backloaded payout structure experience no detectable impact on the likelihood of persisting. There is also no significant impact on first year GPA, nor the likelihood of graduating within four years. We see that students enrolled in two-year institutions who qualify for the ACS experience a marginally significant 0.2 increase in their final reported GPA, relative to students who qualify for the ACS in the pre time period. Again, we do not detect any significant estimates for students who fail to qualify for the ACS in the post time period, relative to the pre time period, giving us confidence in our counterfactual group of students.

Difference-in-Discontinuities Results using Year Fixed Effects

To allow for more flexibility in our estimation strategy, we include year fixed effects into our model rather than using the binary indication of being before or after 2013 to capture the time trends. By using year fixed effects, we avoid forcing all years in the pre-time period and the post-time period to be the same, and instead allow for year-specific shocks to occur. By making comparisons within year, we allow for shocks to impact the treatment and comparison groups in one year, without forcing other years to experience the same effect. Our empirical equation becomes

$$y_{its} = \alpha_0 + \delta(Q_i x Post_{it}) + \alpha_1 Q_i + \alpha_2 Year_i + \alpha_3 CR_i + \alpha_4(CR_i x Q_i) + \alpha_5(CR_i x Year_i) + \alpha_6(CR_i x Q_i x Year_i) + X_{its}\beta + u_{its} \quad (2.2)$$

Here our parameter of interest is still the coefficient, δ, capturing the estimated impact of qualifying for the ACS in the post time period. This captures the effects of being in each year in the post time period, and then aggregating it up into one comprehensive effect. Tables 12 and 13 contain the DDisc estimate of qualifying for the ACS results for persistence and attainment for all postsecondary institutions. We present our variable of interest for all institutions here, while detailed information, including the coefficients for each year, are available in the appendix. Despite the added flexibility in this model, overall, we see that changing the payout structure of the ACS in 2013 has no significant effect on student persistence. As was the case before, we find that qualifying for the ACS in the post-time period has no significant effect on first year, or final GPA, or on the likelihood of graduating within four years. These estimated effects are consistent with our first model.

The story remains consistent when we conduct the analysis for each type of institution, two and four year, individually. Overall, there is no statistically significant evidence that qualifying for the ACS in the post period and therefore being subject to the backloaded payout structure is associated with an increase or decrease in the likelihood of persisting past the first year of college for students enrolled in a four-year institution, or for those enrolled in a two year institution. Additionally, for both two- and four-year institutions individually, we do not find evidence that being subject to the backloaded payout structure has any impact on college GPA, or the likelihood of graduating within four years.

Conclusion

In this study, we seek to answer the question about how changing a merit-based scholarship award payout structure impacts student outcomes. Specifically, we ask how changing from an equal installment payout structure to a progressive payout system impacts the likelihood of persistence past the first year in college, GPA and the likelihood of graduating within four years. Our analysis seeks to compare students who are exposed to treatment (qualifying for the ACS), by meeting a specific cut score. Ideally, we would want to use an RD to evaluate the scholarship's impact. However, we are interested in changes over time, as the policy shifted from an equal installment payout structure, to a backloaded structure in 2013. Evaluating changes over time would lead us to using a DD. But because this policy was statewide, we do not have an appropriate counterfactual. Combining elements from both empirical strategies, we use a hybrid empirical model, differences-in-discontinuities, to compare students who qualify for the ACS in the post-change time period and are therefore subject to the progressive payout structure, to those students who qualify for the ACS in the pre-change time period, and therefore never experience the progressive payout. We use students who never qualify for the ACS in the post-change time period, to those who never qualify in the pre-change time period to construct the counterfactual over time.

Overall, we find no evidence to suggest that the payout structure impacts student college success outcomes. Specifically, we do not find evidence to suggest that *how* money is distributed to students impacts their persistence through college. Additionally, with the exception of a marginally significant six percentage point increase in the likelihood of graduating within four years, we do not see evidence that changing the merit scholarship award payout structure impacts college attainment metrics. Furthermore, when we look specifically at students enrolled in two or four year institutions separately, the story remains the same. Students who qualify for the ACS in the post time period compared to those who qualify in the pre time period do not experience any increases in persistence, GPA or the likelihood of graduating within four years. This holds true for students enrolled in two- or four-year institutions separately. These results persist even after we include year fixed effects rather than a simple pre/post analysis. The inclusion of year fixed effects allows for more flexibility in our model by not subjecting students in the pre time and post time to have the same overall effect, respectively. We make comparisons within year to account for potential shocks that students in given year experience. This added flexibility does not change the overall results.

It is important to remember, that this analysis is conducted for students who score below a 19 on the ACT, and only differ in their ability to qualify for the scholarship based on their high school GPA. Students scoring above a 2.5 qualify for the scholarship, while students with below a 2.5 GPA never qualify on either metric. Therefore, it would be unwise to generalize these effects to the entire college-going population of students. It is possible that we fail to see impacts because the marginal student in this group is unlikely to be moved one way or the other based on simply reallocating when money is distributed.

We further speculate that we do not see significant results from changing the payout structure of this merit-based scholarship because it is possible that students are unaware of where their specific financial aid money comes from. If students have multiple scholarships, grants or aid, they might be aware of the total amount awarded rather than the breakdown of each individual financial assistance. Furthermore, according to the Arkansas Stacking Law, the award amount per student cannot exceed the cost of attendance. If a students' award package exceeds the cost of attendance, the ACS is the first scholarship to be reduced, in which case, the structure of the payout would not matter. A progressive payout structure, like the ACS, awards students increasingly more money as they persist through school, rather than decreasing their assistance over time. As a student persists through school, the pieces of financial aid may change, however, if they have multiple scholarships, their total award per semester may stay relatively constant.

Finally, as we note in our theoretical expectations, while financial constraints represent a real barrier to postsecondary access, success, and completion, they do not represent the *only* barrier. If other barriers, such as cultural institutional knowledge eclipse the financial barrier, then we would not expect that changing *how* money is awarded to students would be enough to change their behavior in college.

Overall, our results suggest that the way the award money for the ACS is paid out to students does not seem to have a significant effect on their postsecondary outcomes. Whether students receive the same amount of money each year, or progressively more over time, does not appear to change their behavior when measured by persistence, GPA or the likelihood of graduating within four years.

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Figures

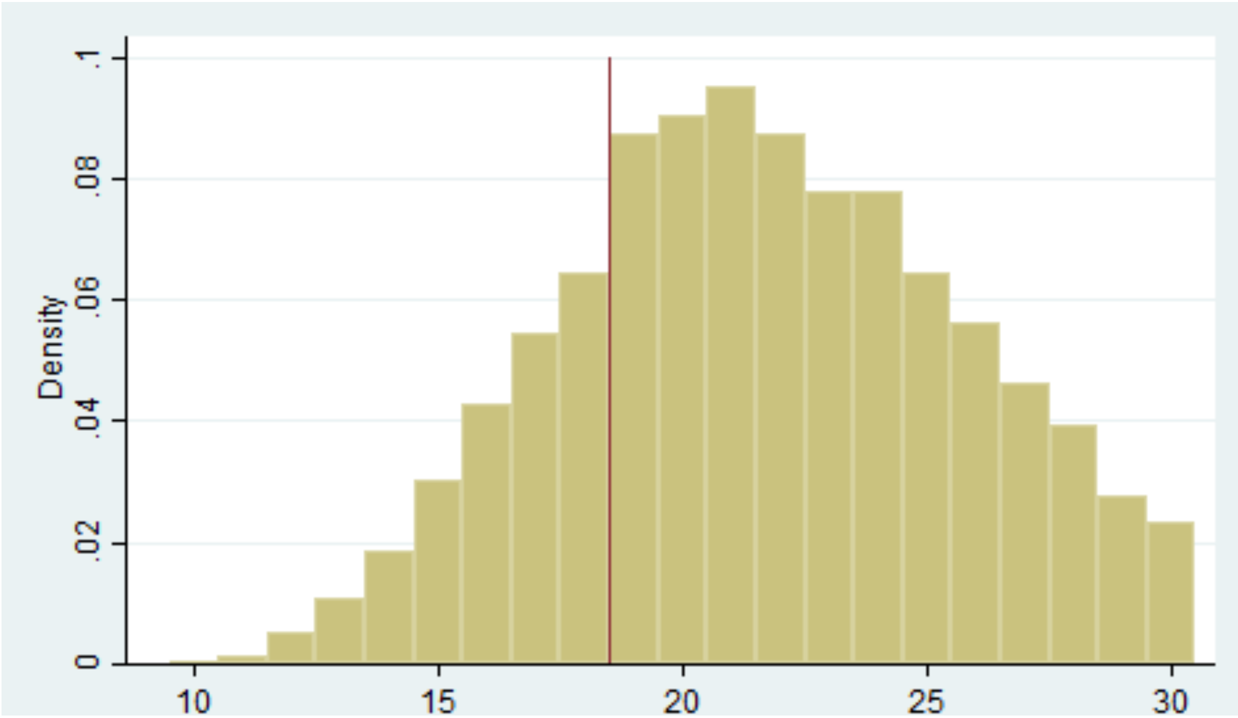

Figure 1: *Histogram of ACT Scores for Analytic Sample of Students, All Years*
Notes: Histogram represents the density of the sample of students scoring between a 10-30 on the ACT. Sample includes all first-time, full-time, in-state students who enrolled in Arkansas postsecondary institutions between academic years 2010-11 and 2015-16.

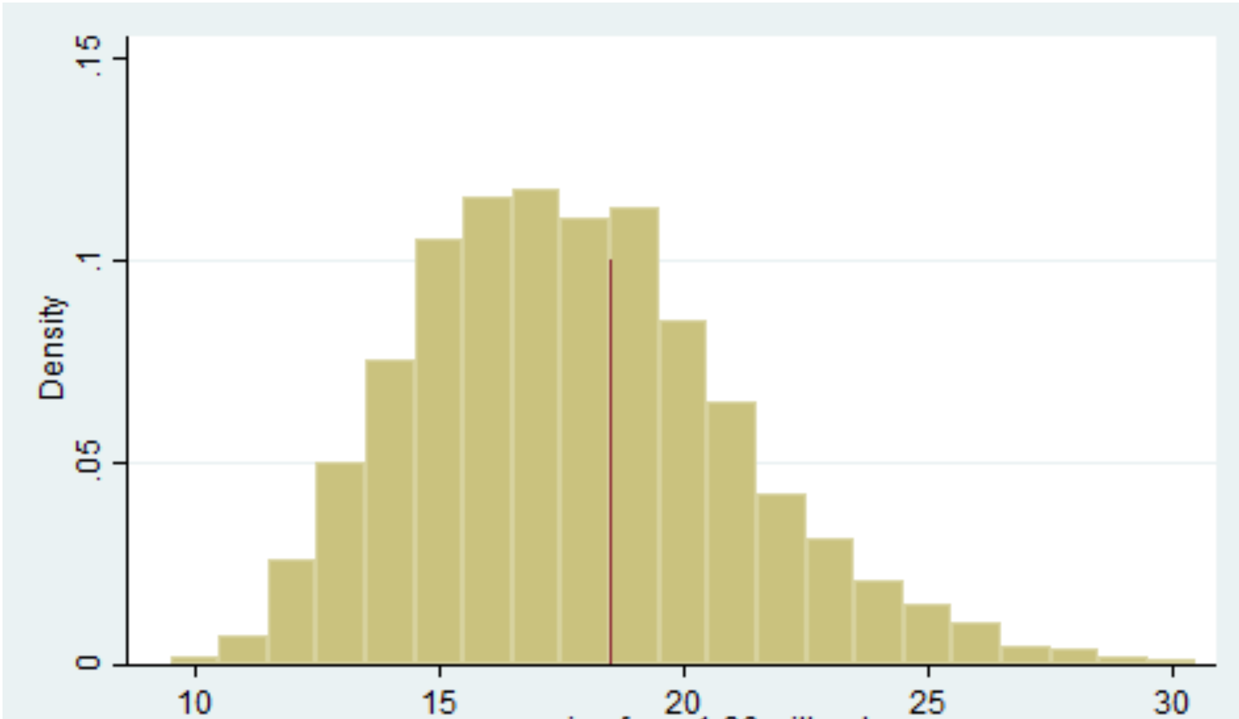

Figure 2: *Histogram of ACT Scores for Analytic Sample of Students Who Have Less than a 2.5 High School GPA, All Years*
Notes: Histogram represents the density of the sample of students scoring between a 10-30 on the ACT. Sample includes first-time, full-time, in-state students who enrolled in Arkansas postsecondary institutions between academic years 2010-11 and 2015-16 who earned less than a 2.5 high school GPA, and therefore would vary in qualification for the ACS based on ACT score.

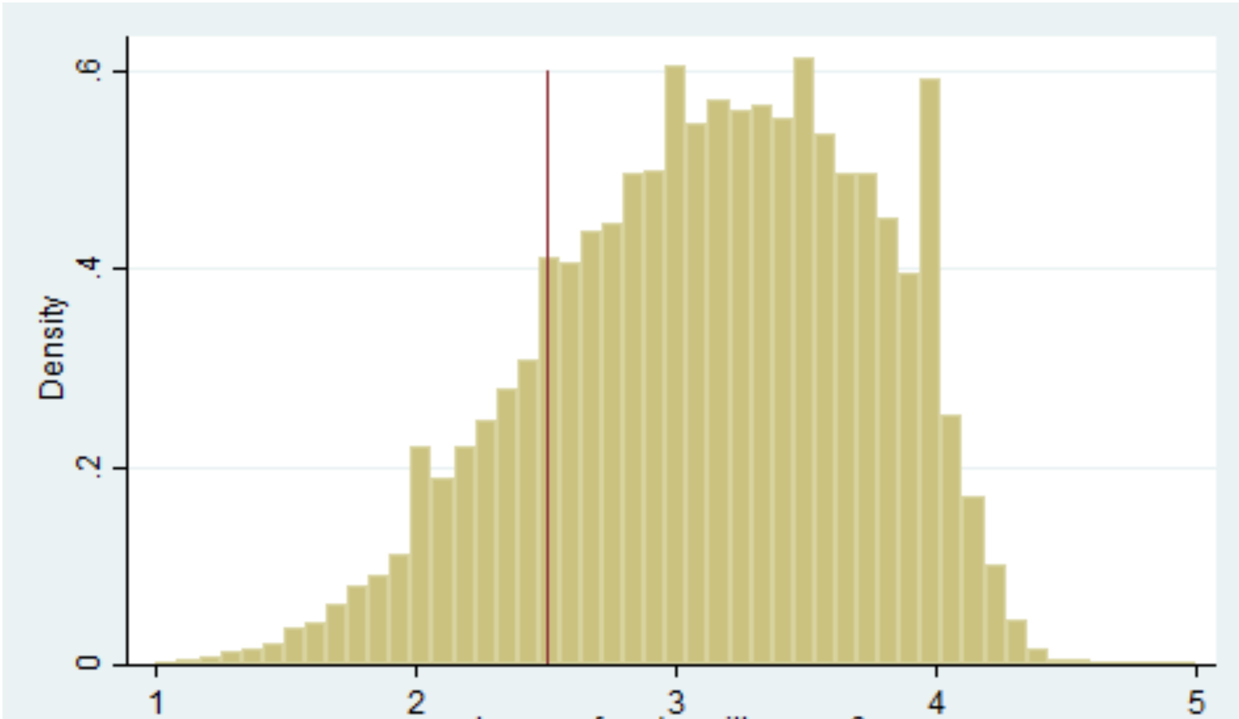

Figure 3: *Histogram of High School GPA for Analytic Sample of Students, All Years*
Notes: Histogram represents the density of the sample of students earning between a 1 and 5 high school GPA. Sample includes first-time, full-time, in-state students who enrolled in Arkansas postsecondary institutions between academic years 2010-11 and 2015-16.

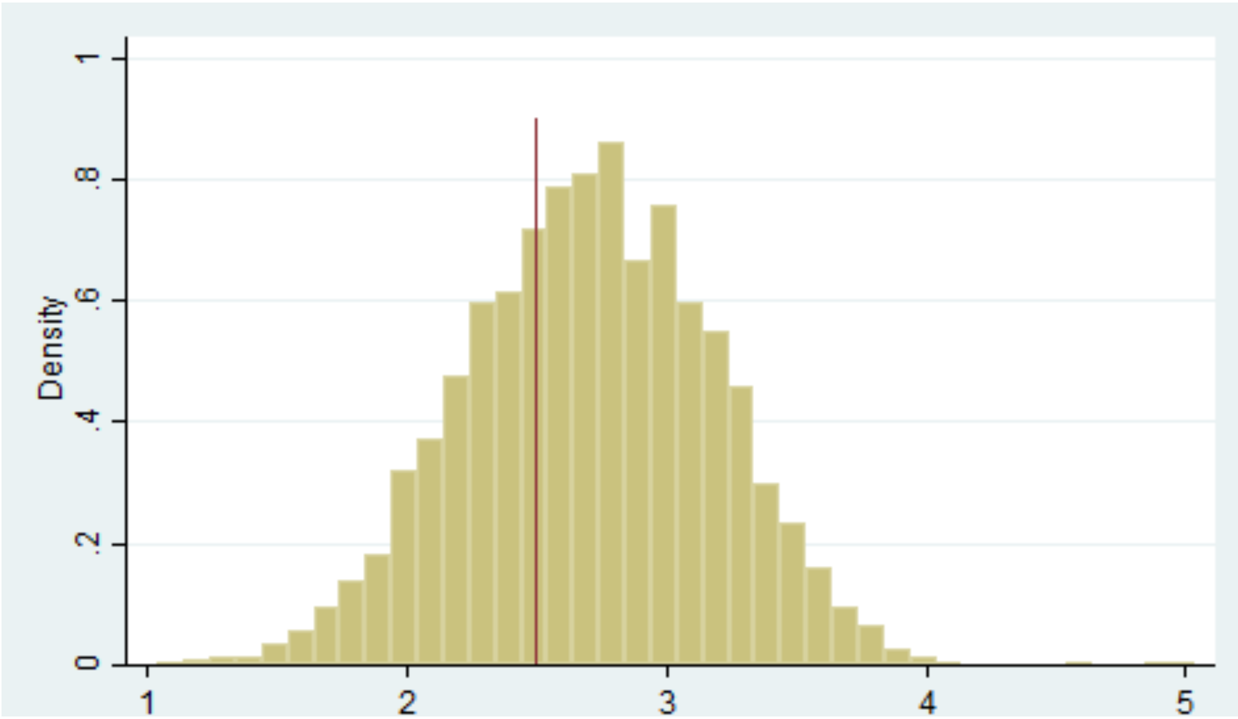

Figure 4: *Histogram of High School GPA for Analytic Sample of Students Who Have Less than a 19 on ACT, All Years*

Notes: Histogram represents the density of the sample of students earning between a 1 and 5 high school GPA. Sample includes first-time, full-time, in-state students who enrolled in Arkansas postsecondary institutions between academic years 2010-11 and 2015-16 who score less than a 19 on the ACT or concordant score on the SAT, and therefore would vary in qualification for the ACS based on high school GPA.

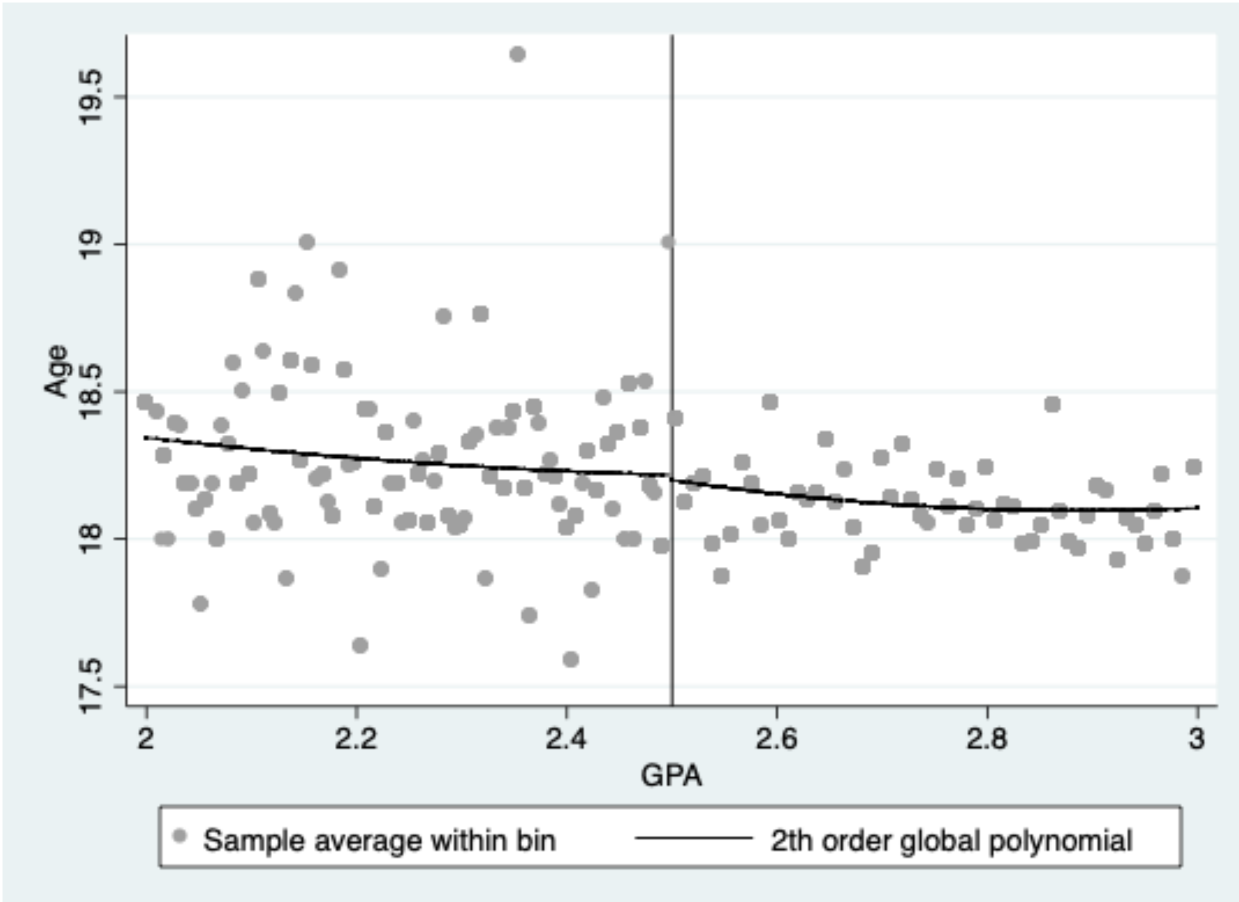

Figure 5: *Regression Discontinuity Plot Varying High School GPA and Student Age*
Notes: Regression discontinuity plot predicting student age using the rating variable of high school GPA. This prediction is limited to students who score less than a 19 on the ACT or concordant SAT score, and therefore would be included in the analytic sample.

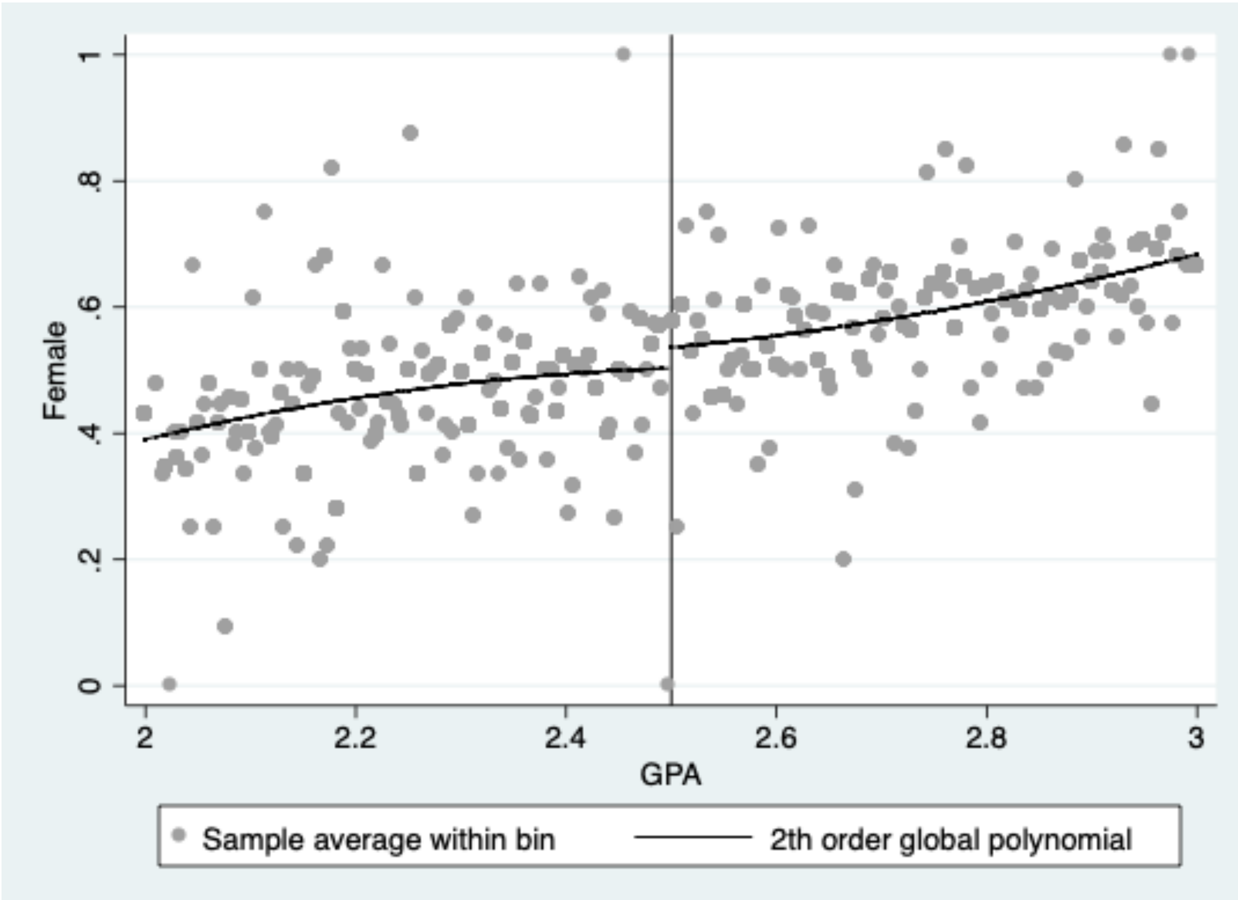

Figure 6: *Regression Discontinuity Plot Varying High School GPA and Student Gender*
Notes: Regression discontinuity plot predicting student gender using the rating variable of high school GPA. This prediction is limited to students who score less than a 19 on the ACT or concordant SAT score, and therefore would be included in the analytic sample.

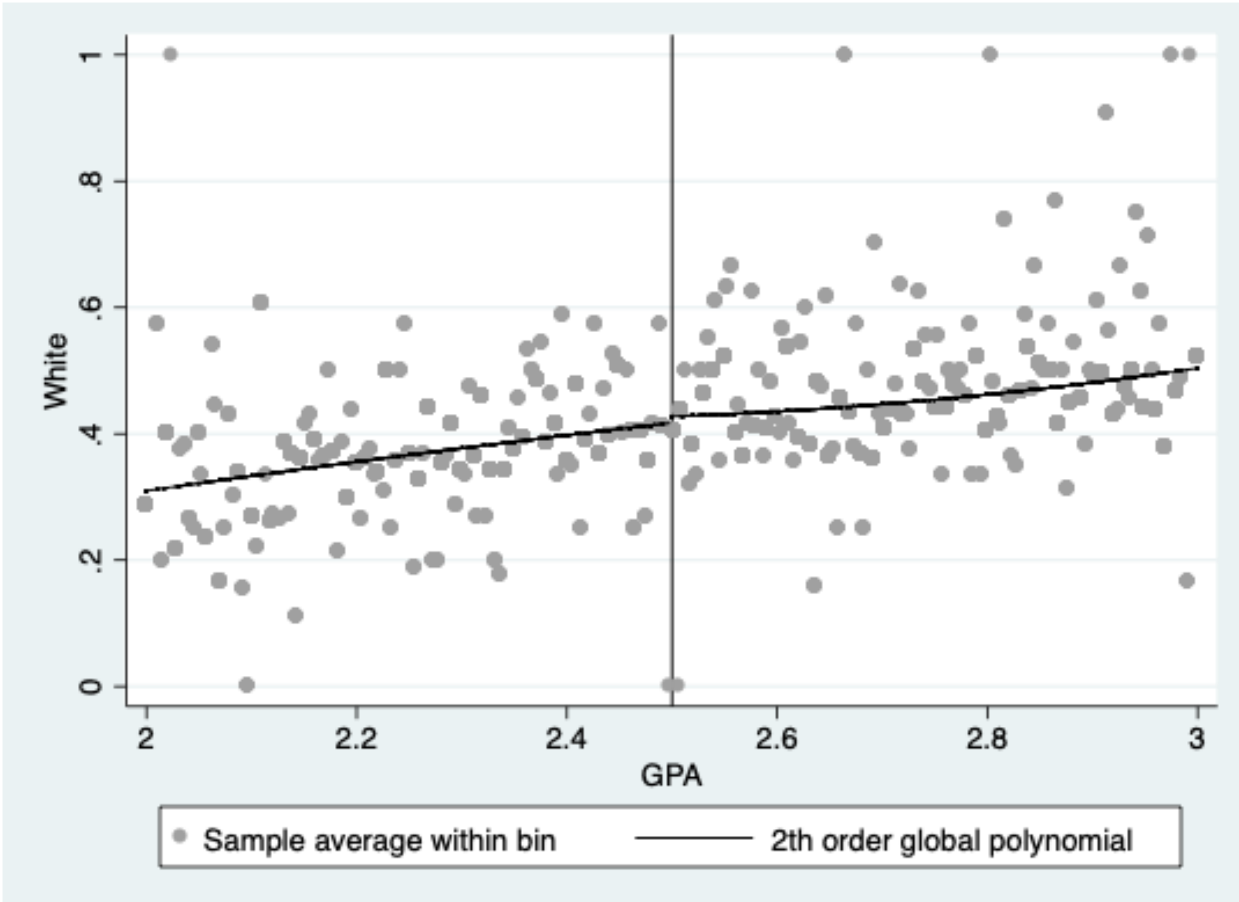

Figure 7: *Regression Discontinuity Plot Varying High School GPA and Student Ethnicity, White*
Notes: Regression discontinuity plot predicting student race/ethnicity as measured by being white using the rating variable of high school GPA. This prediction is limited to students who score less than a 19 on the ACT or concordant SAT score, and therefore would be included in the analytic sample.

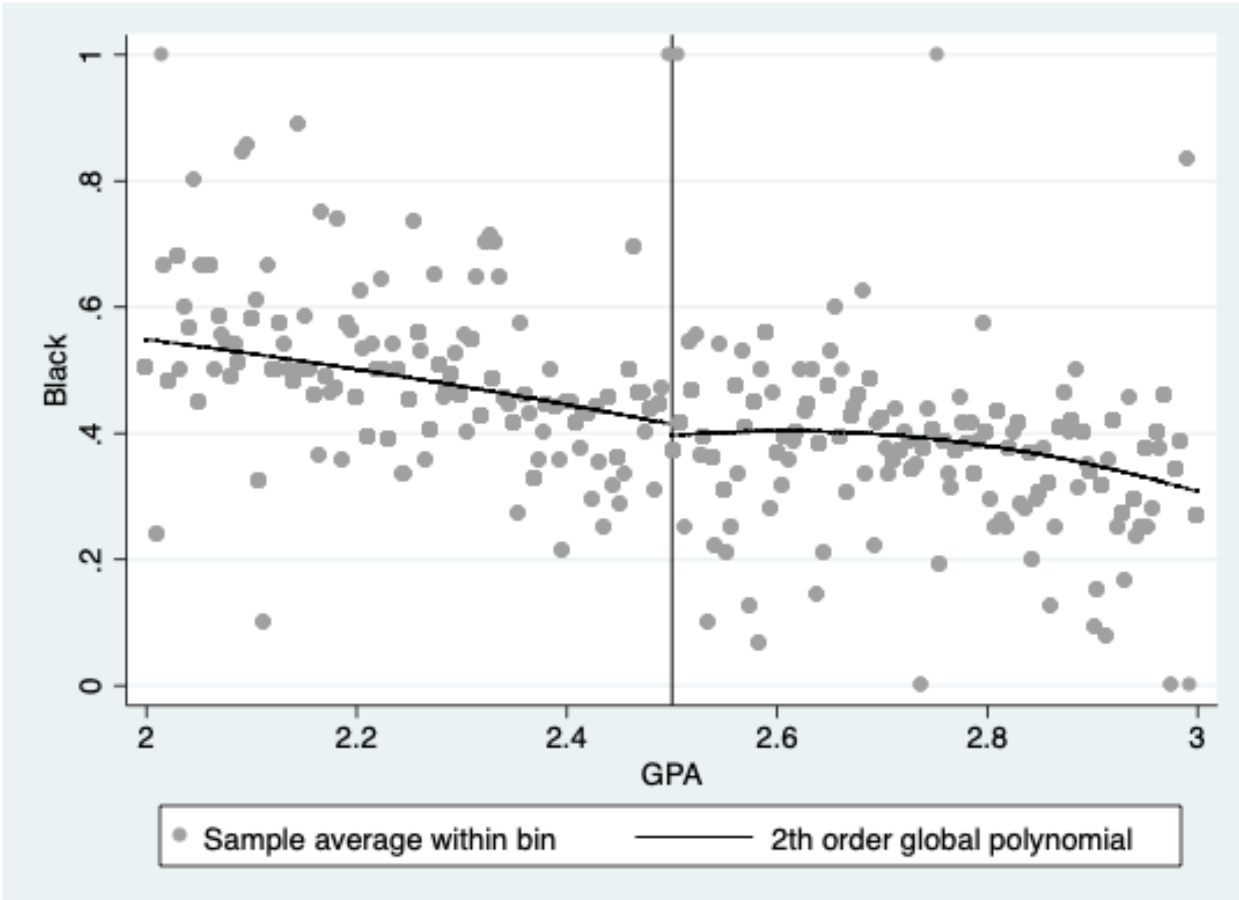

Figure 8: *Regression Discontinuity Plot Varying High School GPA and Student Ethnicity, Black*
Notes: Regression discontinuity plot predicting student gender as measured by being Black, using the rating variable of high school GPA. This prediction is limited to students who score less than a 19 on the ACT or concordant SAT score, and therefore would be included in the analytic sample.

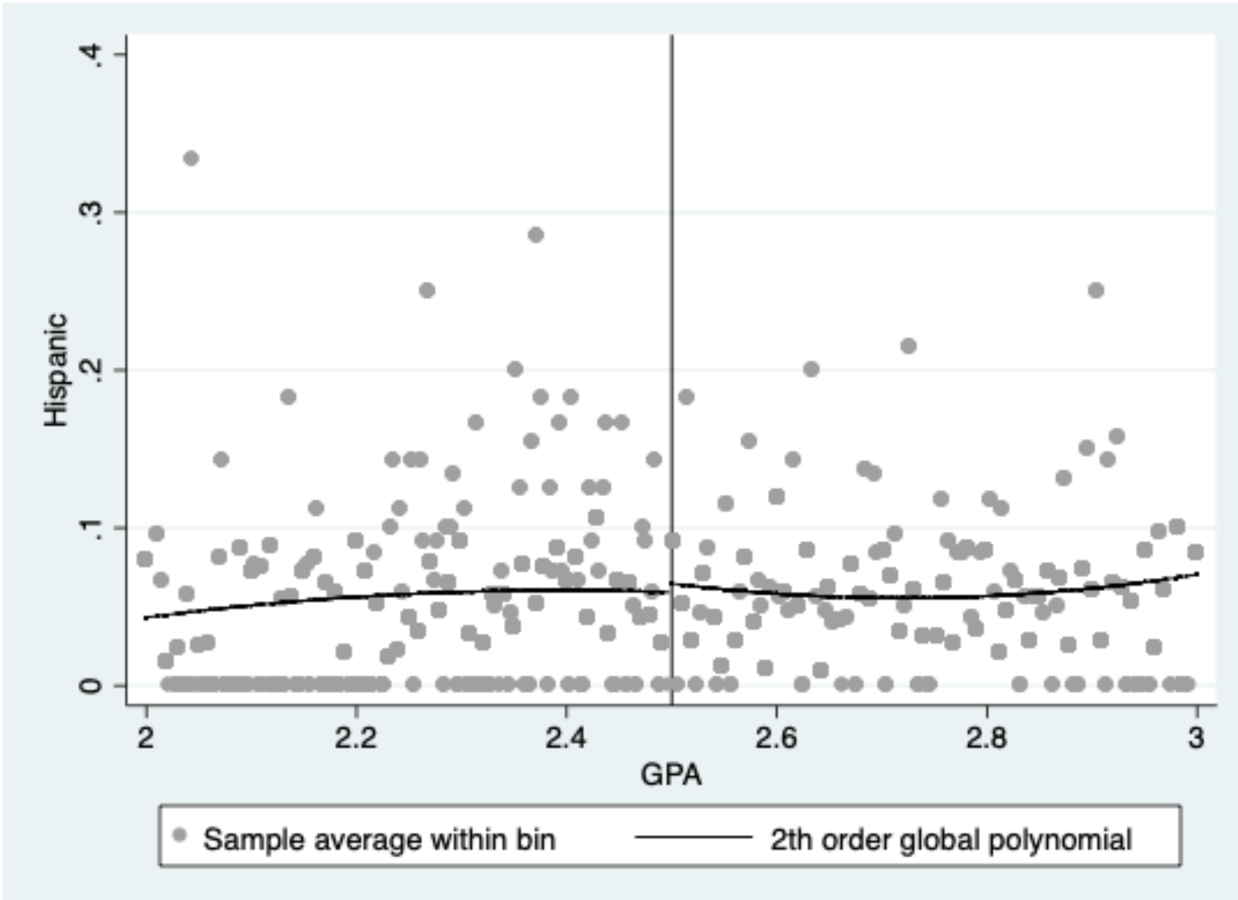

Figure 9: *Regression Discontinuity Plot Varying High School GPA and Student Ethnicity, Hispanic*
Notes: Regression discontinuity plot predicting student race/ethnicity as measured by being Hispanic, using the rating variable of high school GPA. This prediction is limited to students who score less than a 19 on the ACT or concordant SAT score, and therefore would be included in the analytic sample

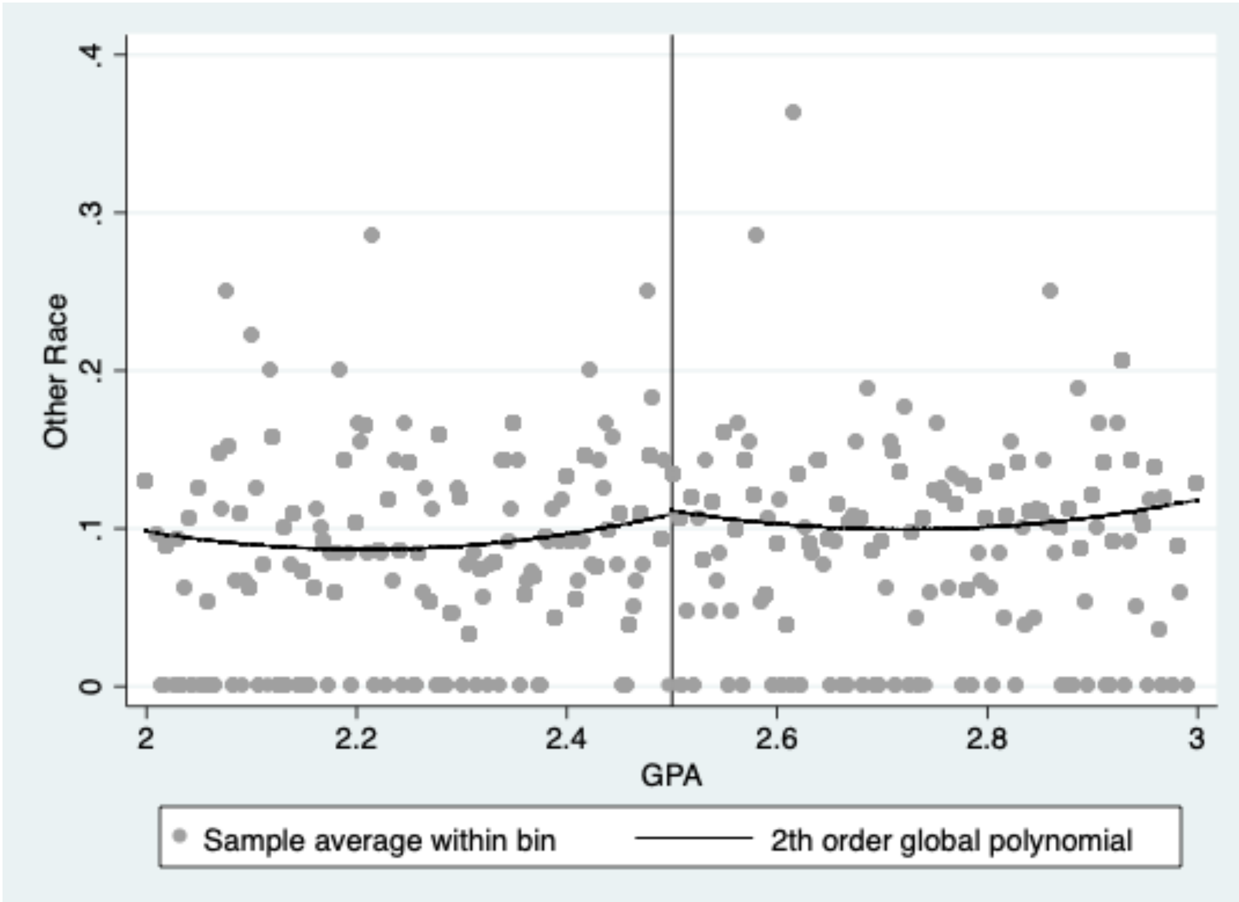

Figure 10: *Regression Discontinuity Plot Varying High School GPA and Student Ethnicity, Multi- or Other-Race*

Notes: Regression discontinuity plot predicting student race/ethnicity, as measured by being of multiple or “other” race, using the rating variable of high school GPA. This prediction is limited to students who score less than a 19 on the ACT or concordant SAT score, and therefore would be included in the analytic sample

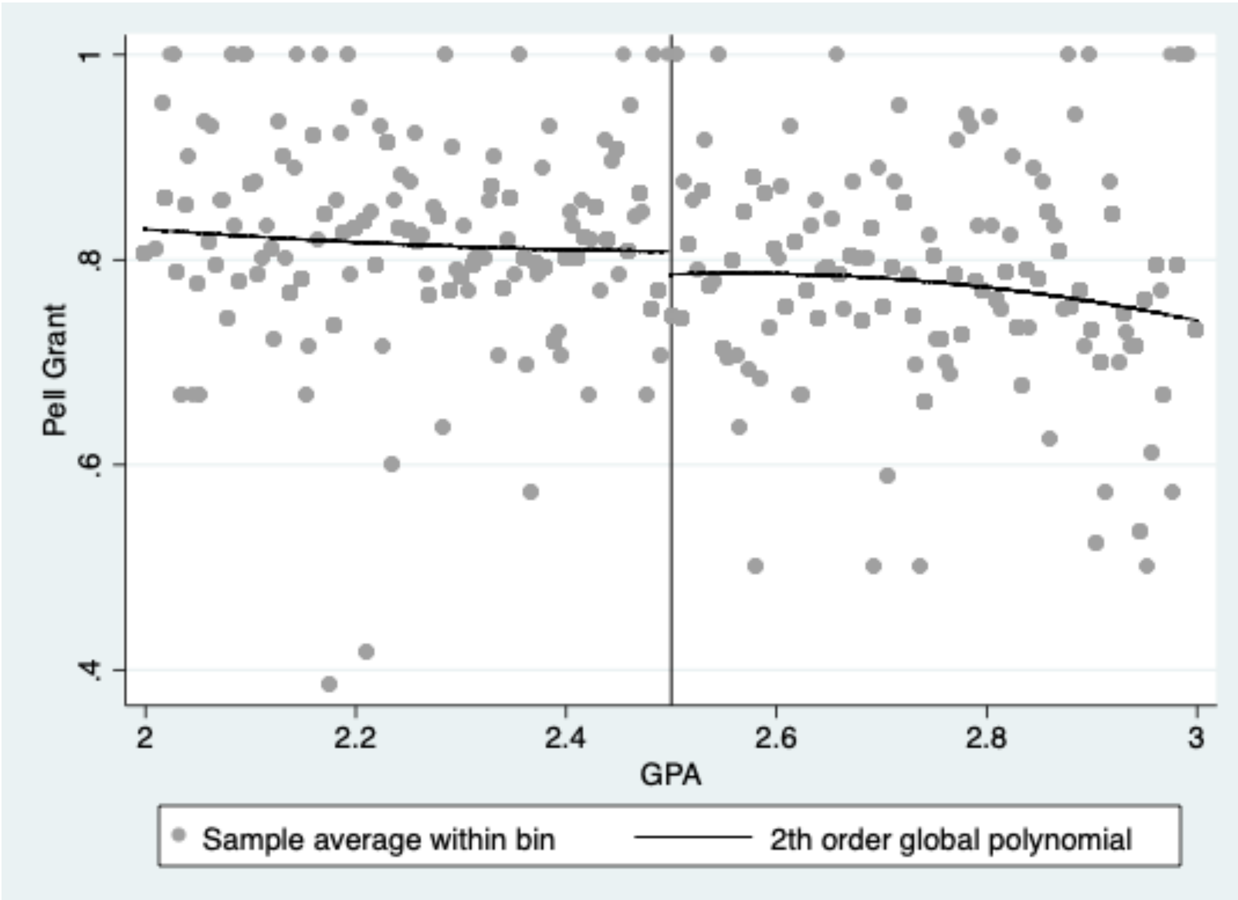

Figure 11: *Regression Discontinuity Plot Varying High School GPA and Student Pell Grant Eligibility*

Notes: Regression discontinuity plot predicting student Pell Grant eligibility using the rating variable of high school GPA. This prediction is limited to students who score less than a 19 on the ACT or concordant SAT score, and therefore would be included in the analytic sample

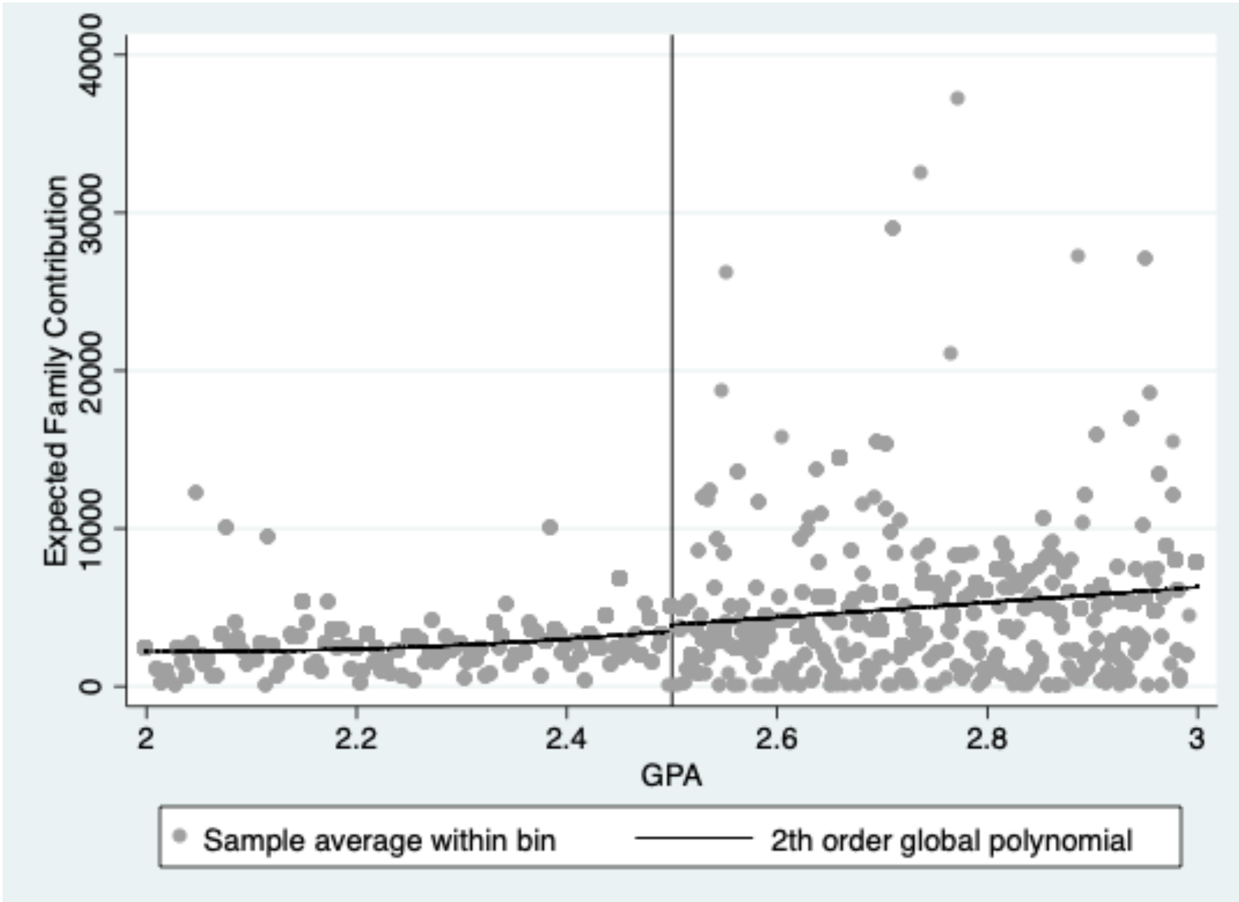

Figure 12: *Regression Discontinuity Plot Varying High School GPA and Student Expected Family Contribution*
Notes: Regression discontinuity plot predicting student expected family contribution using the rating variable of high school GPA. This prediction is limited to students who score less than a 19 on the ACT or concordant SAT score, and therefore would be included in the analytic sample

Tables

Table 1: *ACS Award Amounts by Year*

Year (Fall)	Amount by Year	Four-Year School	Two-Year School
2010	All Years	$5,000	$2,500
2011-2012	All Years	$4,500	$2,250
2013-2015	Year 1	$2,000	$2,000
	Year 2	$3,000	
	Year 3	$4,000	
	Year 4	$5,000	

Source: Arkansas Department of Higher Education (https://scholarships.adhe.edu/scholarships/detail/academic- challenge-scholarships)
Notes. "All Years" indicates that awards were paid out in equal installments to students attending four-year institutions for all four years

Table 2: *Summary Statistics for In-State Students Enrolled in All Institutions, by Year*

	Time 1			Time 2		
	2011	2012	2013	2014	2015	2016
Female	0.55	0.55	0.56	0.56	0.55	0.56
	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)
Age	19.48	19.38	19.21	19.13	18.71	18.58
	(5.14)	(4.96)	(4.79)	(4.76)	(3.71)	(3.39)
White	0.67	0.66	0.67	0.65	0.67	0.66
	(0.47)	(0.48)	(0.47)	(0.48)	(0.47)	(0.47)
Black	0.17	0.17	0.19	0.18	0.18	0.17
	(0.37)	(0.38)	(0.40)	(0.39)	(0.38)	(0.38)
Hispanic	0.04	0.05	0.05	0.06	0.06	0.06
	(0.19)	(0.21)	(0.21)	(0.23)	(0.23)	(0.24)
Other Race	0.13	0.13	0.09	0.11	0.10	0.11
	(0.33)	(0.33)	(0.29)	(0.31)	(0.29)	(0.31)
Exam Score	21.94	21.99	21.97	22.04	22.33	22.33
	(4.53)	(4.54)	(4.53)	(4.46)	(4.56)	(4.56)
High School GPA	3.01	2.92	2.98	3.12	3.17	3.19
	(0.71)	(0.92)	(0.90)	(0.64)	(0.64)	(0.63)
Qualify for ACS	0.83	0.83	0.85	0.86	0.88	0.89
	(0.38)	(0.38)	(0.36)	(0.35)	(0.33)	(0.32)
Observations	17,870	17,826	17,673	17,196	16,560	16,517

Notes: Observation totals represent the highest number of individuals used to calculate summary statistics, for some variables, missing data yields smaller observation counts. Each academic year represents the year in the spring. For example, in Time 2, 2014 represents the academic year 2013-14. Standard deviations are in parentheses.

Table 3: *Summary Statistics for In-State Students Enrolled in Four-Year Institutions, by Year*

	Time 1			Time 2		
	2011	2012	2013	2014	2015	2016
Female	0.55	0.55	0.55	0.56	0.55	0.55
	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)
Age	18.55	18.53	18.42	18.38	18.18	18.09
	(3.33)	(3.30)	(3.19)	(3.09)	(2.22)	(1.75)
White	0.68	0.67	0.68	0.67	0.68	0.67
	(0.47)	(0.47)	(0.47)	(0.47)	(0.47)	(0.47)
Black	0.16	0.17	0.17	0.17	0.17	0.17
	(0.37)	(0.38)	(0.38)	(0.38)	(0.37)	(0.37)
Hispanic	0.04	0.04	0.05	0.05	0.05	0.06
	(0.19)	(0.20)	(0.21)	(0.22)	(0.23)	(0.23)
Other Race	0.13	0.12	0.10	0.11	0.10	0.11
	(0.33)	(0.32)	(0.31)	(0.31)	(0.30)	(0.31)
Exam Score	22.53	22.65	22.74	22.76	23.06	23.09
	(4.46)	(4.45)	(4.41)	(4.39)	(4.48)	(4.47)
High School GPA	3.17	3.15	3.22	3.29	3.32	3.34
	(0.64)	(0.75)	(0.68)	(0.57)	(0.57)	(0.56)
Qualify for ACS	0.91	0.91	0.92	0.93	0.94	0.94
	(0.29)	(0.29)	(0.27)	(0.26)	(0.24)	(0.23)
Observations	12,172	12,155	12,107	11,686	11,666	11,428

Notes: Observation totals represent the highest number of individuals used to calculate summary statistics, for some variables, missing data yields smaller observation counts. Each academic year represents the year in the spring. For example, in Time 2, 2014 represents the academic year 2013-14. Standard deviations are in parentheses.

Table 4: *Summary Statistics for In-State Students Enrolled in Two-Year Institutions, by Year*

	Time 1			Time 2		
	2011	2012	2013	2014	2015	2016
Female	0.58	0.57	0.58	0.57	0.57	0.58
	(0.49)	(0.49)	(0.49)	(0.5)	(0.5)	(0.49)
Age	20.10	19.95	19.74	19.67	19.16	19.06
	(6.02)	(5.79)	(5.52)	(5.57)	(4.59)	(4.43)
White	0.64	0.63	0.65	0.64	0.66	0.66
	(0.48)	(0.48)	(0.48)	(0.48)	(0.48)	(0.48)
Black	0.17	0.17	0.21	0.19	0.18	0.17
	(0.38)	(0.38)	(0.41)	(0.39)	(0.39)	(0.37)
Hispanic	0.04	0.04	0.04	0.06	0.06	0.06
	(0.18)	(0.21)	(0.21)	(0.23)	(0.23)	(0.24)
Other Race	0.16	0.15	0.09	0.12	0.10	0.11
	(0.36)	(0.36)	(0.2)	(0.32)	(0.31)	(0.32)
Exam Score	20.81	20.76	20.70	20.80	20.92	20.93
	(4.07)	(4.04)	(4.04)	(4.01)	(4.01)	(4.11)
High School GPA	2.85	2.68	2.72	2.96	2.99	3.00
	(0.71)	(1.02)	(1.03)	(0.64)	(0.65)	(0.65)
Qualify for ACS	0.78	0.76	0.78	0.81	0.83	0.83
	(0.42)	(0.43)	(0.41)	(0.39)	(0.38)	(0.38)
Observations	10,446	10,199	9,963	9,620	8,597	8,095

Notes: Observation totals represent the highest number of individuals used to calculate summary statistics, for some variables, missing data yields smaller observation counts. Each academic year represents the year in the spring. For example, in Time 2, 2014 represents the academic year 2013-14. Standard deviations are in parentheses.

Table 5: *Differences in baseline characteristics between Qualified and Non-Qualified and Time Period Cohort, Limited to students who scored less than a 19 on ACT, and High School GPA Between 2.0 and 3.0*

	Time 2				Time 1				Not Qualified Diff (3-7)
	N	Qualified	Not Qualified	Diff	N	Qualified	Not Qualified	Diff	
	1	2	3	4	5	6	7	8	9
Age	5479	18.082***	18.233***	-0.152***	5525	18.169***	18.290***	-0.121**	-0.057
		(0.034)	(0.048)	(0.032)		(0.060)	(0.043)	(0.044)	(0.035)
Female	5479	0.590***	0.459***	0.132***	5525	0.606***	0.472***	0.134***	-0.013
		(0.014)	(0.027)	(0.020)		(0.011)	(0.019)	(0.015)	(0.023)
Ethnicity									
White	5479	0.442***	0.329***	0.112***	5525	0.474***	0.409***	0.065*	-0.080**
		(0.049)	(0.049)	(0.019)		(0.058)	(0.066)	(0.035)	(0.033)
Black	5479	0.384***	0.524***	-0.140***	5525	0.371***	0.439***	-0.068*	0.085**
		(0.063)	(0.063)	(0.020)		(0.064)	(0.076)	(0.040)	(0.036)
Hispanic	5479	0.072***	0.055***	0.017**	5525	0.048***	0.058***	-0.010	-0.003
		(0.017)	(0.013)	(0.007)		(0.010)	(0.012)	(0.007)	(0.005)
Other	5479	0.103***	0.092***	0.011	5525	0.107***	0.094***	0.013*	-0.003
		(0.014)	(0.013)	(0.008)		(0.012)	(0.013)	(0.008)	(0.015)
Pell Eligible	5479	0.762***	0.803***	-0.041***	5525	0.785***	0.827***	-0.042***	-0.024*
		(0.021)	(0.020)	(0.011)		(0.019)	(0.022)	(0.013)	(0.013)
Expected Family Contribute	5479	4,826***	2,488***	2,338***	5525	5,307***	2,828***	2,479***	-339**
		(461.874)	(240.049)	(362.112)		(396.465)	(237.153)	(332.279)	(150.753)

Notes: Expected Family Contribution rounded to nearest cents. Standard errors in parentheses. Sample limited to students with less than a 19 on the ACT to exploit variation in qualification for the ACS using high school GPA. High school GPA limited to 2.0 to 3.0 as this approximates the optimal bandwidth for the regression discontinuity analysis. Expected family contribution is rounded to the nearest whole dollar.

Table 6: *Differences-in-Discontinuities Estimate of Changing the ACS Payout Structure on Postsecondary Persistence, All Institutions*

	Persist 1 Year (1)	Persist 1 Year (2)	Persist 2 Year (3)	Persist 2 Year (4)	Persist 3 Year (5)	Persist 3 Year (6)	Persist 4 Year (7)	Persist 4 Year (8)
Qualify for ACS*Post	0.010	0.014	0.026	0.030	0.032	0.036	0.003	0.010
	(0.031)	(0.030)	(0.041)	(0.041)	(0.038)	(0.036)	(0.046)	(0.043)
Qualify for the ACS	-0.017	-0.019	-0.036	-0.040	-0.013	-0.017	0.003	-0.001
	(0.026)	(0.026)	(0.026)	(0.026)	(0.025)	(0.024)	(0.024)	(0.024)
High School GPA	0.168**	0.182**	0.141	0.152	0.168*	0.177*	0.010	0.022
	(0.078)	(0.078)	(0.099)	(0.102)	(0.087)	(0.088)	(0.074)	(0.071)
Qualify for ACS*Post*GPA	-0.217	-0.185	-0.319*	-0.301*	-0.157	-0.139	-0.586**	-0.553**
	(0.166)	(0.169)	(0.166)	(0.167)	(0.208)	(0.204)	(0.271)	(0.264)
Qualify for ACS*GPA	0.167	0.141	0.326*	0.308*	0.151	0.124	0.317***	0.288***
	(0.152)	(0.145)	(0.165)	(0.162)	(0.161)	(0.156)	(0.109)	(0.103)
Post	0.010	0.001	0.024	0.016	0.005	-0.002	0.057	0.045
	(0.027)	(0.028)	(0.022)	(0.022)	(0.029)	(0.027)	(0.038)	(0.035)
GPA*Post	0.089	0.069	0.113	0.096	0.006	0.003	0.300*	0.280
	(0.121)	(0.120)	(0.126)	(0.129)	(0.150)	(0.146)	(0.177)	(0.175)
Constant	0.561***	0.425***	0.374***	0.253***	0.289***	0.173***	0.201***	0.084***
	(0.039)	(0.035)	(0.030)	(0.026)	(0.028)	(0.028)	(0.022)	(0.026)
Observations	8,046	8,046	8,451	8,451	7,430	7,430	6,138	6,138
R-squared	0.008	0.032	0.011	0.033	0.011	0.037	0.011	0.037
Covariates	No	Yes	No	Yes	No	Yes	No	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: Regression discontinuity estimated for each time period, and then differenced, using the difference-in-discontinuities method. Optimal bandwidth for each outcome variable was approximately 2.2-2.9 high school GPA. Sample limited to students who scored less than a 19 on the ACT or concordant score on the SAT. Standard errors are clustered at the postsecondary institution level.

Table 7: *Differences-in-Discontinuities Estimate of Changing the ACS Payout Structure on Postsecondary Attainment, All Institutions*

	Year 1 GPA (1)	Year 1 GPA (2)	Final GPA (3)	Final GPA (4)	Graduate in 4 (5)	Graduate in 4 (6)
Qualify for ACS*Post	0.010	0.001	0.083	0.086	0.059*	0.057*
	(0.067)	(0.069)	(0.074)	(0.073)	(0.035)	(0.033)
Qualify for the ACS	-0.022	-0.021	-0.048	-0.052	-0.019	-0.019
	(0.050)	(0.050)	(0.047)	(0.046)	(0.016)	(0.014)
High School GPA	0.373	0.295	0.624***	0.593***	-0.059	-0.073
	(0.264)	(0.244)	(0.196)	(0.192)	(0.094)	(0.087)
Qualify for ACS*Post*GPA	-0.316	-0.380	-0.545	-0.519	-0.423**	-0.419**
	(0.466)	(0.479)	(0.350)	(0.351)	(0.168)	(0.159)
Qualify for ACS*GPA	0.673**	0.758***	0.709***	0.719***	0.392***	0.417***
	(0.267)	(0.260)	(0.253)	(0.247)	(0.128)	(0.127)
Post	0.106	0.128*	0.076	0.081	0.056**	0.060**
	(0.067)	(0.067)	(0.054)	(0.052)	(0.026)	(0.024)
GPA*Post	0.248	0.267	0.099	0.048	0.107	0.090
	(0.363)	(0.375)	(0.284)	(0.288)	(0.145)	(0.135)
Constant	1.909***	2.004***	1.665***	1.644***	0.090***	0.135***
	(0.075)	(0.095)	(0.055)	(0.083)	(0.017)	(0.021)
Observations	6,100	6,100	7,901	7,901	6,402	6,402
R-squared	0.025	0.041	0.035	0.046	0.012	0.033
Covariates	No	Yes	No	Yes	No	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: Regression discontinuity estimated for each time period, and then differenced, using the difference-in-discontinuities method. Optimal bandwidth for each outcome variable was approximately 2.2-2.9 high school GPA. Sample limited to students who scored less than a 19 on the ACT or concordant score on the SAT. Standard errors are clustered at the postsecondary institution level.

Table 8: *Differences-in-Discontinuities Estimate of Changing the ACS Payout Structure on Postsecondary Persistence, Four-Year Institutions*

	Persist 1 Year (1)	Persist 1 Year (2)	Persist 2 Year (3)	Persist 2 Year (4)	Persist 3 Year (5)	Persist 3 Year (6)	Persist 4 Year (7)	Persist 4 Year (8)
Qualify for ACS*Post	-0.025	-0.024	0.049	0.049	0.036	0.042	-0.039	-0.041
	(0.044)	(0.048)	(0.065)	(0.064)	(0.052)	(0.050)	(0.084)	(0.079)
Qualify for the ACS	-0.018	-0.017	-0.081*	-0.081*	-0.010	-0.015	-0.006	-0.005
	(0.039)	(0.042)	(0.045)	(0.046)	(0.037)	(0.036)	(0.036)	(0.037)
High School GPA	0.292*	0.268*	0.481**	0.436**	0.125	0.112	0.052	0.004
	(0.165)	(0.152)	(0.198)	(0.202)	(0.120)	(0.127)	(0.164)	(0.178)
Qualify for ACS*Post*GPA	-0.324	-0.325	0.303	0.290	-0.097	-0.135	0.034	-0.031
	(0.360)	(0.348)	(0.269)	(0.254)	(0.309)	(0.293)	(0.896)	(0.874)
Qualify for ACS*GPA	0.154	0.144	0.162	0.176	0.252	0.235	0.362	0.370
	(0.306)	(0.278)	(0.282)	(0.273)	(0.221)	(0.217)	(0.279)	(0.291)
Post	0.037	0.033	-0.023	-0.026	-0.003	-0.007	0.035	0.031
	(0.048)	(0.052)	(0.028)	(0.028)	(0.043)	(0.038)	(0.075)	(0.069)
GPA*Post	0.189	0.196	-0.297	-0.277	0.031	0.038	0.238	0.299
	(0.280)	(0.273)	(0.172)	(0.160)	(0.228)	(0.220)	(0.416)	(0.396)
Constant	0.595***	0.357***	0.433***	0.230***	0.316***	0.133***	0.244***	0.079*
	(0.066)	(0.065)	(0.052)	(0.041)	(0.041)	(0.030)	(0.035)	(0.041)
Observations	4,310	4,310	4,200	4,200	3,907	3,907	2,530	2,530
R-squared	0.014	0.046	0.020	0.049	0.013	0.046	0.010	0.042
Covariates	No	Yes	No	Yes	No	Yes	No	Yes

Robust standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Notes: Regression discontinuity estimated for each time period, and then differenced, using the difference-in-discontinuities method. Optimal bandwidth for each outcome variable was approximately 2.2-2.9 high school GPA. Sample limited to students who scored less than a 19 on the ACT or concordant score on the SAT. Standard errors are clustered at the postsecondary institution level.

Table 9: *Differences-in-Discontinuities Estimate of Changing the ACS Payout Structure on Postsecondary Attainment, Four-Year Institutions*

	Year 1 GPA (1)	Year 1 GPA (2)	Final GPA (3)	Final GPA (4)	Graduate in 4 (5)	Graduate in 4 (6)
Qualify for ACS*Post	-0.075	-0.073	-0.061	-0.049	0.017	0.019
	(0.089)	(0.092)	(0.070)	(0.072)	(0.023)	(0.022)
Qualify for the ACS	-0.041	-0.039	-0.002	-0.008	-0.022*	-0.023*
	(0.050)	(0.050)	(0.048)	(0.049)	(0.012)	(0.011)
High School GPA	0.640**	0.536**	0.539***	0.479**	0.025	0.009
	(0.261)	(0.246)	(0.163)	(0.173)	(0.082)	(0.076)
Qualify for ACS*Post*GPA	0.124	0.070	-0.858***	-0.880***	-0.610***	-0.589***
	(0.560)	(0.546)	(0.279)	(0.274)	(0.120)	(0.116)
Qualify for ACS*GPA	0.571*	0.643*	0.698**	0.722**	0.260*	0.270**
	(0.323)	(0.312)	(0.298)	(0.291)	(0.125)	(0.122)
Post	0.029	0.045	0.108*	0.111**	0.056	0.057*
	(0.070)	(0.074)	(0.052)	(0.049)	(0.032)	(0.032)
GPA*Post	0.076	0.096	0.567***	0.531**	0.288**	0.258**
	(0.415)	(0.435)	(0.183)	(0.180)	(0.125)	(0.118)
Constant	1.830***	1.774***	1.583***	1.399***	0.059**	0.078***
	(0.096)	(0.070)	(0.069)	(0.055)	(0.022)	(0.011)
Observations	3,488	3,488	4,710	4,710	3,714	3,714
R-squared	0.030	0.042	0.042	0.056	0.010	0.026
Covariates	No	Yes	No	Yes	No	Yes

Robust standard errors in parentheses

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

Notes: Regression discontinuity estimated for each time period, and then differenced, using the difference-in-discontinuities method. Optimal bandwidth for each outcome variable was approximately 2.2-2.9 high school GPA. Sample limited to students who scored less than a 19 on the ACT or concordant score on the SAT. Standard errors are clustered at the postsecondary institution level.

Table 10: *Differences-in-Discontinuities Estimate of Changing the ACS Payout Structure on Postsecondary Persistence, Two-Year Institutions*

	Persist 1 Year (1)	Persist 1 Year (2)	Persist 2 Year (3)	Persist 2 Year (4)	Persist 3 Year (5)	Persist 3 Year (6)	Persist 4 Year (7)	Persist 4 Year (8)
Qualify for ACS*Post	0.069	0.066	0.007	0.004	0.029	0.029	0.030	0.028
	(0.048)	(0.051)	(0.041)	(0.045)	(0.062)	(0.064)	(0.052)	(0.050)
Qualify for the ACS	-0.061	-0.061	-0.023	-0.022	-0.009	-0.009	0.007	0.008
	(0.041)	(0.041)	(0.038)	(0.036)	(0.035)	(0.034)	(0.030)	(0.030)
High School GPA	0.231*	0.232*	0.037	0.023	0.126	0.116	-0.002	-0.012
	(0.129)	(0.133)	(0.102)	(0.100)	(0.125)	(0.127)	(0.114)	(0.111)
Qualify for ACS*Post*GPA	0.141	0.183	-0.148	-0.127	-0.280	-0.230	-0.520	-0.455
	(0.187)	(0.183)	(0.162)	(0.163)	(0.256)	(0.258)	(0.328)	(0.341)
Qualify for ACS*GPA	0.058	0.038	0.244*	0.238*	0.074	0.060	0.218	0.201
	(0.169)	(0.165)	(0.142)	(0.137)	(0.192)	(0.191)	(0.185)	(0.183)
Post	-0.038	-0.041	0.027	0.026	0.026	0.022	0.060	0.054
	(0.032)	(0.034)	(0.031)	(0.032)	(0.033)	(0.032)	(0.045)	(0.045)
GPA*Post	-0.182	-0.204	0.112	0.102	0.039	0.015	0.145	0.117
	(0.142)	(0.147)	(0.139)	(0.135)	(0.164)	(0.158)	(0.254)	(0.256)
Constant	0.542***	0.460***	0.333***	0.233***	0.239***	0.158***	0.145***	0.057*
	(0.035)	(0.038)	(0.033)	(0.032)	(0.029)	(0.032)	(0.029)	(0.030)
Observations	4,064	4,064	4,276	4,276	3,314	3,314	2,527	2,527
R-squared	0.007	0.028	0.007	0.032	0.005	0.028	0.006	0.033
Covariates	No	Yes	No	Yes	No	Yes	No	Yes

Robust standard errors in parentheses

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

Notes: Regression discontinuity estimated for each time period, and then differenced, using the difference-in-discontinuities method. Optimal bandwidth for each outcome variable was approximately 2.2-2.9 high school GPA. Sample limited to students who scored less than a 19 on the ACT or concordant score on the SAT. Standard errors are clustered at the postsecondary institution level.

Table 11: *Differences-in-Discontinuities Estimate of Changing the ACS Payout Structure on Postsecondary Attainment, Two-Year Institutions*

	Year 1 GPA (1)	Year 1 GPA (2)	Final GPA (3)	Final GPA (4)	Graduate in 4 (5)	Graduate in 4 (6)
Qualify for ACS*Post	0.103	0.091	0.217*	0.214*	0.093	0.089
	(0.118)	(0.118)	(0.115)	(0.111)	(0.064)	(0.062)
Qualify for the ACS	-0.065	-0.058	-0.069	-0.070	-0.020	-0.020
	(0.091)	(0.093)	(0.089)	(0.089)	(0.028)	(0.028)
High School GPA	0.528	0.458	0.444	0.438	-0.067	-0.079
	(0.375)	(0.363)	(0.348)	(0.351)	(0.124)	(0.118)
Qualify for ACS*Post*GPA	-0.220	-0.226	-0.733	-0.674	-0.202	-0.280
	(0.698)	(0.702)	(0.580)	(0.566)	(0.280)	(0.252)
Qualify for ACS*GPA	0.526	0.637	1.002**	0.993**	0.474**	0.529**
	(0.476)	(0.454)	(0.411)	(0.409)	(0.215)	(0.224)
Post	0.151	0.165	0.074	0.081	0.049*	0.056**
	(0.100)	(0.101)	(0.092)	(0.090)	(0.028)	(0.026)
GPA*Post	0.067	0.056	-0.041	-0.115	-0.099	-0.066
	(0.556)	(0.553)	(0.479)	(0.463)	(0.170)	(0.154)
Constant	2.081***	2.179***	1.746***	1.754***	0.143***	0.183***
	(0.100)	(0.164)	(0.089)	(0.125)	(0.024)	(0.037)
Observations	2,630	2,630	3,603	3,603	2,833	2,833
R-squared	0.035	0.046	0.035	0.046	0.018	0.031
Covariates	No	Yes	No	Yes	No	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: Regression discontinuity estimated for each time period, and then differenced, using the difference-in-discontinuities method. Optimal bandwidth for each outcome variable was approximately 2.2-2.9 high school GPA. Sample limited to students who scored less than a 19 on the ACT or concordant score on the SAT. Standard errors are clustered at the postsecondary institution level.

Table 12: *Difference-in-Discontinuities Estimate of Changing the ACS Payout Structure, on Postsecondary Persistence, All Institutions (Model 2)*

	Persist 1 Year (1)	Persist 1 Year (2)	Persist 2 Year (3)	Persist 2 Year (4)	Persist 3 Year (5)	Persist 3 Year (6)	Persist 4 Year (7)	Persist 4 Year (8)
Qualify for ACS*Post	0.012	0.016	0.028	0.033	0.034	0.037	0.003	0.010
	(0.030)	(0.029)	(0.041)	(0.041)	(0.037)	(0.035)	(0.045)	(0.043)
Qualify for ACS	-0.019	-0.021	-0.038	-0.041	-0.014	-0.018	0.003	-0.001
	(0.026)	(0.026)	(0.025)	(0.025)	(0.024)	(0.024)	(0.024)	(0.024)
2011 Cohort	0.028	0.019	0.095**	0.088*	0.049	0.038	0.057	0.046
	(0.053)	(0.051)	(0.044)	(0.044)	(0.044)	(0.042)	(0.038)	(0.036)
2012 Cohort	-0.033	-0.038	0.017	0.014	0.010	0.005	0.049	0.046
	(0.042)	(0.042)	(0.034)	(0.034)	(0.036)	(0.036)	(0.035)	(0.035)
2014 Cohort	0.022	0.004	0.089**	0.075*	0.061	0.045	0.092**	0.076**
	(0.037)	(0.036)	(0.041)	(0.040)	(0.043)	(0.042)	(0.038)	(0.037)
2015 Cohort	-0.008	-0.016	0.031	0.024	-0.015	-0.024		
	(0.041)	(0.041)	(0.045)	(0.045)	(0.035)	(0.036)		
2016 Cohort	0.005	-0.010	0.060	0.047				
	(0.051)	(0.051)	(0.040)	(0.040)				
GPA*2011 Cohort	0.194	0.186	0.416***	0.402***	0.320**	0.295**	0.153	0.125
	(0.126)	(0.129)	(0.141)	(0.135)	(0.119)	(0.122)	(0.095)	(0.103)
GPA*2012 Cohort	-0.071	-0.058	-0.061	-0.043	0.041	0.055	0.008	0.034
	(0.162)	(0.161)	(0.144)	(0.147)	(0.141)	(0.140)	(0.141)	(0.131)
GPA*2013 Cohort	0.450**	0.492***	0.087	0.119	0.144	0.184	-0.147	-0.105
	(0.172)	(0.174)	(0.153)	(0.161)	(0.116)	(0.124)	(0.126)	(0.125)
GPA*2014 Cohort	0.389*	0.376*	0.399***	0.397***	0.427***	0.420***	0.310*	0.302*
	(0.204)	(0.207)	(0.124)	(0.126)	(0.126)	(0.120)	(0.158)	(0.156)
GPA*2015 Cohort	0.041	0.076	0.045	0.063	-0.117	-0.099		
	(0.120)	(0.127)	(0.157)	(0.158)	(0.125)	(0.124)		
GPA*2016 Cohort	0.302*	0.267	0.286*	0.250				
	(0.164)	(0.170)	(0.163)	(0.168)				

Table 12 (Cont.): *Difference-in-Discontinuities Estimate of Changing the ACS Payout Structure, on Postsecondary Persistence, All Institutions (Model 2)*

	Persist 1 Year (1)	Persist 1 Year (2)	Persist 2 Year (3)	Persist 2 Year (4)	Persist 3 Year (5)	Persist 3 Year (6)	Persist 4 Year (7)	Persist 4 Year (8)
GPA*ACS*2011	0.063	0.036	-0.116	-0.127	-0.067	-0.072	0.076	0.085
	(0.245)	(0.250)	(0.201)	(0.201)	(0.278)	(0.273)	(0.207)	(0.208)
GPA*ACS*2012	0.586**	0.589**	0.547**	0.533**	0.269	0.251	0.242	0.210
	(0.287)	(0.279)	(0.263)	(0.261)	(0.231)	(0.226)	(0.232)	(0.222)
GPA*ACS*2013	-0.197	-0.254	0.545*	0.507*	0.263	0.195	0.650***	0.576***
	(0.285)	(0.280)	(0.285)	(0.285)	(0.219)	(0.219)	(0.199)	(0.192)
GPA*ACS*2014	-0.257	-0.233	-0.289	-0.294	-0.454**	-0.446**	-0.269	-0.265
	(0.304)	(0.309)	(0.207)	(0.206)	(0.206)	(0.204)	(0.239)	(0.237)
GPA*ACS*2015	0.239	0.188	0.385*	0.351*	0.494**	0.467**		
	(0.149)	(0.156)	(0.209)	(0.207)	(0.205)	(0.201)		
GPA*ACS*2016	-0.085	-0.040	-0.031	0.010				
	(0.272)	(0.273)	(0.210)	(0.218)				
Constant	0.563***	0.432***	0.336***	0.219***	0.269***	0.158***	0.165***	0.053
	(0.049)	(0.043)	(0.041)	(0.041)	(0.037)	(0.039)	(0.034)	(0.035)
Observations	8,046	8,046	8,451	8,451	7,430	7,430	6,138	6,138
R-squared	0.009	0.034	0.013	0.034	0.013	0.038	0.012	0.038
Covariates	No	Yes	No	Yes	No	Yes	No	Yes

Robust standard errors in parentheses

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

Notes: Regression discontinuity estimated for each time period, and then differenced, using the difference-in-discontinuities method. Optimal bandwidth for each outcome variable was approximately 2.2-2.9 high school GPA. Sample limited to students who scored less than a 19 on the ACT or concordant score on the SAT. Standard errors are clustered at the postsecondary institution level. Yearly cohorts are represented by the spring term year. For example, enrollment cohort 2013 represents academic year 2012-13. Data unavailable for three and four year persistence for 2015 and 2016, as not enough time has passed for students to have persisted that amount of time, given the data we have.

Table 13: *Difference-in-Discontinuities Estimate of Changing the ACS Payout Structure, on Postsecondary Attainment, All Institutions (Model 2)*

	Year 1 GPA (1)	Year 1 GPA (2)	Final GPA (3)	Final GPA (4)	Graduate in 4 (5)	Graduate in 4 (6)
Qualify for ACS*Post	0.015	0.007	0.085	0.088	0.047	0.045
	(0.066)	(0.068)	(0.072)	(0.071)	(0.032)	(0.031)
Qualify for ACS	-0.025	-0.023	-0.049	-0.054	-0.018	-0.019
	(0.051)	(0.051)	(0.047)	(0.046)	(0.016)	(0.014)
2011 Cohort	0.058	0.080	-0.062	-0.053	-0.041**	-0.034**
	(0.087)	(0.081)	(0.066)	(0.065)	(0.017)	(0.016)
2012 Cohort	0.132*	0.136**	0.008	0.005	-0.005	-0.002
	(0.066)	(0.063)	(0.065)	(0.061)	(0.024)	(0.023)
2014 Cohort	0.134*	0.161**	0.112	0.117	0.075***	0.084***
	(0.075)	(0.074)	(0.075)	(0.073)	(0.027)	(0.026)
2015 Cohort	0.118	0.143	-0.013	-0.010	-0.031	-0.025
	(0.090)	(0.088)	(0.071)	(0.068)	(0.025)	(0.025)
2016 Cohort	0.253***	0.298***	0.062	0.076	0.877***	0.865***
	(0.076)	(0.075)	(0.069)	(0.068)	(0.025)	(0.026)
GPA*2011 Cohort	0.074	0.077	0.136	0.142	-0.054	-0.042
	(0.351)	(0.345)	(0.347)	(0.333)	(0.122)	(0.126)
GPA*2012 Cohort	0.878**	0.795**	0.636**	0.601*	-0.204*	-0.217**
	(0.386)	(0.366)	(0.306)	(0.301)	(0.103)	(0.103)
GPA*2013 Cohort	0.324	0.148	1.216***	1.145***	0.065	0.020
	(0.462)	(0.416)	(0.355)	(0.346)	(0.148)	(0.135)
GPA*2014 Cohort	0.642	0.590	1.114***	1.056***	0.229	0.207
	(0.422)	(0.401)	(0.308)	(0.306)	(0.172)	(0.161)
GPA*2015 Cohort	0.407	0.322	0.315	0.204	-0.059	-0.099
	(0.413)	(0.398)	(0.362)	(0.347)	(0.166)	(0.148)
GPA*2016 Cohort	0.839*	0.797*	0.679*	0.600	-0.080	-0.131
	(0.443)	(0.422)	(0.375)	(0.364)	(0.075)	(0.093)
GPA*ACS*2011	0.653	0.607	1.496***	1.423***	0.472***	0.458**
	(0.545)	(0.543)	(0.470)	(0.457)	(0.170)	(0.182)
GPA*ACS*2012	-0.081	0.017	0.547	0.581	0.493***	0.511***
	(0.566)	(0.523)	(0.489)	(0.473)	(0.179)	(0.181)
GPA*ACS*2013	1.282**	1.513***	-0.035	0.042	0.216	0.281
	(0.495)	(0.468)	(0.537)	(0.529)	(0.221)	(0.217)
GPA*ACS*2014	0.643	0.686	-0.481	-0.465	-0.400*	-0.381*
	(0.641)	(0.608)	(0.437)	(0.441)	(0.224)	(0.212)
GPA*ACS*2015	0.585	0.627	0.802*	0.862*	0.257	0.291
	(0.550)	(0.552)	(0.457)	(0.454)	(0.221)	(0.219)

Table 13 (Cont.): *Difference-in-Discontinuities Estimate of Changing the ACS Payout Structure, on Postsecondary Attainment, All Institutions (Model 2)*

	Year 1 GPA (1)	Year 1 GPA (2)	Final GPA (3)	Final GPA (4)	Graduate in 4 (5)	Graduate in 4 (6)
GPA*ACS*2016	-0.277	-0.316	0.265	0.298	0.030	0.070
	(0.607)	(0.567)	(0.468)	(0.458)	(0.035)	(0.099)
Constant	1.850***	1.932***	1.685***	1.663***	0.105***	0.140***
	(0.083)	(0.095)	(0.063)	(0.086)	(0.022)	(0.021)
Observations	6,100	6,100	7,901	7,901	6,402	6,402
R-squared	0.027	0.044	0.037	0.047	0.095	0.113
Covariates	No	Yes	No	Yes	No	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: Regression discontinuity estimated for each time period, and then differenced, using the difference-in-discontinuities method. Optimal bandwidth for each outcome variable was approximately 2.2-2.9 high school GPA. Sample limited to students who scored less than a 19 on the ACT or concordant score on the SAT. Standard errors are clustered at the postsecondary institution level. Yearly cohorts are represented by the spring term year. For example, enrollment cohort 2013 represents academic year 2012-13. Data unavailable for three and four year persistence for 2015 and 2016, as not enough time has passed for students to have persisted that amount of time, given the data we have.

Chapter 3: High School GPA and College Admission Exams: The Differential Predictive Nature Based on High School Characteristics

Introduction

Postsecondary education, has gained traction in the American public and worldwide. The returns to postsecondary education are well documented, as measured by increased wages, and better life outcomes, such as improved health, and lower rates of divorce (Abel & Deitz, 2014; Wang, 2015). Given these documented benefits, it should come as no surprise that postsecondary enrollment has increased 24 percent from 1996 to 2006 (National Center for Education Statistics, 2019a). Enrollment increases can be thought of as a result of increased information to families on the benefits of college, as well as reduced barriers to entry, such as financial aid. While college enrollment has increased, college completion has not. Nationally, nearly 70 percent of recent high school graduates enrolled in some form of postsecondary education in 2016 (U.S. Bureau of Labor Statistics, 2017), while not all graduate; specifically, the six year graduation rate is only 60 percent (National Center for Education Statistics, 2019b).

The inconsistencies between enrollment and attainment, as measured by college completion, are troublesome, as students who enroll, and financially invest in higher education, but then withdraw before completing their degree, do not experience the same positive returns as students who earn their degree. Simply put, students may invest time and money, and forgo present wages, and come out behind, as they will not experience the same increase in lifetime wages, and not reap the positive social benefits as their counterparts who earns a degree. Students make the decision not to continue in college for various reasons; however, one potentially salient reason is a lack of complete or potentially inaccurate information between high schools, colleges, and students. Namely, student characteristics, such as high school GPA and score on a college readiness exam, such as the ACT, provide information to the student, and college, about how that student would fare if they enrolled in higher education. If that information is flawed in any way, then there is a miscommunication between institutions and students that could result in students having misinformed expectations of their likelihood of college success, encouraging them to enroll in college, but later drop out if their expected success is not reflected in their experience.

High school GPA and college admission tests play an important role in college admissions decisions, and with good reason, as these measures of student success are predictive of success in college (Belfield & Crosta, 2012; Cohn et al., 2004; Komarraju et al., 2012; Noble & Sawyer, 2004; Sawyer, 2013). However, while the metrics are situated on the same scales nationally, namely, high school GPAs generally range from 0-4, the ACT ranges from 1-36, and the SAT ranges from 0-2400, the implementation and use of these scales could be different between high schools, districts, or states. The scoring practices of college entrance exams are standardized; therefore it is reasonable to assume that a score of 28 on the ACT in New York is conveying the same academic qualification and success as a score of 28 in Arkansas. However, if various high schools across a state, or the nation, systematically award grades differently, then measures such as high school GPA could differ in its ability to predict later success in college. For example, if two students present with a high school GPA of 3.8, but experienced different high school environments that awarded their GPAs differently, then the accuracy of the GPA in communicating the academic ability of each student would be flawed. Beyond college admissions, once a student arrives on a college campus, knowing how different high school environments influence the accuracy of their high school GPA and college admissions exam score on their likelihood of being successful in college, colleges would be better able to identify students who could require additional supports to persist through to their terminal degree. I seek to address the question of the consistency of students' measures of college preparedness, such as high school GPA and college admissions exam score, such as ACT and SAT[29], on college success measures, differentiated by high school type. Specifically, my research questions are as follows:

R(1): What is the relationship between measured student characteristics, such as high school GPA and college admissions exam score, on college success outcomes - as measured by persistence past the first year of college, GPA after one year, and the likelihood of on time graduation, respectively?

R(2): How do the relationships between measured student characteristics, such as high school GPA and college admissions exam score, and college success outcomes - as measured by persistence, GPA after one year, and the likelihood of on time graduation, change based on specific high school characteristics such as school size, percent of students eligible for free and reduced price lunch, and percent of minority students?

In this chapter, I use multivariate regression models to identify the relationships between student high school GPA and college admissions exam score on college success outcomes for students who graduated from a high school in Arkansas and enrolled in an Arkansas postsecondary institution. I include additional variables that account for the specific high school characteristics the student experienced. In this way, I am able to identify specific high school characteristics that impact college success outcomes. Finally, I interact these high school characteristics with student high school GPA, and ACT score to determine if there is a

[29] The ACT is the preferred college admission test in Arkansas, however students have the option of taking and reporting the SAT to the college of their choice. For students taking the SAT, their score has been converted to the ACT scale, and therefore the exam score measure in this study ranges from 1-36, and includes students taking both ACT and SAT as their college admission test.

differential relationship between student characteristics such as high school GPA and ACT score and college outcomes, based on the type of high school the student attended. While many studies have investigated the predictive nature of high school GPA and admissions exam score on college successes, this paper contributes to this growing literature by investigating how the accuracy of these metrics could change as the origin high school environment changes.

My results suggest that changes in some high school characteristics indeed have a differential impact on the predictive nature of student high school GPA and college admissions exam score. While high school GPA and college admissions exam score are always positively associated with the college outcomes of persistence past the first year of college, college GPA at the end of the first year, and likelihood of graduating within four years, the magnitude of the effect changes when interacted with high school characteristics. Increasing the share of FRL or minority students in the origin high school above the state average of 56 percent and 25 percent, respectively, is associated with a reduction in the predicted improvements to college outcomes associated with high school GPA, but is associated with larger predicted gains associated with admissions exam scores. This is perhaps evidence that grading practices differ depending on high school type, as measured by percent FRL or minority students. When interacting school size with student high school academic metric, no clear pattern emerges.

This paper proceeds as follows: I briefly document the landscape of Arkansas education, highlighting the variability in high school characteristics throughout the state, and detailing the different postsecondary education options available to students in Arkansas. Then review the relevant literature of the relationship between student high school characteristics, and later postsecondary outcomes. I then explain the data and methods used for this project, while the final sections discuss the results and implications of the findings.

Landscape of Arkansas Education System

The landscape of Arkansas school districts, high schools, and students varies dramatically across the state, and therefore student experiences can be equally varied, depending on where they reside and attend school during their formative years. Arkansas is generally thought of as having five distinct geographic regions; Northwest, Northeast, Central, Southwest, and Southeast. While there are many small rural areas across and throughout the entire state, there are a few concentrated urbanized areas; however these are clustered primarily in the northwest and central regions.[30] In contrast, the southern regions are generally composed primarily of small rural areas. Many Arkansas school districts are small, and a majority of districts have only one high school. As of academic year 2019-20, within the 278 public school districts in Arkansas, there are a total of 1,053 K-12 schools, 25 open enrollment charter schools, and 304 high schools (ADE Data Center, 2020). However, the size, and demographics of the high school indeed varies throughout the state.

Table 1 presents pooled descriptive statistics for high schools in Arkansas pooled across all regions, and all years. High school enrollment ranges from approximately 20 students to over 4,000, with the average settling around 500. The percent of students who qualify for free and reduced price lunch also varies across the state, ranging from zero percent to 100 percent. Table 2 shows the high school averages by year, where we can see the percent of FRL students at a high school goes from 50 to 60 percent, with a pooled average of 56 percent across all years (Table 1). Table 3 presents the descriptive characteristics of Arkansas high schools by region, pooled across all years. The percent of FRL students is lowest in the Central and Northwest regions, and greatest in the Southeast region. The overall percent of minority students across all

[30] Northwest Arkansas metro area, and Little Rock metro area.

regions and years, is approximately 25 percent. As was the case with the percent of FRL students, at the high school, the percent minority ranges from approximately 22 to 27 percent, and varies across regions, with the lowest percent of minority student being in the Northwest region, and the largest concentration of minority students is in the Southeast region.

Throughout the state, high school students take annual benchmark tests, and beginning in the 2015-16 school year, eleventh grade students took the ACT (Rogers, 2015). Since 2013, at least 90 percent of Arkansas' high school graduates completed the ACT, and in 2017 and 2018, 100 percent of students were tested (Howell, 2018). As more students have taken the ACT, the average composite score in Arkansas has decreased from 20.2 in 2013, to 19.4 in 2018, while the national average has stayed about the same, ranging from 20.8 to 21 during the same time period (Howell, 2018).

The high school graduation rate in Arkansas has been steadily increasing since 2010, with approximately 77 percent of students graduating within four years in 2010, and 89 percent in 2019 (Arkansas Division of Elementary and Secondary Education, 2019). About 50 percent of students in Arkansas enroll in a postsecondary institution following high school graduation (Arkansas Department of Higher Education, 2017), and according to the U.S. Census Bureau, approximately 22 percent of Arkansas residents over the age of 25 have a Bachelor's Degree or higher as of 2018 (United States Census Bureau, 2018). Students enrolling in public four-year institutions has decreased slightly, from 33 percent in 2012, to 30 percent in 2016, while the share of students enrolling in private or independent institutions has increased from nearly two percent in 2012, to nearly four percent in 2016 (Arkansas Department of Higher Education, 2017). Additionally, similar to national trends, students identified as being high income are more likely to enroll in postsecondary institutions, compared to middle and lower income students (The Pell Institute, 2018).

Postsecondary education institutions in Arkansas can be broadly put into four categories; public four-year, public two-year, independent institutions, and other entities. There are 12 public four-year institutions, 22 public two-year, and 16 independent institutions throughout the state (Arkansas Division of Higher Education, 2019). As of 2019, a report out of the Arkansas Division of Higher Education shows that college retention rates are on the rise across Arkansas (Walkenhorst, 2019).

Review of the Literature of High School GPA and College Admission Exam Score

College admissions in Arkansas, and throughout the United States typically require measurements demonstrating student academic success, generally measured by high school GPA and/or score on a college readiness standardized test, such as the ACT or SAT. Many "competitive" colleges present guidelines on thresholds for these metrics, indicating what GPA or test score is needed for admission. Additionally, colleges consider other student characteristics, such as extracurricular activities, when granting admission. Finally some institutions are open-enrollment, meaning students of various academic backgrounds are able to enroll in coursework without meeting a prescribed academic standard.

There is a robust literature documenting the predictive power of high school GPA, and students' performance on standardized college readiness exam score on later success in college, as measured by persistence, GPA, credit accumulation, and graduation. Cohn et al. (2004), using regression and simulation analyses, find that high school GPA, high school rank, and SAT score are predictive in modeling college GPA in South Carolina. They additionally find that excluding *either* high school GPA or high school rank, not both, does not substantially alter their model, as GPA and class rank are highly correlated.

Interestingly, while high school GPA and ACT/SAT scores are both predictive of later college success, they appear to capture slightly different student characteristics. Specifically, researchers find that high school GPA and ACT scores reveal different patterns of readiness levels of college freshmen (Komarraju et al., 2012). They find that high school GPA is correlated with increases in survey reported non-cognitive measures such as discipline, determination, and stronger study skills, which may account for students' success in high school. In contrast, students with higher ACT scores report feeling academically self-confident, likely as a result of life-time academic achievement, but generally score lower on the other non-cognitive skills.

Recently, a study using an expanded sample of 192 four-year institutions reveals a similar pattern that perhaps high school GPA is partially capturing non-cognitive skills, and test scores are better capturing academic ability. Sawyer (2013), finds that high school GPA is a more useful admissions metric than test score for low selectivity institutions, and is better at predicting minimal to average academic performance. On the other hand, test scores are more useful when deciding admissions in highly selective institutions, and at predicting high academic performance (Sawyer, 2013). Similarly, Nobel & Sawyer (2004), find that high school GPA and ACT score are both predictive of college success, with high school GPA being more reliable at predicting moderate level college GPAs, and ACT score better predicting higher levels of first year GPA.

Furthermore, a study out of California shows that while both high school GPA and college admission exam scores are predictive of student outcomes in college, exam scores are currently better predictors of first year college GPA, and about as good as high school GPA at predicting retention, overall undergraduate GPA, and graduation (University of California

Academic Senate, 2010). This study also finds that high schools in California vary in their grading practices, and grade inflation contributes to the decrease in predictive ability of high school GPA.

While ACT and SAT have been shown to predict college success, other forms of testing are less reliable. A study of community colleges found that placement tests such as COMPASS[31] and ACCUPLACER[32] do not strongly predict college success (Belfield & Crosta, 2012). While these tests are positively correlated with credit accumulation, they are only weakly correlated with college GPA: this is especially true after controlling for high school GPA. High school GPA, in contrast, was shown to have a high association with both college GPA and credit accumulation.

While much of the literature documents the levels of reliability of high school GPA and college admissions exam scores on the likelihood of being successful in college, less is known about how student high school experiences influence their later likelihood of collegiate success. There is little research, for example, examining how two students with similar admissions credentials, but different high school characteristics, might have different collegiate experiences. This paper contributes to the growing literature by documenting how the reliability of measured student characteristics changes as high school characteristics change.

Data

The student-level data used in this analysis were provided by Arkansas Division of Higher Education for students enrolling in all Arkansas postsecondary institutions (two and four

[31] The ACT COMPASS test is a placement test used in college admissions. COMPASS was phased out in 2016. See (https://www.petersons.com/blog/act-phases-out-compass-placement-test/).
[32] College Board ACCUPLACER is a placement test used in college admissions, and placement decisions. See (https://accuplacer.collegeboard.org/).

year colleges) between fall of 2005 and fall of 2017[33] (academic years 2005-06 through 2017-18). These data include individual student enrollment, course-taking, and graduation records. The dataset allow us to see individual student demographics, including race and gender, student characteristics such as high school GPA, college admissions exam score, Pell Grant eligibility, expected family contribution, and where a student attended high school. Additionally, the complete dataset provides information on what institution students enrolled in, the year, their course-taking throughout college, and graduation record, where applicable.

The ADHE college level data is supplemented with publicly available data from the Office for Education Policy (OEP), at the University of Arkansas. This dataset contains aggregate descriptive information about each high school in Arkansas for the school years 2004-05 through 2016-17. High school characteristics include school size, measured by student enrollment, percent of minority students, and percent of students who are eligible for free and reduced price lunch, which will be used as a proxy for socioeconomic status of students at the high school.

To create a comprehensive dataset, the high school data was merged into the file containing student-level data. Specifically, the student level data contains the year that a given student graduated high school, as well as the high school code that awarded the degree. Using this information, I am able to merge in school characteristics for the high school that the student graduated from in a given year. This is the best representation of the school conditions that the student experienced while in high school.[34]

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[33] Data for this study are limited to Arkansas students who select into postsecondary education, specifically in the state, and subsequently enroll in college.

[34] The data do not reflect the length of time a student attended a high school, and therefore there is no way to detect student mobility prior to high school graduation. By using the high school characteristics for the year they graduated, I can be that at least for a year, these were the conditions the student experienced.

Analytic Sample

As the primary interest of this paper is the differential effect of measured high school characteristics on the relationship between student academic characteristics and later college outcomes, there are a few restrictions I must place on the data. First, the sample is limited to in-state students, as I only have aggregated high school data for public high schools in Arkansas. Additionally, in order to calculate graduation within four years, and the availability of complete data, I limit the sample to academic years 2005-06 through 2016-17 for the outcome variables of persistence past the first year, and college GPA at the end of the first year. For the outcome variable of graduation within four years, the data are further limited to academic years 2005-06 through 2014-15, to allow enough time for students to reach the four year mark. Finally, I limit the sample to first-time degree seeking students, as this is the best representation of the traditional student who would matriculate to college.

Table 4 presents the overall summary statistics for students who are included in the sample. Consistent with national trend, across all years, females make up the majority of the sample, ranging from 54 to 56 percent (U.S. Department of Education, National Center for Education Statistics, 2019a). The sample gets progressively younger, with the average age at enrollment of around 19.1 in 2006, dropping to 18.5 in 2017. White students make up almost 70 percent of the sample, followed by Black, other/multi-race, and Hispanic students. The average college admissions exam score improves slightly over time, increasing from 21.7 to 22.5. Finally, high school GPA follows a similar pattern, increasing from 3.05 to 3.13 over the 12 year period.

One might expect differences in the composition of students who choose to attend a four-year institution over a two-year institution, and there are several statistically significant differences worth mentioning. Table 5 presents the sample averages by institution type, with year fixed effects. Columns 2 and 4 present the average for the specific characteristic at four, and two year institutions, respectively, column 5 presents the difference, and column 6 shows the corresponding p-value of the difference. While there are slight differences in the percent of females and white students by institution type, these differences are small in magnitude, and more importantly, they are not statistically significant. However, students at four-year institutions are significantly younger than those choosing to enroll in two-year colleges. Additionally, the percent of black and Hispanic students is smaller at four year colleges relative to two-year colleges, while a greater percentage of students identifying as multi- or other-race are enrolled in four-year institutions. Finally, students at four year colleges have significantly higher college admission exam scores, and higher high school GPAs.

It is important to note that about half of the students in two-year institutions do not have valid exam score data, as can be seen in the reduction the sample size from over 50,000 students, to only 26,000 being include in the exam score comparison. This is likely due to the fact that students attending two-year institutions may take the COMPASS or ACCUPLACER tests in lieu of the ACT or SAT. As was stated before, the predictive relationship between scores on the COMPASS/ACCUPLACER and later success outcomes in college is not as reliable as those scores on the ACT/SAT (Belfield & Crosta, 2012). Therefore, the results will be driven by students who have valid exam score data, and therefore chose to take the ACT or SAT, and are also more likely to be enrolled in a four-year institution. If these students have differential ability, relative to students who opted to take the COMPASS or ACCUPLACER test and enroll in a two-year college, then our results could be skewed.

It is clear that the composition of students attending four and two year institutions differ in terms of measured student academics. Therefore, it is appropriate to control for institution type, to account for any potential differences in the collegiate experiences of students who choose a four-year institution over a two-year institution, or vice versa.

Finally, Table 6 presents the pooled summary statistics for the college outcomes of interest. Over the study time period, 66 percent of students persist past the first year of college, and have an average college GPA of 2.64 after their first year. Approximately 25 percent of students graduate within four years.

Methodology

The purpose of this research is to produce a preliminary understanding of the relationship between reported student characteristics and later college success outcomes, and more specifically, how that relationship changes for students who experience different high school environments[35]. I use ordinary least squares (OLS), and linear probability model (LPM) estimation strategies to descriptively explore the relationship between the student characteristics of high school GPA and ACT score and college success outcomes, including persistence past the first year of college, college GPA after the first year, and the likelihood of graduating within four years. My first model estimates the relationship between measured student academics (high school GPA and ACT score) and college success outcomes, while controlling for student demographics, and college institution type. Specifically, I model the following relationship:

$$y_{ist} = \beta_0 + \beta_1 HSGPA_i + \beta_2 Exam_i + X_i\beta_3 + \delta_c + \gamma_t + \varepsilon_{ist} \quad (3.1)$$

[35] In this research setting, I can only observe students who select into, and enroll in college. This research setting cannot be extrapolated to students who have similar high school GPAs and college admission exam scores, who choose not to enroll in a postsecondary education institution.

where y_{ist} is the college success outcome (first-year GPA, final reported GPA, persistence, and likelihood of graduation within four years)[36] for student i, in school s, in year t. Additionally, $HSGPA_i$ takes the standardized value of the students' reported high school GPA by year, and $Exam_i$ is the corresponding standardized ACT score for that student, by year. Finally, X_i is a vector of student demographics including gender, and race, δ_c controls for postsecondary institution type, and takes the value 1 for four-year institutions, and 0 for two-year institutions, γ_t is a year fixed effect[37], representing the postsecondary cohort for each student, and ε_{ist} is the idiosyncratic error term, which is clustered at the high school level.

To address how the relationship between reported student characteristics and college outcomes vary as students experience different high school environments, I individually add measures of the high school environment into the regression, including school size, as measured by student enrollment, percent of students eligible for free and reduced priced lunch, and percent of minority students. Specifically, the regression becomes:

$$y_{ist} = \beta_0 + \beta_1 HSGPA_i + \beta_2 Exam_i + X_i\beta_3 + HSC_s\beta_4 + \delta_c + \gamma_t + \varepsilon_{ist} \qquad (3.2)$$

All variables take on the same meaning as before, and HSC_s represents the measure of the included high school characteristic, centered at the average for the sample across all years. Percent FRL is centered at approximately 55 percent, and minority students is centered at about 25 percent of students. I add each characteristic into the regression individually to determine the

[36] First-year GPA and final reported GPA are both standardized within year. The likelihood of persisting in college and graduating within four years are represented as binary variables taking on a value of 1 for persistence and graduation, respectively.

[37] I use postsecondary enrollment cohort as year fixed effects to account for any year specific shocks. I choose postsecondary cohort as my year fixed effects over high school graduation cohort because the majority of high school students graduating in the spring on one year, will matriculate to college in the fall of that same year. Therefore, the cohort of students will remain similar regardless of which measure I use. However, if there are students who delay entrance into college, it is likely that they are substantially different from there high school peers, than their later college peers. Finally, postsecondary cohort is most appropriate because I am focusing on first-time college freshmen.

specific impact each characteristic has on later college outcomes. Finally, I interact each high school characteristic measure with the reported student characteristics (high school GPA and ACT score), to explore the possibility of differential impacts across students:

$$y_{ist} = \beta_0 + \beta_1 HSGPA_i + \beta_2 Exam_i + X_i\beta_3 + HSC_s\beta_4 + (HSC_s * HSGPA_i)\beta_5 + (HSC_s * Exam_i)\beta_6 + \delta_c + \gamma_t + \varepsilon_{ist} \qquad (3.3)$$

Specifically, I seek to address whether schools with certain characteristics differentially influence the degree to which high school GPA or ACT score predicts college success outcomes. The additions are the interactions between included high school characteristics and students' high school GPA, and score on college admissions exam, respectively. In this way, I can identify differential trends for students with a similar resume, who experienced different high schools.

Results

The Relationship Between High School GPA and ACT Score on College Success

To begin, I explore the relationship between the student academic metrics of high school GPA and ACT score on the college success outcome measurement of the likelihood of persisting past the first year of college, GPA after one year, and the likelihood of graduating within four years, with and without student demographic controls. All models include year fixed effects and standard errors that account for nesting/clustering of students within high schools. Results are presented in Table 7. There is a positive relationship between high school GPA, and ACT score, and the likelihood of being successful in college, respectively. A one standard deviation increase in high school GPA is associated with a two percentage point increase in the likelihood of persisting past the first year of college. Additionally, students with high school GPAs that are one standard deviation above the mean generally earn first-year college GPAs that are 0.3 standard deviations above the mean, and are six percentage points more likely to graduate within four years compared to their counterparts. Results for models that control for student demographics are consistent with these findings, albeit slightly smaller in magnitude. Similarly, students who score one standard deviation higher on their college admissions exam are one percentage point more likely to persist past the first year of college, experience a 0.2 standard deviation increase in their first year college GPA, and are five percentage points more likely to graduate within four years. This analysis includes both four- and two-year institutions, and therefore students enrolled in two-year institutions have more of an opportunity to graduate "on-time" compared to students enrolled in four-year institutions. It is possible that estimated effects on graduation are larger as a result of including both institution types, therefore, graduation results should be interpreted with caution.

These results, which are consistent with the documented positive relationship between student high school academic measurements and college success (Belfield & Crosta, 2012; Cohn et al., 2004; Komarraju et al., 2012; Noble & Sawyer, 2004), provide a baseline from which I can begin to explore the impact that specific high school characteristics have on later college success, and specifically how the relationship between high school environment and student characteristics might differentially impact success in college. In the following sections, I include measures of high school characteristics to determine how high school environment shapes the predictive nature of student high school academics.

How High School FRL Moderates the Relationship Between High School GPA and ACT Score on College Success

Table 8 presents the results of high school GPA and college admission exam score on college success outcomes when the percent of students in the high school who are eligible for free and reduced-price lunch (FRL) is included into the regression. Odd numbered columns present the results with the inclusion of percent FRL, whereas even numbered columns present the results with the inclusion of percent FRL, as well as the interaction of percent FRL and the reported student academics from high school. The percent of FRL students is centered at the average of 56 percent in the state of Arkansas and scaled so that a one unit change in percent FRL is interpreted to be a 10 percent increase in the amount of FRL students at the high school. As was the case before, high school GPA and admission exam score are positively associated with the likelihood of persisting past the first year of college (two and one percentage point increase, respectively), college GPA at the end of their first year (0.3 and 0.2 standard deviation increases, respectively), and the likelihood of graduating within four years (five percentage point increase). All effect sizes are approximately the same as before the inclusion of percent FRL.

As FRL can be thought of as a proxy for socioeconomic status, a higher percent of students who are eligible for free or reduced price lunch can be thought of a greater level of disadvantage at the school level. Students who qualify for free and reduced-price lunch likely face a financial hardship at home, and higher rates of percent of FRL students at the high school indicate a larger share of the student population who are disadvantaged at an economic level. Students with average high school GPAs and admission exam scores that experience a high school with higher levels of FRL peers are 0.3 percentage points less likely to persist past the first year of college. Interestingly, however, these students are one percentage point more likely to graduate within four years. There is no change in college GPA after one year, as a result of including percent FRL.

Of particular interest to this study, is the differential relationship between high school characteristics and the consistency of the predictive power of high school GPA and admission exam score on college outcomes. I interact the percent of FRL students at the origin high school with the student academic characteristics used in college admissions to determine if there is a differential relationship of high school GPA or exam score on college outcomes, as it varies with the percent of FRL students at a high school. When including and interacting the percent of FRL students at the high school level with high school GPA and admission exam score, an interesting pattern emerges, as can be seen in Table 8. High school GPA and admission exam score are still positively associated with all college outcomes, however, the coefficient on the interaction of FRL and high school GPA trends zero to negative, while the interaction of FRL and exam score, trends positively.

When high school GPA is interacted with percent FRL, the expected likelihood of persistence past the first year of college decreases slightly, college GPA increases, and likelihood of graduation increases. Holding exam score fixed, a student with a high school GPA one standard deviation above the mean and additionally attending a high school with a higher FRL student population (66 percent) is 2.7 percentage points more likely to persist past the first year of college, earns a college GPA that is 0.251 standard deviations higher than the average, and is 4.9 percentage points more likely to graduate in four years. A student with a similar high school GPA one standard deviation above the average but attending a high school with the average FRL student population (55 percent) is 2.9 percentage points more likely to persist, have a college GPA 0.266 standard deviations higher than the average, and is 4.6 percentage points more likely to graduate. With the exception of graduation, students who attended a high school with a higher FRL student population generally see a reduction in the anticipated college gains, as predicted by high school GPA.

When we instead hold high school GPA constant at the average, we find that students with an exam score one standard deviation above the average, who additionally attended a high school with a higher FRL student population (66 percent) are 1.1 percentage points more likely to persist past the first year, earn college GPAs 0.217 standard deviations above the average, and are 6.4 percentage points more likely to graduate within four years. For a student with a similar exam score who attended a high school with the average FRL student population (55 percent), he/she is 1.3 percentage points more likely to persist, earn a GPA 0.189 standard deviations above the average, and is 5 percentage points more likely to graduate within four years. With the exception of persistence, students who attended a higher percent FRL high school, experience increase in college outcomes, predicted by exam score.

Overall, these results indicate that while higher high school GPAs and exam scores are always associated with improved college outcomes, these relationships vary with percent FRL from the origin high school. We see that overall, the percent FRL decreases the magnitude of the predicted college outcomes when interacted with high school GPA, but improves the predicted outcomes when interacted with exam score. It is possible then, that predictive power of high school GPAs may be relative to the socioeconomic status of the student population at the high school.

How High School Percent Minority Moderates the Relationship Between High School GPA and ACT Score on College Success

Table 9 presents the results of high school GPA and admission exam score on college success outcomes when the percent of minority students at the high school is added into the regression. Odd numbered columns present the results with the inclusion of percent minority, whereas even numbered columns present the results with the inclusion of percent minority, as well as the interaction of percent minority and the reported student academics from high school. The percent of minority students is centered at the average of approximately 25 percent in the state of Arkansas and scaled so that a one unit change in percent minority is interpreted to be a 10 percentage point increase in the amount minority students attend a high school.

Holding exam score fixed, students who have a high school GPA one standard deviation above the mean are about three percentage points more likely to persist past the first year of college, see increases in their college GPA after one year of about 0.3 standard deviations, and are over five percentage points more likely to graduate within four years. Additionally, holding high school GPA fixed, students who score one standard deviation above the mean on their college admission exam are about one percentage point more likely to persist past the first year of college, see increase in their college GPA of about 0.18 standard deviations, and are about five percentage points more likely to graduate within four years. These estimates are fairly consistent with the models including the percent of FRL students, as these variables are positively correlated[38], as well as those without any high school characteristics included. Finally, increasing the percent of minority students at the high school by 10 percentage points is associated with a less than a one percentage point increase in the likelihood of persisting, no change in college GPA at the end of the first year, and a less than a one percentage point decrease in the likelihood of the student graduating within four years.

As was the case with percent of FRL students at the high school, when interacting student characteristics with percent of minority students, the predicted gains associated with high school GPA on college outcomes decrease in magnitude, while the predicted improvements to college outcomes based on exam score are slightly increased. Specifically holding exam score fixed, a student attending a high school with the state average of 25 percent of the student population identifying as minority, a one standard deviation increase in high school GPA is associated with

[38] Correlation coefficient by year ranges from approximately 0.43 to 0.64.

a three percentage point increase in the likelihood of persisting past the first year of college, a 0.32 standard deviation increase in college GPA after one year, and a six percentage point increase in the likelihood of graduating within four years. However, when a student with the same GPA attended a high school where 35 percent of the student population was minority, those improvements to college outcomes all decrease slightly. Conversely, holding GPA fixed, students attending a high school with the average percent of minority students, but experience a one standard deviation increase in their college admission exam score are one percentage point more likely to persist, earn college GPAs that are 0.17 standard deviations higher, and are over four percentage points more likely to graduate within four years. When that same higher achieving student, as measured by exam score, comes from a high school with an higher minority student population, he/she experience small increases in the already positive college outcomes. While all changes are relatively small in magnitude, I detect a similar pattern compared to what happens to the predictive nature of student characteristics when interacted with percent of FRL students, as these variables are positively correlated. Specifically, high school GPA effects generally become slightly smaller in magnitude, while college admission exam effects become slightly larger.

If FRL and/or percent minority is thought of as a measure of disadvantage, then perhaps high schools with larger disadvantaged student populations assign grades, and therefore high school GPAs less consistently than more affluent high schools. This implies that GPAs coming out of disadvantaged high schools may be slightly less reliable than those coming out of advantaged schools. In contrast, higher percentages of FRL or minority students at the high school interacted with student college admission exam score, increased the likelihood of some positive college outcomes indicating that perhaps students with higher exam scores, who also originate from disadvantaged high schools have overcome their disadvantage, and are more likely to be successful, relative to their high school peers who attended a more advantaged high school.

How High School Size Moderates the Relationship Between High School GPA and ACT Score on College Success

Table 10 presents the results of high school GPA and college admission exam score on college success outcomes when high school enrollment is included into the regression. Odd numbered columns present the results with the inclusion of enrollment, whereas even numbered columns present the results with the inclusion of high school enrollment, as well as the interaction of high school enrollment and the reported student academics from high school. As was the case before, high school GPA and admission exam score are of the same magnitude, and positively associated with the likelihood of persisting past the first year of college, college GPA at the end of the first year, and the likelihood of graduating within four years. Additionally, the impact of enrollment, while significant, is small in magnitude. Increasing enrollment by 100 students is associated with a 0.1 percentage point increase in the likelihood of persisting past the first year, a 0.003 standard deviation decrease in college GPA at the end of the first year, and a 0.3 percentage point decrease in the likelihood of graduating within four years.

Unlike with high school percent FRL, and percent minority, there is no clear or differential pattern that emerges. The interaction of enrollment and GPA or exam score is extremely small in magnitude, and generally negative, and not significant. Therefore, there is little evidence that school size differentially impacts the predictive nature of high school GPA and exam score on student college outcomes. This is not entirely surprising given school size is variable across the state, with some smaller schools being in rural areas, with other smaller schools belonging to the school choice system, and its smaller nature could be a positive attribute that entices selection into that high school.

Conclusion

Overall, the results suggest that certain high school characteristics differentially influence the predictive nature of high school GPA and ACT score on college success measures. I find that students who earn higher high school GPAs and college admission exam scores are more likely to persist past their first year of college, earn higher college GPAs and are generally more likely to graduate within four years. When I interact the student academic characteristics of high school GPA and score on college admissions exams with specific high school measures, I find differential relationships. Generally, when high school GPA is interacted with percent of FRL or minority students at the high school, the resulting effect on the successful college outcomes is of a smaller magnitude compared to high school GPA alone. Specifically, two students, both with a high school GPA one standard deviation above the mean, have different expected college outcomes depending on the high school environment they came from, as increasing the percent of FRL or minority students by 10 percentage points above the average results in college outcome gains that are smaller compared to the expected gains for the student who attended a high school with the state average percent FRL or minority students.

In contrast, when student score on college admissions exams is interacted with the percent of FRL or minority students at the high school, the expected gains generally get larger. Two students with college admission exam scores one standard deviation above the mean, are expected to see different likelihoods of persistence and graduation, and differential increases to their college GPA at the end of the first year. Specifically, a student with an exam score one standard deviation above the mean, who attended a high school with an FRL or minority population 10 percent above the average for the state is expected to have larger gains in college outcomes, compared to a similarly scoring student who attended high school with FRL or minority populations at the state average. There is no clear differential relationship when including and interacting school size with student high school academics.

These results suggest that students who experience different high school environments prior to enrolling in postsecondary education may expect different outcomes based on high school compositional factors such as percent FRL and percent minority of students at the high school. Specifically, as the composition of students at the origin high school is more disadvantaged, students with academic metrics of high school GPA one standard deviation above the mean might be expected to have smaller gains than students who attended a more advantaged high school. In contrast, when the disadvantaged composition of students at the origin high school is higher, students scoring one standard deviation above the mean on their college admission exam experience greater gains in college success outcomes, relative to students who attended a more advantaged school. These results suggest that perhaps disadvantaged high schools award grades, and therefore high school GPAs more generously, or have lower standards for what constitutes each grade, than advantaged high schools. Therefore, the high school GPA may be a less reliable predictor of college success when coming from a disadvantaged school. By contrast, college admission exam score is likely capturing raw academic talent, since students scoring above the mean on their ACT/SAT, who come from a disadvantaged high school fare better than their more advantaged peers with similar scores.

Equipped with this information, colleges might better be able to identify students who may need additional supports in order to experience the same expected academic successes as their fellow students, as measured by similar high school GPAs and college admission exam scores. In this way, colleges might be able to help and encourage students through to the end of their terminal degree, and the percent of students completing college might begin to approach the percent of students who enroll.

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Tables

Table 1: *Summary Statistics for Arkansas High Schools, Overall*

Variable	Observations	Mean	Std. Dev.	Min	Max
Enrollment	3,558	488.91	451.82	21	4,512
FRL (%)	3,557	0.56	0.17	0	1
Minority (%)	3,558	0.25	0.27	0	1

Notes: Pooled summary statistics for high schools in Arkansas from academic years 2005-2006 through 2016-2017. There are 250-305 high schools depending on the academic year. High school characteristics do not vary greatly by year, as can be seen in subsequent tables.

Table 2: *Summary Statistics for Arkansas High Schools, by Year*

Variable	Observations	Mean	Std. Dev.	Min	Max
2005					
Enrollment	305	432.06	379.70	37	2,707
FRL (%)	305	0.50	0.19	0.11	1
Minority (%)	305	0.23	0.28	0	1
2006					
Enrollment	293	463.87	387.16	40	2,422
FRL (%)	293	0.50	0.17	0	0.96
Minority (%)	293	0.22	0.26	0	1
2007					
Enrollment	282	482.72	404.14	41	2,933
FRL (%)	282	0.52	0.18	0.14	1
Minority (%)	282	0.22	0.25	0	0.97
2008					
Enrollment	279	478.38	409.00	43	3,135
FRL (%)	279	0.53	0.19	0.14	1
Minority (%)	279	0.23	0.26	0	0.97
2009					
Enrollment	278	474.92	422.21	40	3,187
FRL (%)	278	0.55	0.19	0.13	1
Minority (%)	278	0.24	0.27	0	0.98
2010					
Enrollment	276	477.54	430.56	21	3,333
FRL (%)	276	0.57	0.18	0.17	1
Minority (%)	276	0.26	0.27	0	1
2011					
Enrollment	272	487.11	442.76	36	3,495
FRL (%)	272	0.57	0.15	0.21	0.94
Minority (%)	272	0.26	0.27	0	1

Table 2 (Cont.): *Summary Statistics for Arkansas High Schools, by Year*

Variable	Observations	Mean	St. Dev.	Min	Max
2012					
Enrollment	269	491.92	447.54	51	3,589
FRL (%)	269	0.58	0.15	0.2	0.95
Minority (%)	269	0.26	0.27	0	1
2013					
Enrollment	269	505.39	488.52	33	3,900
FRL (%)	269	0.57	0.17	0	0.95
Minority (%)	269	0.27	0.27	0	0.99
2014					
Enrollment	268	510.57	500.27	38	4,144
FRL (%)	268	0.59	0.15	0.22	0.95
Minority (%)	268	0.27	0.27	0	1
2015					
Enrollment	258	517.12	507.39	56	4,358
FRL (%)	257	0.59	0.15	0.19	0.97
Minority (%)	258	0.27	0.27	0.01	0.98
2016					
Enrollment	259	524.62	534.05	58	4,512
FRL (%)	259	0.60	0.15	0.19	0.97
Minority (%)	259	0.28	0.27	0	0.98
2017					
Enrollment	250	526.06	515.09	65	3,511
FRL (%)	250	0.60	0.16	0.19	1
Minority (%)	250	0.28	0.27	0.01	0.98

Notes: Summary statistics for Arkansas high schools by year, pooled by region.

Table 3: *Summary Statistics for Arkansas High Schools, By Region*

Variable	Observations	Mean	Std. Dev.	Min	Max
Northwest					
Enrollment	1,076	521.73	577.06	40	4,512
FRL (%)	1,076	0.54	0.16	0.11	1
Minority (%)	1,076	0.14	0.15	0	0.77
Northeast					
Enrollment	928	416.86	260.31	50	1,441
FRL (%)	928	0.58	0.16	0	1
Minority (%)	928	0.17	0.25	0	0.98
Central					
Enrollment	617	736.84	566.53	21	2,793
FRL (%)	616	0.49	0.18	0	1
Minority (%)	617	0.36	0.31	0	1
Southwest					
Enrollment	613	351.13	253.94	37	1,402
FRL (%)	613	0.59	0.15	0	1
Minority (%)	613	0.33	0.23	0.01	0.93
Southeast					
Enrollment	324	374.80	161.38	56	850
FRL (%)	324	0.68	0.19	0.25	1
Minority (%)	324	0.53	0.28	0.01	1

Notes: Pooled summary statistics for high schools in Arkansas from academic years 2005-2006 through 2016-2017, by geographic region. There are 250-305 total high schools depending on the academic year, with more high schools in the northern region, and fewer high schools in the southern regions. High school characteristics do not vary greatly by year, as can be seen in subsequent tables.

Table 4: *Summary Statistics of In-State Students Enrolled in Arkansas Postsecondary Institutions, All Institutions*

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Female	0.56	0.56	0.56	0.56	0.54	0.55	0.55	0.56	0.56	0.55	0.56	0.55
	(0.48)	(0.50)	(0.50)	(0.45)	(0.50)	(0.50)	(0.50)	(0.5)	(0.50)	(0.50)	(0.50)	(0.50)
Age	19.13	18.98	19.26	19.03	19.58	19.48	19.38	19.21	19.13	18.71	18.58	18.47
	(4.40)	(4.20)	(4.96)	(4.44)	(5.42)	(5.14)	(4.96)	(4.79)	(4.76)	(3.71)	(3.39)	(3.09)
White	0.68	0.68	0.67	0.66	0.68	0.67	0.66	0.67	0.65	0.67	0.66	0.68
	(0.47)	(0.47)	(0.47)	(0.48)	(0.47)	(0.47)	(0.48)	(0.47)	(0.48)	(0.47)	(0.47)	(0.47)
Black	0.18	0.16	0.17	0.17	0.17	0.17	0.17	0.19	0.18	0.18	0.17	0.16
	(0.38)	(0.37)	(0.37)	(0.37)	(0.37)	(0.37)	(0.38)	(0.40)	(0.39)	(0.38)	(0.38)	(0.37)
Hispanic	0.02	0.02	0.02	0.03	0.03	0.04	0.05	0.05	0.06	0.06	0.06	0.07
	(0.13)	(0.15)	(0.15)	(0.16)	(0.17)	(0.19)	(0.21)	(0.21)	(0.23)	(0.23)	(0.24)	(0.25)
Other Race	0.12	0.13	0.142	0.153	0.13	0.13	0.13	0.09	0.11	0.10	0.11	0.09
	(0.33)	(0.34)	(0.35)	(0.36)	(0.33)	(0.33)	(0.33)	(0.29)	(0.31)	(0.29)	(0.31)	(0.29)
Exam Score	21.72	21.96	21.87	22.03	21.91	21.94	21.99	21.97	22.04	22.33	22.33	22.49
	(4.60)	(4.61)	(4.61)	(4.61)	(4.67)	(4.53)	(4.54)	(4.53)	(4.46)	(4.56)	(4.56)	(4.60)
HS GPA	3.05	2.99	3.07	3.09	3.01	3.01	2.92	2.98	3.12	3.17	3.19	3.13
	(0.74)	(0.89)	(0.66)	(0.66)	(0.71)	(0.71)	(0.92)	(0.90)	(0.64)	(0.64)	(0.63)	(0.85)
Obs.	12,545	13,250	13,775	14,349	15,511	16,441	16,663	16,788	16,520	16,143	16,197	15,488

Notes: Summary statistics for students enrolled in postsecondary institutions in Arkansas by year. Sample of students is limited to those who are considered "in-state," as they are the ones who will be included in the analytic sample. Female takes the value of 1 if student is a female, and 0 for male. Age is measured at time of enrollment. Exam score includes ACT scores, and concordant SAT scores (i.e. scaled to the ACT 1-36 scale).

Table 5: *Descriptive Statistics of In-State Students Enrolled in Arkansas Postsecondary Institutions, Difference Between Four and Two Year with Year Fixed Effects*

	Four-Year		Two-Year		Four versus Two Year	
	N (1)	Average (2)	N (3)	Average (4)	Adjusted Difference (5)	p-value (6)
Female	133,279	0.548	50,391	0.550	-0.001	0.634
Age	133,278	17.777	50,388	18.535	-0.758	0.000
White	133,279	0.692	50,391	0.690	0.002	0.449
Black	133,279	0.160	50,391	0.171	-0.012	0.000
Hispanic	133,279	0.015	50,391	0.027	-0.012	0.000
Other Race	133,279	0.134	50,391	0.112	0.022	0.000
Exam Score	124,709	22.290	26,678	18.823	3.467	0.000
HS GPA	130,540	3.252	44,282	2.631	0.621	0.000

Notes: Pooled results from regressing descriptive characteristics on type of institution to identify any statistically significant differences between the composition of students at four year and two year institutions, includes year fixed effects.

Table 6: *Summary Statistics for College Outcome Variables, Pooled Across Years*

Variable	Observations	Mean	Std. Dev.	Min	Max
Persist 1 Year	199,538	0.66	0.47	0	1
Year 1 GPA	159,679	2.64	0.95	0	4
Graduate in Four	170,123	0.25	0.43	0	1

Notes: Presented summary statistics are pooled across all years in the study. These statistics are consistent with other Arkansas retention and graduation reports. See (https://static.ark.org/eeuploads/adhe/publications/Retention_Graduation_Rate_2015.pdf).

Table 7: *Impacts of Student High School Academics on College Outcomes*

	Persist 1 Year (1)	Persist 1 Year (2)	First Year GPA (3)	First Year GPA (4)	Graduate in 4 (5)	Graduate in 4 (6)
HS GPA	0.024***	0.023***	0.287***	0.274***	0.066***	0.055***
	(0.002)	(0.002)	(0.021)	(0.021)	(0.006)	(0.006)
Exam	0.009***	0.011***	0.174***	0.185***	0.051***	0.048***
	(0.001)	(0.002)	(0.009)	(0.009)	(0.005)	(0.005)
Four Year	0.115***	0.113***	-0.074***	-0.074***	-0.260***	-0.246***
	(0.006)	(0.006)	(0.018)	(0.017)	(0.010)	(0.011)
Female		0.005**		0.099***		0.063***
		(0.002)		(0.007)		(0.006)
Black		0.016***		0.008		-0.101***
		(0.004)		(0.018)		(0.011)
Hispanic		0.012**		0.008		-0.028**
		(0.005)		(0.019)		(0.012)
Other Race		0.010**		0.018		-0.030**
		(0.004)		(0.018)		(0.015)
Multi Race		-0.007		-0.018		0.012
		(0.005)		(0.020)		(0.015)
Constant	0.828***	0.824***	0.306***	0.250***	0.635***	0.605***
	(0.007)	(0.007)	(0.018)	(0.017)	(0.010)	(0.009)
Observations	49,884	49,884	48,948	48,948	43,812	43,812
R-squared	0.086	0.087	0.282	0.288	0.155	0.162

Robust standard errors in parentheses

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

Notes: Sample of students limited to “in-state” students. Standard errors clustered at the high school level. High school GPA is standardized to have a mean of 0, and standard deviation of 1 by high school graduation year. Exam includes ACT scores, as well as concordant SAT score. Exam is also standardized to have a mean of 0 and a standard deviation of 1, by high school graduation year. First year college GPA is standardized to have a mean of 0 and a standard deviation of 1, by enrollment cohort.

Table 8: *Impacts of Student High School Academics and Average High School Percent FRL on College Outcomes*

	Persist 1 Year	Persist 1 Year	First Year GPA	First Year GPA	Graduate in 4	Graduate in 4
	(1)	(2)	(3)	(4)	(5)	(6)
HS GPA	0.027***	0.029***	0.291***	0.266***	0.053***	0.046***
	(0.003)	(0.003)	(0.022)	(0.021)	(0.006)	(0.006)
Exam	0.010***	0.013***	0.181***	0.189***	0.050***	0.050***
	(0.002)	(0.002)	(0.009)	(0.010)	(0.005)	(0.005)
FRL (%)	-0.003***	-0.004***	0.005	0.017**	0.009***	0.013***
	(0.001)	(0.001)	(0.004)	(0.008)	(0.003)	(0.004)
FRL*HS GPA		0.002		-0.032***		-0.010***
		(0.001)		(0.011)		(0.004)
FRL*Exam		0.002**		0.011**		0.001
		(0.001)		(0.005)		(0.003)
Four Year	0.112***	0.112***	-0.073***	-0.072***	-0.241***	-0.240***
	(0.007)	(0.007)	(0.019)	(0.019)	(0.011)	(0.011)
Female	0.003	0.003	0.089***	0.087***	0.055***	0.055***
	(0.002)	(0.002)	(0.008)	(0.008)	(0.006)	(0.006)
Black	0.024***	0.027***	0.004	-0.001	-0.117***	-0.121***
	(0.005)	(0.005)	(0.020)	(0.020)	(0.012)	(0.011)
Hispanic	0.014***	0.015***	-0.002	0.000	-0.036***	-0.036***
	(0.005)	(0.005)	(0.021)	(0.021)	(0.013)	(0.013)
Other Race	0.011**	0.011**	0.007	0.007	-0.032*	-0.032*
	(0.005)	(0.005)	(0.020)	(0.020)	(0.017)	(0.016)
Multi Race	-0.006	-0.007	-0.016	-0.016	0.009	0.009
	(0.006)	(0.006)	(0.021)	(0.022)	(0.018)	(0.017)
Constant	0.816***	0.816***	0.250***	0.262***	0.622***	0.624***
	(0.008)	(0.007)	(0.019)	(0.020)	(0.011)	(0.012)
Observations	41,891	41,891	41,065	41,065	36,739	36,739
R-squared	0.088	0.089	0.294	0.297	0.162	0.163

Robust standard errors in parentheses

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

Notes: Sample of students limited to "in-state" students. Standard errors clustered at the high school level. High school GPA is standardized to have a mean of 0, and standard deviation of 1 by high school graduation year. Exam includes ACT scores, as well as concordant SAT score. Exam is also standardized to have a mean of 0 and a standard deviation of 1, by high school graduation year. First year college GPA is standardized to have a mean of 0 and a standard deviation of 1, by enrollment cohort.

Table 9: *Impacts of Student High School Academics and Average High School Percent Minority on College Outcomes*

	Persist 1 Year (1)	Persist 1 Year (2)	First Year GPA (3)	First Year GPA (4)	Graduate in 4 (5)	Graduate in 4 (6)
HS GPA	0.027***	0.029***	0.292***	0.320***	0.055***	0.061***
	(0.003)	(0.003)	(0.023)	(0.023)	(0.007)	(0.007)
Exam	0.011***	0.010***	0.179***	0.169***	0.047***	0.044***
	(0.002)	(0.002)	(0.010)	(0.010)	(0.006)	(0.005)
Minority (%)	0.001*	0.002**	0.000	0.010***	-0.007***	-0.005**
	(0.001)	(0.001)	(0.003)	(0.004)	(0.002)	(0.002)
Minority*HS GPA		-0.003***		-0.028***		-0.006***
		(0.001)		(0.005)		(0.002)
Minority*Exam		0.001**		0.004		0.004**
HS GPA		(0.001)		(0.003)		(0.002)
Four Year	0.113***	0.112***	-0.075***	-0.083***	-0.241***	-0.242***
	(0.007)	(0.007)	(0.019)	(0.018)	(0.011)	(0.012)
Female	0.004	0.003	0.089***	0.083***	0.054***	0.053***
	(0.002)	(0.002)	(0.008)	(0.008)	(0.006)	(0.006)
Black	0.015***	0.015***	0.011	-0.017	-0.075***	-0.073***
	(0.005)	(0.005)	(0.020)	(0.017)	(0.013)	(0.013)
Hispanic	0.012**	0.012**	-0.001	-0.001	-0.024*	-0.023*
	(0.005)	(0.005)	(0.020)	(0.019)	(0.012)	(0.013)
Other Race	0.010**	0.010**	0.006	0.008	-0.028*	-0.028**
	(0.005)	(0.005)	(0.020)	(0.021)	(0.015)	(0.014)
Multi Race	-0.007	-0.007	-0.015	-0.020	0.012	0.012
	(0.006)	(0.006)	(0.022)	(0.023)	(0.016)	(0.015)
Constant	0.821***	0.821***	0.241***	0.240***	0.602***	0.602***
	(0.008)	(0.008)	(0.018)	(0.018)	(0.011)	(0.011)
Observations	41,891	41,891	41,065	41,065	36,739	36,739
R-squared	0.088	0.089	0.294	0.302	0.162	0.163

Robust standard errors in parentheses

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

Notes: Sample of students limited to "in-state" students. Standard errors clustered at the high school level. High school GPA is standardized to have a mean of 0, and standard deviation of 1 by high school graduation year. Exam includes ACT scores, as well as concordant SAT score. Exam is also standardized to have a mean of 0 and a standard deviation of 1, by high school graduation year. First year college GPA is standardized to have a mean of 0 and a standard deviation of 1, by enrollment cohort.

Table 10: *Impacts of Student High School Academics and High School Enrollment on College Outcomes*

	Persist 1 Year	Persist 1 Year	First Year GPA	First Year GPA	Graduate in 4	Graduate in 4
	(1)	(2)	(3)	(4)	(5)	(6)
HS GPA	0.028***	0.043***	0.288***	0.299***	0.051***	0.055***
	(0.003)	(0.004)	(0.022)	(0.030)	(0.007)	(0.010)
Exam	0.009***	0.015***	0.184***	0.198***	0.053***	0.046***
	(0.002)	(0.003)	(0.009)	(0.013)	(0.006)	(0.009)
Enrollment	0.001***	0.002***	-0.003**	-0.001	-0.003***	-0.003***
	(0.000)	(0.000)	(0.001)	(0.002)	(0.001)	(0.001)
Enroll*HSGPA		-0.001***		-0.001		-0.000
		(0.000)		(0.004)		(0.001)
Enroll*Exam		-0.001***		-0.001		0.001
		(0.000)		(0.001)		(0.001)
Four Year	0.112***	0.110***	-0.071***	-0.074***	-0.239***	-0.238***
	(0.007)	(0.007)	(0.019)	(0.019)	(0.011)	(0.010)
Female	0.003	0.003	0.089***	0.088***	0.055***	0.056***
	(0.002)	(0.002)	(0.008)	(0.007)	(0.006)	(0.006)
Black	0.019***	0.019***	0.014	0.015	-0.100***	-0.100***
	(0.004)	(0.004)	(0.022)	(0.021)	(0.013)	(0.013)
Hispanic	0.010**	0.009*	0.009	0.006	-0.023*	-0.022*
	(0.005)	(0.005)	(0.021)	(0.021)	(0.013)	(0.012)
Other Race	0.008*	0.009**	0.014	0.015	-0.024	-0.024
	(0.005)	(0.005)	(0.020)	(0.020)	(0.016)	(0.016)
Multi Race	-0.005	-0.007	-0.020	-0.022	0.005	0.005
	(0.006)	(0.006)	(0.022)	(0.022)	(0.016)	(0.016)
Constant	0.813***	0.807***	0.259***	0.252***	0.630***	0.630***
	(0.008)	(0.008)	(0.019)	(0.024)	(0.013)	(0.013)
Observations	41,891	41,891	41,065	41,065	36,739	36,739
R-squared	0.089	0.092	0.295	0.295	0.163	0.163

Robust standard errors in parentheses

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

Notes: Sample of students limited to "in-state" students. Standard errors clustered at the high school level. High school GPA is standardized to have a mean of 0, and standard deviation of 1 by high school graduation year. Exam includes ACT scores, as well as concordant SAT score. Exam is also standardized to have a mean of 0 and a standard deviation of 1, by high school graduation year. First year college GPA is standardized to have a mean of 0 and a standard deviation of 1, by enrollment cohort.

Conclusion

Postsecondary education is a very real pathway for many Americans. Students in a K-12 setting are increasingly taking Advanced Placement courses, presumably with the hopes of passing the annual exam and earning college credit, while still enrolled in high school (College Board, 2018). Additionally, high school students are increasingly enrolling in concurrent coursework with a local college, earning both high school and college credit at the same time, with the same course (Chatlani, 2018; National Center for Education Statistics, 2019). In a given year, approximately 70 percent of high school graduates enroll in some form of postsecondary education later that same year (U.S. Bureau of Labor Statistics, 2017). However, while postsecondary education enrollment has been steadily increasing over the last two decades (National Center for Education Statistics, 2019), attainment figures have not. There are a fair number of students who enroll in, and subsequently exit their collegiate career before earning their terminal degree. The six year graduation rate at American public four year institutions is 60 percent, meaning only 60 percent of students who enrolled in some form of university earn their terminal degree within 150 percent of the time allocated for that degree (National Center for Education Statistics, 2019).

This gap in postsecondary education enrollment and attainment is potentially problematic, as the later life outcome benefits associated with college such as increased lifetime earnings, improved health, and lower likelihood of divorce (Chetty et al., 2017; Lawrence, 2017; Oreopoulos & Petronijevic, 2013; Wang, 2015), may not apply to students who do not complete college. For some students, choosing to exiting the university education system after they have invested in their education is likely an appropriate choice, however; for many, dropping out of college without their terminal degree saddles them with the debt they incurred while in college, compounded by forgone wages for the time they were in school, and no guarantee that their career salary will make up the loss. While on average college is still considered to be "worth the investment" (Abel & Deitz, 2014), this may not be true for students who do not complete college.

When thinking about these established differences in enrollment and attainment, it is important to consider the factors that could influence student decisions to enroll, persist, and then earn their degree. Factors such as the cost of college, and the signals students receive about how they would fare in an academic setting, are some of the ways they may be swayed to enroll, and subsequently attain their degree. In this dissertation, I examined a change in an Arkansas merit-based financial aid program, and the impacts it had on student enrollment and attainment in Arkansas colleges. I then explored the relationship between the traditional student academic metrics, of high school GPA and ACT/SAT score, used in college admission decisions, and scholarship awards to determine if the degree to which they predict college success changes depending on the type of high school environment the student faced.

Chapter 1 of this dissertation examined the Arkansas Academic Challenge Scholarship (ACS) program that was introduced in the 1990s, and expanded in 2010 as a result of a state-wide lottery approval. Students meeting the ACS academic, residential, and application requirements were awarded a generous scholarship amount, paid in equal installments over their four year college experience, covering over 90 percent of average annual tuition at the state's flagship university.[39] However, in 2013, the ACS award amount was reduced, and the payout installments were modified to a backloaded system, meaning students were awarded a smaller

[39] Based on average tuition amounts for the ten public universities in the state of Arkansas as reported for the 2010- 11 school year. For comparison: the published tuition for the Arkansas flagship university, the University of Arkansas-Fayetteville, 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/).

amount upon enrollment in their freshmen year, and progressively larger amounts as they progressed through college. We estimate the impact of the change to Arkansas's scholarship program using a difference-in-differences design applied to state-level panel data on college enrollment in Southern states, available through the Integrated Postsecondary Education Data System (IPEDS). Simply, we estimated the effect of the payout change in Arkansas by comparing trends in college enrollment in Arkansas to similar southern states before and after the switch to the backloaded structure. In general, our results indicate no statistically significant impact on overall college enrollment or enrollment in public four-year institutions in Arkansas. However, while our results are not significant, they tend to be negative, suggesting that substantial changes to a financial aid payout structure may have adverse effects on college enrollments.

The second chapter of this dissertation further examined how the change in the ACS payout structure influences students postsecondary experience. We took advantage of the ACS academic requirements to incorporate a regression discontinuity element to our difference-in-differences empirical approach. Using student-level administrative data for all first-time, full-time enrollees in public four year institutions between 2010 and 2015, we utilized a difference-in-discontinuities approach to identify the causal effects of qualifying for the ACS as well as the impacts of the shift in payout structure in 2013 to compare student postsecondary attainment outcomes. In effect, we estimated the RD estimate of qualifying for the ACS compared to not qualifying for the ACS in each time period, and then differenced those estimates, to determine the impact of the payout structure change. Overall, our findings indicate no evidence of changes in ACS qualified students' postsecondary outcomes measured by persistence, GPA and likelihood of graduating within four years following the 2013 payout change compared to students receiving the scholarship under the initial regime of equal installments prior to 2013.

Finally, as high school GPA and student score on college admissions tests are used to determine many scholarship awards, such as the ACS, as well as being used as primary metrics in college admission decisions, the third chapter of this dissertation examined the predictive power of these two student academic metrics in Arkansas, and specifically, how the magnitude of the effect changes when students experienced different high school environments. Specifically, I explored how the inclusion and interaction of the percent of students at the origin high school that are free and reduced price (FRL) eligible, the percent of minority students, and school size differentially impact the degree to which high school GPA and college admissions exam score predict persistence past the first year of college, college GPA at the end of the first year, and the likelihood of graduating within four years. Overall, I found that high school GPA and admissions exam score are always positively associated with college success outcomes. However, when the percent of FRL students at the high school is included and subsequently interacted with the student academic regressors, I found that the expected increases in college success differ. Specifically, the expected gains associated with increasing high school GPA are diminished slightly, while the expected gains associated with increasing college admission exam score increase. Overall, this pattern remains the same when percent minority is included and interacted with student academic regressors. However, there is no discernible pattern when high school enrollment is included. While descriptive, this suggests that students with similar academic ability who experienced different high school environments could expect to fare differently in college. Equipped with this information, colleges might better be able to identify students who could require additional support to achieve the anticipated success, and possibly increase the likelihood of college attainment.

Taken together, the results of this dissertation suggest that postsecondary enrollment, persistence, and completion decisions are complex. While financial aid seeks to reduce a tangible barrier to access and success in college, chapters 1 and 2 of this dissertation suggest that perhaps money is not the driving force behind student postsecondary decisions. While the initial offer of merit-based aid increased enrollment, the subsequent reduction in the total aid amount, and switch to backloaded payout structure did not significantly impact enrollment, or college success outcomes, suggesting that other factors may eclipse finances in college. However, it is important to keep in mind, that chapter 2 was limited to students scoring less than a 19 on the ACT and varied in their ability to qualify for the ACS using their high school GPA. Therefore, it is possible that the results of this analysis would not generalize to higher achieving students. Alternatively, higher achieving students could also be the individuals who have additional sources of merit-based financial aid. Therefore a slight reduction in initial award amount, or progressive increases in later years may not be enough to influence their decisions, as these students have likely already made the decision to enroll in, or persist through college.

Chapter 3 of this dissertation provides evidence both of the predictive roles that high school GPA and college admission exam score have on college outcomes, as well as how these relationships vary across high schools in Arkansas. Specifically, it appears that high school GPA is less predictive of college success outcomes, while exam score is more predictive, when the student attended a more disadvantaged high school, as measured by percent FRL students, or percent minority students. As high school GPA and college admission exam scores are used in college admission decisions, as well as decisions to award financial aid to students, this association implies that perhaps a greater emphasis on exam score is appropriate when attempting to predict which students will be most successful. This relationship can also be used to identify promising students, who may need additional supports to make it to and through their postsecondary education career. Generally, college administrators making admission and award decisions should be aware of these varying relationships, and should account for high school characteristics when making these decisions.

This shift is already occurring in Arkansas. As of the 2016-17 school year, the Academic Challenge Scholarship dropped high school GPA from the required academic qualifications.[40] Additionally, policymakers made yet another change to the ACS award payout structure, further backloading the award disbursement by providing $1,000 for year one, $4,000 during years two and three, and $5,000 for the final year of college. Furthermore, ACS award disbursement for two-year colleges is also backloaded as of the 2016-17 school year,[41] awarding students $1,000 for the first year, and $3,000 during the second year. In some regards, these changes are in line with the results presented in this dissertation. Nevertheless, given the complex nature of student behaviors as it relates to postsecondary education decisions, additional research will be required to determine the long run effects of these additional policy changes.

[40] Arkansas Academic Challenge Scholarship Program, see (https://scholarships.adhe.edu/scholarships/detail/academic-challenge-scholarships).
[41] See Academic Challenge Award Amounts (https://scholarships.adhe.edu/scholarships/detail/academic-challenge-scholarships).

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Institutional Review Board Approval

IRB Approval: Chapter 2

To:	Jonathan Norman Mills GRAD 212
From:	Douglas James Adams, Chair IRB Committee
Date:	07/11/2019
Action:	**Expedited Approval**
Action Date:	07/08/2019
Protocol #:	1708009418R002
Study Title:	Impact of the Expansion of the Arkansas Academic Challenge Scholarship and its Later Change in Award Schedule on First-Time Freshman Enrollments and College Outcomes
Expiration Date:	07/13/2020
Last Approval Date:	07/14/2019

The above-referenced protocol has been approved following expedited review by the IRB Committee that oversees research with human subjects.

If the research involves collaboration with another institution then the research cannot commence until the Committee receives written notification of approval from the collaborating institution's IRB.

It is the Principal Investigator's responsibility to obtain review and continued approval before the expiration date.

Protocols are approved for a maximum period of one year. You may not continue any research activity beyond the expiration date without Committee approval. Please submit continuation requests early enough to allow sufficient time for review. Failure to receive approval for continuation before the expiration date will result in the automatic suspension of the approval of this protocol. Information collected following suspension is unapproved research and cannot be reported or published as research data. If you do not wish continued approval, please notify the Committee of the study closure.

Adverse Events: Any serious or unexpected adverse event must be reported to the IRB Committee within 48 hours. All other adverse events should be reported within 10 working days.

Amendments: If you wish to change any aspect of this study, such as the procedures, the consent forms, study personnel, or number of participants, please submit an amendment to the IRB. All changes must be approved by the IRB Committee before they can be initiated.

You must maintain a research file for at least 3 years after completion of the study. This file should include all correspondence with the IRB Committee, original signed consent forms, and study data.

cc: Katherine M Kopotic, Investigator
Gary Ritter, Investigator

Page 1 of 1

IRB Approval: Chapter 3

To:	Jonathan Norman Mills GRAD 212
From:	Douglas James Adams, Chair IRB Committee
Date:	02/11/2020
Action:	**Expedited Approval**
Action Date:	02/11/2020
Protocol #:	2001241296
Study Title:	An Evaluation of the Relative Predictive Power of Student Academics, by High School Type
Expiration Date:	01/25/2021
Last Approval Date:	

The above-referenced protocol has been approved following expedited review by the IRB Committee that oversees research with human subjects.

If the research involves collaboration with another institution then the research cannot commence until the Committee receives written notification of approval from the collaborating institution's IRB.

It is the Principal Investigator's responsibility to obtain review and continued approval before the expiration date.

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cc: Katherine M Kopotic, Investigator