HOPE for Community College Students: The Impact of Merit Aid on Persistence, Graduation, and Earnings

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Abstract

Community colleges play a major role in postsecondary education, yet previous research has emphasized the impact of merit aid on four-year students rather than two-year students. Furthermore, researchers have focused on the impact of merit aid on enrollment and outcomes during college, but to my knowledge, none have yet considered the impact of aid on earnings after college. This paper utilizes discontinuities in eligibility criteria for a large merit scholarship to examine the local impact of aid on student outcomes both during college and after college. The findings suggest that reducing the cost of community college does not impact persistence, academic performance, degree completion, expected earnings, or short-term earnings after college for marginally eligible students.

JEL: I22, I23, H75, J08

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1 Introduction

Many imagine the typical college student as one attending a four-year public university, but two in five college enrollees attend two-year institutions rather than four-year institutions (National Center for Education Statistics). This emphasizes how community colleges play a major role in postsecondary education, yet the majority of the previous literature that examines the impact of merit aid on student outcomes emphasizes the effect on four-year students rather than two-year students. Furthermore, researchers have focused on the impact of merit aid on enrollment and outcomes during college, but to my knowledge, none have yet considered the impact of aid on earnings after college. States have limited budgets for scholarships and funding for higher education, and knowing how the cost of community college impacts students is influential for policymakers. Reducing the cost of attending a community college may lead students to make better decisions while enrolled which in turn could result in higher earnings after college. This paper directly examines this point in question by analyzing the impact of eligibility for a large merit-based scholarship program, the Tennessee HOPE Scholarship, on post-matriculation outcomes, earnings while enrolled, expected earnings based on major choice, and short-term earnings after college specifically for community college students.

Previous studies have found that there are gains from both community college attendance and completion relative to no college attendance, but this is the first study to examine whether community college students who receive aid have higher earnings immediately after college compared to those students who do not receive aid. Receiving the HOPE scholarship may impact earnings after college through several channels. For example, receiving a scholarship may reduce the need for

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2Tennessee’s thirteen state community colleges offer certificate programs and two-year associate’s degrees.

3Following the canonical study by Kane & Rouse (1995), a considerable amount of research has examined the labor-market returns to postsecondary education. Belfield & Bailey (2011) provide a review of this literature that specifically focuses on community college students, and in a recent study, Jepsen et al. (2014) likewise find gains from community college attendance and earning an associate’s degree, diploma, and certificate. Jepsen et al. (2014) find that associate’s degrees have quarterly returns of about $1,500 for men and $2,400 for women, and for both women and men, certificates have a quarterly return of about $300.
students to work while enrolled, and this along with the opportunity of receiving the scholarship could increase persistence, performance in school, transfer rates to four-year colleges, and degree completion. Also, the HOPE scholarship has renewal requirements such that students must meet a minimum grade point average (GPA) in order to maintain their scholarship throughout their studies which could incentivize students to more diligently study and raise their GPA. The accumulation of these outcomes could positively affect earnings after college.

On the contrary, the HOPE scholarship might yield lower earnings after college if students choose less financially beneficial degrees or professions since they will face less debt from the cost of college. Also, if students do work less during enrollment, then students may not make as many professional connections which could lead to lower short-term earnings after college. This is a particularly relevant mechanism in community colleges, where part-time work may complement vocational study. Higher earnings not only imply private benefits such as increasing the standard of living for individuals, but higher earnings also have public benefits such as increasing government revenues.

Community colleges serve many different kinds of students, including high school graduates who are marginally interested in and/or marginally capable of succeeding in college. Also, community college students compared to four-year university students are more likely to come from economically disadvantaged families and be first generation college students (Horn & Neville, 2006; Berkner & Choy, 2008). Given these typical student characteristics in addition to community colleges being touted as cost-effective routes to obtaining job skills and earning a bachelor’s degree (through transferring credits), community college freshmen may be particularly sensitive to the cost of college. Merit aid alleviates the cost of college for a targeted group of students with college-ready ACT scores, and this study examines whether a generous merit aid program makes a difference in terms of those students’ postsecondary success. In addition, these results will serve as context for emerging community college aid programs such as the Tennessee Promise which will broaden the focus to all high school graduates going to a community college.


5The Tennessee Promise will be a last-dollar scholarship available to all Tennessee high school graduates who directly enroll in a community college or college of applied technology in Tennessee beginning with the graduating class of 2015, and the program will entail both a community service and mentoring component.
Furthermore, while it is important to examine the effect of merit aid programs on student outcomes during college, it is equally as important to assess whether these programs impact students after college. Individuals and governments often invest in education because of the outcomes after college such as higher earnings, professional growth, increasing the stock of educated workforce, and creating a more productive and competitive economy. Yet to date, the research on the impact of large financial aid programs on student outcomes after college is limited. Therefore, this paper contributes to the literature by exclusively focusing on the impact of merit aid on community college students and including outcomes such as earnings after college in addition to outcomes during college.

The analytic sample consists of entering freshman in academic years 2005-2009 at any of Tennessee’s thirteen state community colleges. Students who receive either a minimum weighted final high school GPA of 3.0 or a minimum ACT score of 21 are eligible for the HOPE scholarship. Receiving the HOPE scholarship is likely correlated with unobserved characteristics such as ability that also affect student outcomes and earnings. Therefore, I exploit a regression discontinuity design using ACT scores as the forcing variable to overcome such biases. Given that students very close to the 21 ACT cutoff are comparable both in terms of observables and unobservables, I find the local impact of HOPE eligibility by comparing the outcomes of interest for the students who marginally surpass the 21 ACT threshold to those that marginally fall short of the 21 ACT threshold. I find that students re-take the ACT multiple times in order to push themselves past the required 21 ACT points which implies that students marginally above 21 ACT points are no longer comparable to students marginally below 21 ACT points. Therefore, I utilize students’ first ACT score rather than maximum ACT score as first ACT scores exhibit no signs of heaping at the threshold.

Results indicate that HOPE eligibility does not significantly impact number of semesters students enroll, cumulative hours after one year, last observed GPA, transfer rates, or whether students obtain an associate’s or a bachelor’s degree. However, surpassing the 21 ACT requirement does have a weakly significant local impact on cumulative hours after two years for students whose ACT score determines HOPE eligibility. HOPE eligibility is also found to have no local impact on earnings while enrolled, expected earnings, or earnings after college.
Overall, results for the marginally HOPE-eligible student near the ACT threshold are informative for policymakers. Generous merit aid packages are premised on the idea that broad-based aid will increase access to college, improve success in college, and ultimately support employment. Moreover, individuals without college credentials require more public assistance (Vernez et al., 1999). While understanding the mechanism through which financial aid affects students’ choices and outcomes are beyond the scope of this paper, students losing their HOPE scholarship after enrollment may be a contributing factor to HOPE having an insignificant local impact on students. Additionally, the HOPE scholarship considerably reduces the cost of attending a community college in terms of tuition and fees, but the value of the HOPE scholarship is relatively small compared to students’ future life-time earnings which may also be a contributing factor.

To ensure robustness of the overall zero local effect of HOPE, I show that the results are consistent across various specifications and bandwidths in Section 6. I also show that the overall zero local effect of HOPE is homogeneous across students’ income status in Section 7.1. Furthermore, Bruce & Carruthers (2014) find that the Tennessee HOPE scholarship induced a small but significant substitution away from two-year schools and toward four-year schools. In Section 7.2, I show that the overall zero effect of the HOPE scholarship for the marginally eligible student is not due to this substitution effect, and that the effect of HOPE eligibility is homogeneous across the likelihood of attending a community college versus a four-year university.

The remainder of this paper is organized as follows. The subsequent section discusses related literature, and Section 3 provides an overview of the HOPE scholarship program. Section 4 provides a description of the data and delves into the details of the empirical method used. Section 5 discusses the impact of HOPE eligibility on post-matriculation outcomes, earnings while enrolled, expected earnings, and earnings after college. Section 6 demonstrates that the results are robust across different specifications and bandwidths while Section 7 discusses the heterogeneity of the results across income and the potential for selection bias. The paper concludes with a discussion and a conclusion in Section 8.
2 Related Literature

In terms of economic theory, researchers often turn to a classical life cycle model to predict the impact of aid on student outcomes. According to a classical life cycle model, when the cost of college decreases, people are more likely to invest in their education both in terms of attendance and completion (Becker, 1993). This theory implies that the HOPE scholarship should positively affect student outcomes such as persistence and degree completion. However, the value of the HOPE scholarship is relatively small compared to the discounted present value of a student’s lifetime earnings which implies that the HOPE scholarship may have no meaningful impacts if students can borrow against their future earnings. Thus, many researchers have turned to empirical analyses to examine the impact of aid on student choices.

There is a large body of empirical literature that analyzes the impact of both merit-based and need-based scholarships on student outcomes. Several studies have found that merit-based aid programs overall increase access to higher education (Dynarski, 2000; Nyshadham, 2013; Upton, 2013), but the gain in attendance is centered around four-year colleges (Dynarski, 2004; Cornwell et al., 2006b; Bruce & Carruthers, 2014; Cohodes & Goodman, 2014). The research on post-enrollment outcomes is mixed and does not directly focus on the community college sector. Some studies have utilized census data to assess the impact of merit aid (Dynarski, 2008; Sjoquist & Winters, 2012; Fitzpatrick & Jones, 2012). Dynarski (2008) finds that Arkansas and Georgia’s merit-based scholarships increased degree receipts. On the contrary, Sjoquist & Winters (2012) and Fitzpatrick & Jones (2012) find that merit aid programs have no effect on degree completion. A limitation of using census data is the lack of availability of other student outcomes measuring persistence and academic achievement; therefore, several studies have opted to use administrative data to assess specific scholarship programs (Cornwell et al., 2005, 2006a; Lee, 2014; Sjoquist & Winters, 2012, 2013; Scott-Clayton, 2011; Castleman & Long, 2013). For example, Scott-Clayton (2011) and Castleman & Long (2013) find that aid increases cumulative credits earned and bachelor

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There is also a small but growing literature that examines how colleges respond to the introduction of state merit aid programs (Long, 2004; Calcagno & Alfonso, 2007; Topal, 2014). Long (2004) finds that private four-year colleges in Georgia increase tuition and decrease institutional aid in response to the Georgia HOPE scholarship. On the contrary, Topal (2014) finds no evidence that four-year colleges capture scholarship funds by examining the Tennessee HOPE scholarship, and Calcagno & Alfonso (2007) find that public community colleges actually supplement the Florida Bright Futures Program (FBFP) with an increase in institutional aid.
graduation rates by examining the West Virginia Promise and the Florida Student Access Grant (FSAG), respectively. On the other hand, Castleman & Long (2013) and Sjoquist & Winters (2012) find that aid had no impact on students earning an associate’s degree by studying FSAG eligibility and the Georgia HOPE scholarship, respectively. Other studies have also considered whether merit aid programs affect major choice and have found that students are less likely to pursue majors in science, technology, engineering, and math (STEM) fields due to the introduction of merit aid programs (Cornwell et al., 2006a; Sjoquist & Winters, 2013). While some of these studies do include community college students and four-year students in their sample, none have yet focused exclusively on community college students or examined post-college earnings. This paper extends the literature on the impact of aid on student outcomes by specifically focusing on students who start at a community college and examining additional outcomes such as GPA, transfer rates to four-year universities, earnings while enrolled, expected earnings based on major, and short-term earnings after college. Students at community colleges are very different from students at four-year universities in terms of academic preparedness, professional goals, and typical financial position, and aid may impact community college students differently than four-year university students.

This paper also complements a small but growing literature on the impact of debt on student decisions and outcomes after college. Rothstein & Rouse (2011) utilize a natural experiment where a highly selective anonymous university replaced loans with grants, and they find that debt causes graduates to choose jobs in substantially higher-salary industries. Their findings also suggest that the effect of debt on employment outcomes is more due to students’ preferences as they found that debt had no significant or large impact on students’ academic performance or employability (e.g. choice of major, GPA, and graduating with honors). Zhang (2013) uses the Baccalaureate and Beyond 93/97 survey data and finds that debt does not impact salary one year after receiving a bachelor’s degree or the probability of working in the public or non-profit sector. This paper deviates from this literature in that it focuses on the impact of merit aid rather than debt on future salaries, does not rely on survey data for student outcomes, and examines whether receiving aid impacts post-college earnings five years after initial enrollment rather than directly after graduation as in Zhang (2013). Furthermore, the results will be more relevant to community college students compared to Rothstein & Rouse (2011) who focus on one highly selective university and Zhang (2013) who focus on students receiving a bachelor’s degree.
Lastly, Bruce & Carruthers (2014) examine how the Tennessee HOPE scholarship affects enrollment on both the intensive and extensive margin, and they find that the HOPE scholarship induces a significant but small substitution away from two-year colleges and toward four-year colleges. Given that recent studies have found that attending a two-year rather than a four-year college negatively impacts earning a bachelor’s degree (Long & Kurlaender, 2009; Doyle, 2009; Reynolds, 2012), the HOPE may positively impact students who choose to attend a four-year university rather than a community college because of the HOPE. On the other hand, community colleges increase access to higher education and positively impact students who otherwise would not have attended college (Rouse, 1995; Leigh & Gill, 2003; Gonzalez & Hilmer, 2006). While there is an extensive amount of aforementioned research on enrollment and four-year, post-matriculation outcomes, this is the first paper to my knowledge to solely focus on how merit aid impacts community college student outcomes including earnings after college. As states, including Tennessee, continue to emphasize and create educational policies for the community college sector, it is essential to understand how financial aid, including merit aid, impacts these students.

3 Background

The Tennessee Education Lottery Scholarship (TELS) program was enacted in 2004 and utilizes state lottery revenue to provide scholarships and grants to eligible students. The HOPE scholarship is the largest portion of the TELS program both in terms of number of recipients and expenditures, and the HOPE scholarship can be applied toward tuition at eligible four-year and two-year colleges. To be considered for the HOPE, a student must have been a Tennessee resident for at least one year, enroll in an eligible public or private college within 16 months of high school graduation, and apply by completing the Free Application for Federal Student Aid (FAFSA). A 3.0 final weighted high school GPA or a minimum score of 21 on the ACT has been the initial HOPE re-

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7In the 2011-2012 academic year, 11,011 students at community colleges in Tennessee received the HOPE scholarship, and 3,894 of these students received supplements in addition to the HOPE scholarship. The TELS total expenditure for these students was $23.5 million. These values were calculated by the author and are the sum of actual recipients and dollars for the traditional HOPE scholarship, HOPE scholarship with GAM supplement, and HOPE scholarship with Aspire supplement from the following source: Tennessee Lottery Scholarship Program, 2011-2012 TELS Year End Report, Retrieved on 7/17/2013 from http://www.tn.gov/collegepays/mon_college/lottery_scholars.htm.
quirement since 2005. For the entering class of fall 2004, the requirement was a 3.0 final weighted high school GPA or a 19 (instead of a 21) minimum ACT score.

When the program began in the 2004-2005 academic year, the base HOPE scholarship award was $3,000 per year at a four-year institution and $1,500 per year at a community college. The award amounts have increased over time and currently are $6,000 per year at a four-year institution and $3,000 per year at a community college. To maintain the HOPE scholarship, recipients must maintain a minimum cumulative GPA of 2.75 after 24 and 48 attempted hours and a 3.0 minimum cumulative GPA after 72 and 96 attempted hours. The HOPE scholarship is terminated if a recipient earns a baccalaureate degree or five years passes from the date of the student’s initial enrollment. A HOPE recipient who meets the renewal requirements can transfer between eligible institutions as long as there is no break in enrollment. For example, a community college HOPE recipient can transfer to a four-year eligible institution and still receive the HOPE scholarship as long as the student meets the HOPE renewal criteria and maintains continuous enrollment in eligible higher education institutions.

4 Data and Methods

The goal of this paper is to analyze the causal impact of HOPE eligibility on post-matriculation and post-college outcomes for community college students. This causal effect can be measured by the difference in the outcomes of interest in which a student receives the HOPE scholarship and in which the same student does not receive the HOPE scholarship. Obviously, both potential outcomes are not observed for a single student. Additionally, those students that receive the merit-

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8 Students can also qualify for the HOPE scholarship by obtaining a minimum SAT score of 980 rather than a 21 on the ACT. However, less than two percent of the analytic sample have a record of taking the SAT, and less than one percent of the analytic sample qualified for the HOPE award by their SAT score alone. Since the administrative data contains students’ maximum rather than first SAT score, I do not convert these SAT scores to ACT scores. Rather, I include these students in the sample and empirically treat them the same as the other students in the analytic sample. Moreover, this demonstrates how a fuzzy rather than sharp regression discontinuity design should be used since other factors than ACT score alone affect HOPE eligibility.

9 The base annual HOPE scholarship awards increased from $3,000 at four-year schools and $1,500 at two-year schools in 2004 to $3,300 ($1,650) in 2005, $3,800 ($1,900) in 2006, $4,000 ($2,000) in 2007, and $6,000 ($3,000) in 2011. Prior to 2011, the annual awards were divided equally between fall and spring semester. Starting in fall 2011, HOPE recipients of fall 2009 and after could use the award for summer semesters, and the annual award was divided equally between fall, spring, and summer semesters.

10 Prior to the 2008-2009 academic year, the HOPE renewal requirement was a 2.75 minimum cumulative GPA after 24 attempted hours and a 3.0 minimum cumulative GPA after 48, 72, and 96 attempted hours.
Based scholarship are likely of higher unobserved ability than students who do not receive the scholarship, and this positive selection bias means the observed difference in average outcomes could exaggerate any benefits of the scholarship. Ideally, the optimal approach to solve this selection bias problem is to randomly assign the HOPE scholarship to community college students in order to equate HOPE recipients and non-HOPE recipients in terms of both observables and non-observables. Rarely though, is there an opportunity for such a study, and HOPE eligibility is far from being randomly assigned. Students are eligible for the HOPE scholarship by obtaining either a 3.0 final weighted high school GPA or a minimum ACT score of 20.5. This structure of assignment of the HOPE scholarship to students lends itself to using a regression discontinuity (RD) design. Specifically, a fuzzy RD design is exploited rather than a sharp RD design because the probability of being eligible for the HOPE increases significantly but by much less than one at the 20.5 ACT threshold since GPA along with other requirements (e.g. Tennessee residency, enrolling in an eligible college within 16 months of high school graduation, and completing the FAFSA) also affect HOPE eligibility.

4.1 Data

For the RD analysis, the data encompasses entering freshman in academic years 2005-2009 at any of Tennessee’s thirteen state community colleges. Administrative data maintained by the Tennessee Higher Education Commission that spans from spring 2002 to spring 2012 are used to construct post-matriculation outcomes for these five cohorts of students such as persistence, last observed GPA, transfer rates, last observed major, and degree receipts. Since students must enroll in college within 16 months of high school graduation to be eligible for the HOPE scholarship, the analytic sample is restricted to students with an estimated age between 17 and 21 at initial enrollment. These data are then merged with ACT records, FAFSA data, and unemployment insurance records. The ACT data provides students’ ACT scores for each attempt. Students must complete a FAFSA to apply for the HOPE scholarship, and HOPE eligibility is available in the administrative FAFSA records for Tennessee resident applicants. The unemployment records from the state’s Department

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11The actual ACT requirement for HOPE eligibility is 20.5 ACT points instead of 21 because composite test scores are computed to two decimal places.

12Age as of enrollment is estimated by taking the difference between the year of initial enrollment and the year of birth.
of Labor and Workforce Development contain quarterly earnings for all workers with wages in
Tennessee covered by unemployment insurance from the first quarter of 2002 to the second quarter
in 2012.\textsuperscript{13}

In addition, these data are also merged with expected annual wage data to assess whether HOPE
leads students to sort into more or less lucrative fields. Students’ last observed major is mapped to
occupations or Standard Occupational Classifications (SOCs) using a crosswalk provided by the
National Center for Education Statistics.\textsuperscript{14} Wage estimates by occupations are from the Bureau
of Labor Statistics’ Occupational Employment Statistics (OES) survey.\textsuperscript{15} Each major is mapped
to multiple occupations or SOCs; therefore, expected annual wage for a major is the average of
the annual wages for all SOC codes mapped to that major. Furthermore, I assume students begin
forming their expectations regarding wages for their chosen field of study when they enter school,
so estimated wages are based on year of entry into college. The majority of the majors are ac-
curately mapped to SOC codes with the exception of the liberal arts and sciences/liberal studies
major which is only mapped to one occupation, postsecondary teachers. Since forty-five percent
of the analytic sample has this general liberal arts major as their last observed major,\textsuperscript{16} expected
earnings based on level of highest degree (e.g. some college but no degree, associate’s degree, or
bachelor’s degree) from the Current Population Survey is used for these students.\textsuperscript{17} All earnings
including earnings while enrolled, expected earnings, and earnings after college were converted to
2005 dollars using the Consumer Price Index.

\textsuperscript{13}The earnings data does not include self-employment earnings, investment income, or earnings from other states.
\textsuperscript{14}The Classification of Instruction Program (CIP) codes to SOC codes crosswalk was obtained from the following
\textsuperscript{15}The wage estimates exclude self employed persons, owners and partners in unincorporated firms, and household
workers. Annual wage estimates were obtained from the following source: Bureau of Labor Statistics, Occupational
\textsuperscript{16}This major does not appear to be a pipeline major for transferring to four-year colleges as only 3\% of students with
this major transferred to a four-year school. Moreover, most students (roughly 91\%) with the liberal arts major did
not complete college. Eight percent of students in this major obtained an associate’s degree as their highest obtained
degree while less than one percent earned a bachelor’s degree.
\textsuperscript{17}Estimated wages based on education level for each cohort was obtained from the following


4.2 Test for Manipulation of the Running Variable

Final high school GPA data are not included in the administrative data, so ACT scores are used as the forcing variable in the RD analysis. Even if final high school GPA was available, ACT scores would be a more suitable forcing variable. High school GPA may be more easily manipulated by students and schools at the 3.0 GPA threshold for the HOPE scholarship compared to the 20.5 ACT threshold. Yet there is still concern that ACT scores might show signs of manipulation around the 20.5 cutoff. Pallais (2009) finds that students increased their last observed ACT scores in response to the introduction of the TELS program in 2004. Therefore, it is likely that students may improve their preparation or re-take the ACT exam in order to increase their chance of becoming HOPE eligible.

To test for manipulation of ACT scores, the discontinuity in the density function of ACT scores is estimated following McCrary (2008). As can be seen in Figure 1, the density of students is not smooth around the ACT cutoff for the HOPE scholarship when students’ maximum or best ACT score is used. The spike in the density function just above 20.5 implies that students are re-taking the exam until they surpass the necessary score of 20.5 for the HOPE scholarship. This behavioral response implies that students who marginally surpass the 20.5 cutoff are not comparable to students who marginally fail to surpass the 20.5 cutoff. For example, the students who re-take the ACT exam and push themselves above the 20.5 cutoff may be more highly motivated compared to those below the cutoff, and the RD analysis may overstate any benefits of the HOPE scholarship when best ACT scores are used as the forcing variable. When the ACT score from students’ first attempt is used, there is no statistically significant discontinuity in ACT scores around the cutoff (see Figure 1). Therefore, all the empirical analysis will utilize students’ ACT score from their first attempt of taking the exam.

4.3 Empirical Strategy

In fuzzy RD design, the local average treatment effect of HOPE eligibility is found by dividing the discontinuity in the outcome variable of interest at the 20.5 threshold by the discontinuity in the probability of treatment at the 20.5 threshold. Hahn et al. (2001) show that this local average treatment effect is numerically equivalent to a local instrumental variables estimator where passing
the 20.5 threshold is used as an instrument for HOPE eligibility. Therefore, one can find the effect of passing the 20.5 ACT threshold on HOPE eligibility by first estimating the following first stage equation of two stage least squares:

\[ H_i = \alpha_0 + \alpha_1 \text{Higher}_i + f[(ACT \text{ gap}_i) \times \text{Lower}_i] \alpha_2 + g[(ACT \text{ gap}_i) \times \text{Higher}_i] \alpha_3 + \nu_i \]  

(1)

The dependent variable in Equation 1 is a binary indicator for HOPE eligibility for student \( i \). Higher\(_i\) is a binary indicator equal to one for students who score greater than or equal to 20.5 points on the ACT while Lower\(_i\) is a binary indicator equal to one for students who score less than 20.5 points. \( f(\cdot) \) and \( g(\cdot) \) are functions of the gap between \( i \)'s ACT score and the threshold, 20.5 ACT points. Specifying separate functions, \( f(\cdot) \) and \( g(\cdot) \), on either side of the cutoff, allows for the slope and intercept to differ for the regression line above and below the cutoff.

Although final high school GPA is not available in the administrative data, students are asked to report their grades for several classes in the high school curriculum (e.g. English, algebra, calculus, biology, U.S. history, etc.) in a survey each time they take the ACT exam. The ACT calculates a GPA based on these survey responses, and this calculated GPA from students’ last ACT attempt is used as a proxy for final high school GPA. Using a similar methodology as Bruce & Carruthers (2014), the sample is divided between students with a proxy high school GPA that meets the required HOPE high school GPA of 3.0 and students with either a missing proxy GPA or a proxy GPA that is less than 3.0. Figure 2 graphically demonstrates the discontinuity in HOPE eligibility as indicated in the FAFSA data for these two groups of students. The discontinuity in HOPE eligibility is much larger and significant for students with either a missing GPA or a proxy GPA less than 3.0. Specifically, the discontinuity in HOPE eligibility is estimated using Equation 1 for the lower high school GPA group, and the discontinuity is 27.3 percentage points and significant at the one percent significance level. The discontinuity for students with at least a 3.0 proxy high school GPA is insignificant and only 1.6 percentage points. A significant discontinuity in the probability of receiving treatment is necessary for identification of treatment effects in a RD framework (Hahn et al., 2001). Since there is a significant and much larger discontinuity in HOPE eligibility at the 20.5 threshold for students whose high school GPA is missing or is less than the required 3.0 for the HOPE scholarship, the main analysis and baseline results are centered around the lower high school GPA students. Students with at least a 3.0 high school GPA are used as a
falsification test of the identification strategy, and the outcomes for these students should not be affected by HOPE eligibility at the 20.5 ACT threshold as there is not a significant discontinuity in HOPE eligibility at the 20.5 cutoff.

The local average treatment effect of HOPE eligibility is determined by estimating the following second stage equation of two stage least squares:

\[ Y_i = \pi_0 + \tau_{FRD} \hat{H}_i + f[(ACT_{gap_i}) \times Lower_i] \pi_1 + g[(ACT_{gap_i}) \times Higher_i] \pi_2 + \eta_i \]  

(2)

The dependent variables in Equation 2 are the outcomes of interest including measurements of persistence through community college, last observed GPA, transfer rate to a four-year college, degree receipts, earnings while enrolled, expected earnings, and earnings after college. \( \hat{H}_i \) are the fitted values for \( H_i \) obtained from Equation 1, and the other variables in Equation 2 are defined as in Equation 1. The coefficient of interest, \( \tau_{FRD} \), represents the local average treatment effect of HOPE eligibility on the student outcomes.

I estimate Equation 2 for each post-matriculation outcome of interest for lower GPA students whose ACT score is within five points of the 20.5 cutoff, and \( f(\cdot) \) and \( g(\cdot) \) are linear functions of the gap between \( i \)'s ACT score and the 20.5 ACT threshold. Bandwidth selection is an integral component in RD design as there is a tradeoff between bias and precision. Imbens & Kalyanaraman (2012) adapt alternative methods specifically for the RD setting and provide a data dependent algorithm for optimal bandwidth selection that minimizes the mean squared error \( (\hat{\tau}_{SRD} - \tau_{SRD})^2 \). Using this data dependent algorithm, I calculate the optimal bandwidth separately for each outcome, and a five-point bandwidth is utilized in the baseline analysis as the mean and median of the optimal bandwidths, is generally close to five points.\(^{18}\) Also, linear functions for the gap between \( i \)'s ACT score and the 20.5 ACT threshold are used rather than a quadratic or cubic in an effort to prevent students with ACT scores further away from the 20.5 cutoff from carrying too much weight in the specification (Lee & Lemieux, 2010). Yet in Section 6, I test whether the results are stable across alternative specifications including a quadratic and a cubic function for both \( f(\cdot) \) and \( g(\cdot) \) and additional bandwidths including the calculated optimal bandwidth for each outcome. Additionally, robust standard errors, clustered by first ACT score increment, are used in all regressions.

\(^{18}\)For further discussion on optimal bandwidth selection in a regression discontinuity framework see Imbens & Kalyanaraman (2012).
4.4 Descriptive Statistics

Table 1 lists the descriptive statistics for HOPE eligibility, post-matriculation outcomes, and control variables. Column I lists the summary statistics for all students who were entering freshman in 2005-2009 at any of Tennessee’s thirteen public community colleges and whose ACT score is within five points of the 20.5 cutoff. Of these students, 50.3 percent are eligible for the HOPE scholarship according to FAFSA records. Several post-matriculation outcomes are examined including: total number of semesters enrolled including summer semesters, cumulative hours after one calendar year from initial enrollment, cumulative hours after two calendar years from initial enrollment, last observed GPA, and a binary indicator for transferring to a four-year college.19 On average, students enroll in college for 6 semesters and accumulate about 19 and 37 hours after one and two years, respectively. The mean last observed GPA is 2.53, and about 38% of all students transfer to a four-year college. Degree receipt is examined by including outcome variables for earning an associate’s degree within three years for cohorts 2005-2008 and earning a bachelor’s degree within five years for cohorts 2005-2006.20 Roughly 9% earn an associate’s degree within three years and 15% earn a bachelor’s degree within five years. Lastly, earnings while enrolled, expected earnings, and earnings after college are considered. The majority of the sample has at least some earnings while enrolled, and the average quarterly earnings while enrolled is $1,352. The average expected annual wage based on major or level of highest degree is about $50,000. For the 2005-2006 cohorts, approximately 73% of students who exit school prior to the fifth year after initial enrollment with or without a degree have post-college earnings, and the average quarterly earnings in the fifth year is $2,645.21

Columns II and III of Table 1 split the sample into the analytic sample, those students with a missing or sub-3.0 proxy high school GPA, and students with a proxy high school GPA greater than 3.0. As expected, HOPE eligibility is lower for the lower GPA students. Also, lower high

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19Cumulative hours after one and two calendar years from initial enrollment includes enrolled students, dropouts, and transfer students. For students who transfer, cumulative hours includes both hours before and after transferring.
20The administrative data only has degree attainment through spring 2012 which does not provide ample time for the 2009 cohort to earn an associate degree within three years, so the 2009 cohort is excluded for the analysis of this outcome variable. Also, the analytic sample is restricted to cohorts 2005-2006 for earning a bachelor’s degree within five years given that degree attainment is only available through spring 2012.
21The sample is restricted for any earnings and average quarterly earnings in the fifth year to students who exit college prior to the fifth year with or without a degree and to cohorts 2005-2006 for which earnings data is available in the fifth year after initial enrollment. Earnings data is available through the second quarter of 2012.
school GPA students complete slightly fewer number of semesters, are less likely to transfer to a four-year college, and have a lower first and maximum ACT score than the higher GPA students. In addition, expected annual wage based on major or level of highest degree for those with a general liberal arts major is less for lower high school GPA students. Both GPA groups are almost equally likely to have earnings while enrolled and earnings in the fifth year after initial enrollment, but there are small differences in their average quarterly earnings.

Table 1 also includes descriptive statistics for control variables including gender, race, cohort indicators, and an indicator for lower-income. A student is specified as being lower-income if parental adjusted gross income from the FAFSA data is less than $52,000 which is the median parental adjusted gross income. If parental adjusted gross income is missing, then a student is considered lower-income if their estimated total combined income of their parents before taxes is less than $60,000 according to a categorical survey response from the ACT exam. Students with proxy GPAs that are less than 3.0 have a higher percentage of males, black, and lower-income students.

4.5 Test for Discontinuity in Predetermined Characteristics

RD is thought of as a local randomized quasi-experiment where students on the right and left of the cutoff are comparable, but in order for this to be true, predetermined characteristics should exhibit the same distribution above and below the HOPE threshold. To test whether this is the case, I estimate the discontinuity in the control variables at the 20.5 cutoff by replacing the dependent variable with each control variable in Equation 2. The results are reported in Table 2 for students with and without HOPE qualifying proxy high school GPAs. Any significant discontinuity in a covariate would imply that changes in a post-matriculation outcome might be from a different mechanism than the HOPE scholarship. The majority of the estimates are small and insignificant for both the lower and higher GPA groups of students. Surprisingly, the percentage of black students increases at the HOPE threshold for sub-3.0 GPA students. In the Appendix, I provide a graphical analysis for the percentage of black students at the threshold. The percentage of black students does not appear to have a significant discontinuity at the 20.5 threshold, and it appears that the relationship is quadratic rather than linear for the gap between i’s ACT score and the 20.5 threshold. I estimate
Equation 2 using both a quadratic and a cubic rather than a linear specification, and the percentage of black students no longer registers as significant in either case. Therefore, it is unlikely that the discontinuity in the percentage of black students in Table 2 is due to omitted variables that may threaten internal validity of the results. Additionally, baseline findings are robust to including controls as shown in Section 6.

5 Results

5.1 Regression Discontinuity Empirical Analysis

I first estimate Equation 1 to assess the effect of passing the 20.5 ACT threshold on HOPE eligibility, and then I estimate Equation 2 to find the local average treatment effect for each post-matriculation outcome. The estimations include students whose ACT score is within five points of the 20.5 cutoff, and \( f(\cdot) \) and \( g(\cdot) \) in Equation 2 are linear functions of the gap between \( i \)'s ACT score and the 20.5 ACT threshold. Identification relies on the assumption that in absence of treatment, the outcome of interest would be continuous over the 20.5 threshold and HOPE treatment is causing the discontinuity in the outcome variable. The results are shown in Table 3, and robust standard errors, clustered by first ACT score increment, are in parentheses. Column I lists the mean values for each variable for the typical student in this ACT range, and Columns II and III list the treatment on the treated estimates for low and high GPA students, respectively.

As discussed in Section 4.3, the first stage discontinuity is 27.3 percentage points and significant at the one percent significance level for students with a missing or sub-3.0 GPA while the discontinuity is 1.6 percentage points and insignificant for students with a GPA that exceeds 3.0. Since a significant discontinuity in HOPE eligibility at the 20.5 ACT threshold is needed for identification and this discontinuity is only significant for the lower GPA students, the main analysis focuses on students with lower high school GPAs.

Focusing on the outcomes of interest, one might expect that HOPE recipients would not be as financially constrained and thus would not need to work as much while enrolled which may enable students to more easily persist through school by attending full-time and taking more credit hours per semester. Surprisingly, I find that HOPE eligibility has no impact on persistence measures
such as the number of semesters enrolled or cumulative hours after one year. However, HOPE receipt does have a small but significant impact on cumulative hours after two calendar years from initial enrollment. Specifically, students who are above the 20.5 cutoff attempt 3.367 more hours over the course of two years than students below the 20.5 cutoff. This finding is significant at the ten percent level and represents a 9.1 percent increase above 37 hours, the mean cumulative hours after two years for typical students in this ACT range.

As mentioned in Section 3, students must obtain at least a cumulative GPA of 2.75 after 24 and 48 attempted hours and a 3.0 after 72 and 96 attempted hours to keep their HOPE scholarship. One would expect that students who are HOPE eligible would diligently study and increase their GPA to ensure the renewal of their HOPE scholarship. Nevertheless, the RD findings imply that HOPE does not impact students’ last observed GPA at the 20.5 threshold. Furthermore, marginally achieving 20.5 ACT points has no impact on transferring to a four-year college, attaining an associate’s degree within three years, or attaining a bachelor’s degree within five years.

Lastly, earnings while enrolled, expected earnings, and earnings post-college are examined. It is easy to hypothesize that receiving financial aid such as the HOPE scholarship would reduce the need for students to work during school and thereby decrease earnings during enrollment. Contrary to this hypothesis, students that are marginally HOPE eligible are no more likely or unlikely to receive earnings while enrolled, and HOPE eligibility has no impact on the average quarterly earnings while enrolled. Also, the HOPE scholarship might adversely affect earnings after college because students may choose a less financially beneficial major or degree since they will face less debt from the cost of college. However, HOPE eligibility has no impact on expected earnings based on major choice or level of highest degree for those with a general liberal arts major. Therefore, HOPE does not appear to impact major choice or expected earnings based on major choice. Also, meeting the HOPE ACT requirement has no significant local impact on

22 While not included in the main results, I also examined additional measures of persistence such as maximum cumulative hours and full-time status (i.e. greater than 12 hours per semester) in the first year, and both of these measures were also insignificant even though full-time status is needed for a student to be awarded the full value of the HOPE scholarship.

23 HOPE eligibility also did not impact whether students received a less than one year certificate, a 1-2 year certificate, an associate’s degree within two years, or a bachelor’s degree within four years. For brevity, these findings are not included in the main results.

24 HOPE eligibility also did not impact whether students chose a STEM major or a major in humanities, social sciences/education, business/economics, or other majors for their first declared major, last declared major, associate
receiving any post-college earnings in the fifth year after initial enrollment nor on the average quarterly earnings during that fifth year for students who exit school prior to the fifth year either with or without a degree. The findings regarding earnings after college are consistent with the other RD results in this paper in that it would be questionable if HOPE eligibility did not have a local impact on persistence, GPA, transfer rates, or degree receipts but did have an impact on post-college earnings. In addition, these findings suggest that students are not choosing different majors or occupations with different salaries because the HOPE scholarship possibly decreased their debt level.

To synthesize these findings, there is no local impact of surpassing the 20.5 ACT threshold for the HOPE scholarship on the majority of post-matriculation outcomes examined with the exception of a significant local impact on cumulative hours after two years. While this local average treatment effect is significant, the impact is modest as the point estimate is only an increase of about three hours over the course of two years. Therefore, the results indicate that HOPE eligibility does not impact student persistence or earnings for marginally HOPE eligible students, and these findings are robust to several specifications and various bandwidths as discussed and demonstrated in Section 6.

Column III of Table 3 lists the local average treatment effect of surpassing the 20.5 threshold on the outcomes of interest for the high GPA students which are estimated using Equation 2. Since high GPA students do not have a significant discontinuity in HOPE eligibility at 20.5 ACT points, these students should not have a discontinuity in the outcomes variables at 20.5 ACT points. This is the case as all of the discontinuities in the post-matriculation outcomes are small and insignificant for the high GPA students.

### 5.2 Regression Discontinuity Graphical Analysis

Graphical analyses are an integral component of RD and provide an informative illustration of the RD empirical strategy. Figure 3 consists of a graphical analysis for each post-matriculation outcome with the forcing variable on the horizontal axis. The mean value of the outcome for students major, or bachelor major. For conciseness, these results are excluded from the main results.

25There is also no significant impact on average, quarterly, post-college earnings during the third and sixth year after initial enrollment although these findings are excluded in effort to streamline the main results.
with the same ACT score is plotted for all ACT scores within five points of the 20.5 threshold. The size of the circles in the scatter plots increase proportionate to the number of students who received a specific ACT score. The plotted fitted lines on either side of the threshold are the predicted outcome values from estimating the reduced form equation, and the discontinuity or reduced form intent-to-treat effect is listed for each outcome. It is clear from each graph that the number of low GPA students decreases as ACT score increases since the size of the markers decrease in ACT score. Number of semesters, GPA, transferring to a four-year college, and expected annual wage all increase as ACT score rises, but all of these outcomes vary smoothly across the 20.5 threshold. There visually looks like there might be a small discontinuity for cumulative hours after one year, associate’s degree within three years, and bachelor’s degree within five years, but after considering the scales on the vertical axis, these outcomes also seem to not have a significant discontinuity at the 20.5 threshold. It appears that the percentage of students with any earnings while enrolled or any post-college earnings in the fifth year is relatively constant across ACT scores. Also, there does not appear to be a significant large discontinuity in average quarterly earnings while enrolled or average, post-college, quarterly earnings in the fifth year. The only variable that depicts a possible significant discontinuity is cumulative hours after two years, and this same outcome is the only one that registered a significant discontinuity in Equation 2. Yet the local impact is extremely small both visually and in terms of economic magnitude.

6 Robustness and Falsification Checks

I test the robustness of the baseline results to various specifications and bandwidths. The results of the robustness and falsification checks are in Table 4. All reported estimates reflect the local average treatment effect of HOPE eligibility on student outcomes, and robust standard errors, clustered by first ACT score, are in parentheses. Column I lists the baseline results for low GPA students which are the same results as reported in Table 3 and estimated using Equation 2. Columns II through IX also estimate the impact of HOPE on low GPA students whose HOPE receipt likely

26 The reduced form equation is found by substituting Equation 1 into Equation 2 which yields the intent-to-treat effect of HOPE eligibility. The intent-to-treat effect is the numerator of the fuzzy regression discontinuity average treatment effect, and the intent-to-treat effect is equivalent in significance yet smaller in magnitude compared to the local average treatment effects presented in the baseline findings.
depended on the running variable, but each column differs from the baseline specification in one respect. First, controls for gender, race, lower-income, and cohort indicators are added in Column II. Secondly, optimal bandwidths are calculated separately for each outcome using the data dependent algorithm from Imbens & Kalyanaraman (2012) which minimizes the mean squared error \((\hat{\tau}_{SRD} - \tau_{SRD})^2\). Then, local linear estimates from a triangle kernel are found for the calculated optimal bandwidths in Column III (Nichols, 2011). Columns IV and V use a quadratic and a cubic, respectively, rather than a linear function of the gap between \(i\)’s ACT score and the 20.5 threshold for \(f(\cdot)\) and \(g(\cdot)\) in Equation 2. In Column VI, the bandwidth is expanded to include students whose first ACT score is within seven points of the 20.5 threshold, and in Column VII, the bandwidth is contracted to students whose first ACT score is within two points of the 20.5 threshold. Columns VIII and IX test for discontinuities in the outcomes at 18.5 and 22.5 ACT points, respectively, which are not associated with the HOPE scholarship. Lastly, Column X contains the baseline results for high GPA students which are the same discontinuities presented in the main analysis in Table 3.

Overall, the baseline findings indicate that there is no local impact of HOPE eligibility on persistence, academic performance as measured by GPA, degree receipt, earnings during college, expected earnings, or actual earnings after college. Columns II-VII in Table 4 show that the nearly zero local impact of HOPE eligibility on the student outcomes is robust across different specifications and bandwidths as almost all of the estimates remain insignificant across these columns. Moreover, the significant, albeit modest, impact of HOPE on cumulative hours over the course of two years also remains significant across these columns with the exception of when the bandwidth is expanded to seven points in Column VII. Cumulative hours after one year exhibits some inconsistent significant discontinuities, but the coefficients for this outcome remain insignificant for many of the different specifications. Also, number of semesters is significant when a two-point bandwidth is used, but this coefficient is only significant at the ten percent level and remains insignificant for all of the other specifications.\(^{29}\)

\(^{27}\)I estimate the optimal bandwidth for the numerator or the outcome variable as if it was a sharp regression discontinuity design. As noted in Imbens & Kalyanaraman (2012), this basic optimal bandwidth is very similar to the optimal bandwidth for a fuzzy regression discontinuity design.\(^{28}\) Specifically, the stata -rd- command from Nichols (2011) is utilized with plugged in optimal bandwidths that are calculated according to Imbens & Kalyanaraman (2012).\(^{29}\) I also demonstrate in the Appendix that the overall zero local impact of HOPE eligibility is robust to using a
Columns VIII and IX test whether surpassing the threshold of 18.5 and 22.5 ACT points, respectively, impact the outcomes of interest. There may be other scholarship programs or admission criteria that require a minimum ACT score that is not associated with the HOPE scholarship, and any discontinuities at an alternative threshold would imply that a portion of the magnitude of the HOPE impact on the outcomes of interest could be attributed to these other ACT thresholds. Yet cumulative hours after two years is insignificant at both of these alternative thresholds which further confirms the robustness of the baseline findings. The other significant coefficients in Columns VIII and IX, representing 1.7% of the table, may be significant by chance.

Lastly, Column X serves as a falsification test using high GPA students. There could be other scholarships or admission criteria that also require a 20.5 ACT score. As can be seen in Column X of Table 4 and similarly in Column III of Table 3, none of the outcomes exhibit a significant discontinuity at 20.5 ACT points for the high GPA students. Therefore, it is unlikely that a different scholarship program that also has a minimum 21 ACT score requirement is driving the significant result for cumulative hours after two years. It should be noted though that this does not mean that HOPE eligibility does not impact higher GPA students. Higher GPA students show no local impact of surpassing the 20.5 cutoff on the outcomes of interest, but HOPE eligibility may still impact higher ability students with higher ACT scores that are not examined in the RD analysis.

7 Extensions

7.1 Heterogeneity by Income

While the baseline results indicate an overall zero effect of HOPE on student persistence and earnings, the HOPE scholarship may impact students differently depending on their income status. Therefore, I examine whether the baseline findings are heterogeneous across lower-income status in Table 5. Column I lists the baseline results for low GPA students which are estimated using Equation 2 and are the same as those reported in Table 3. Columns II and III are also estimated for low GPA students using Equation 2, but estimations are limited to a subsample of students based on their income status. Cumulative hours after two years remains significant for lower-income one-point, three-point, four-point, and six-point bandwidth.
students, but the point estimate remains modest for these students. HOPE eligibility increases the likelihood of having any earnings in the fifth year after enrollment for lower-income students while HOPE eligibility decreases the likelihood of having any earnings in the fifth year for higher-income students. Yet the average quarterly earnings in the fifth year remains insignificant for both lower and higher-income students. Also, average quarterly earnings while enrolled decreases for higher-income students, but all of the other student outcomes of interest remain insignificant, similar to the baseline findings, regardless of income status.30

7.2 Discussion of Potential Selection Bias

I also examine whether negative selection bias could be driving the overall zero effect of HOPE eligibility on the majority of the student outcomes of interest. Bruce & Carruthers (2014) examine how Tennessee’s HOPE scholarship affects students’ choice of college state and sector, and they find that the HOPE scholarship induces a significant but small substitution away from two-year colleges and towards four-year colleges. This finding suggests that there could be the possibility that students above the 20.5 ACT cutoff in the analytic sample in this paper could be negatively selected in that these students did not substitute away from two-year schools into four-year schools. Is the overall zero effect of HOPE eligibility on the majority of the student outcomes and earnings due to a sorting-induced negative selection bias at the threshold? To examine this possibility, I test whether the discontinuity in the outcomes of interest for community college students vary by the ex-ante likelihood of going to a two-year college rather than a four-year college.

The administrative data for first time freshman at two-year and four-year colleges are used to find the predicted probability of attending a two-year community college. The predicted probability of attending a two-year college rather than a four-year college is found from a linear least squares regression with control variables including gender, race, lower-income status, cohort indicators, parent adjusted gross income (AGI),31 an indicator for parents’ highest level of college

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30I also examine whether the baseline results are heterogeneous across gender and race in addition to income status in the Appendix. There is suggestive evidence of persistence and degree effects on non-white students, but the results are not strong enough to ascribe the discontinuities to a causal effect of HOPE rather than noise. Moreover, the results for non-white students are not robust to small changes in specification or bandwidth.

31An auxiliary regression is used to impute parent AGI when parent AGI is missing.
attainment\textsuperscript{32}, indicators for students’ ex-ante preference for attending a two versus four-year college\textsuperscript{33} and indicators for which Tennessee high school the student attended last according to ACT records.\textsuperscript{34}

To examine whether there are heterogeneous effects of HOPE eligibility across the probability of attending a community college, the baseline specification, Equation 2, is estimated for low GPA students, and students with lower predicted probabilities of attending a community college are omitted. The results for this estimation are in Table 6. Column I repeats the baseline results which are the same as those reported in Table 3, and students in the lower percentiles for the predicted probability of attending a community college are omitted in ascending order starting with omitting the 5\textsuperscript{th} percentile in Column II through the 50\textsuperscript{th} percentile in Column XI. There is some suggestive but weak evidence of the possibility of negative selection bias as average quarterly earnings in the fifth year after enrollment becomes positive and significant when the 20\textsuperscript{th} through the 35\textsuperscript{th} percentiles are omitted in Columns V through VIII, but the coefficients become insignificant after the 40\textsuperscript{th} percentile and beyond are omitted. All of the other outcome variables that are insignificant in the baseline results remain consistently insignificant across the probability of attending a two-year school even after a substantial number of students in the lower percentiles are excluded from the estimation. Also, cumulative hours after two years becomes insignificant after the 5\textsuperscript{th} percentile is omitted. Table 6 suggests that HOPE eligibility does not have a local impact on student persistence, academic performance, degree receipt, or earnings, and this finding is homogeneous across the likelihood of attending a community college.\textsuperscript{35} Therefore, the overall finding of a zero effect of HOPE on students’ post-matriculation outcomes and earnings is not due to a negative selection bias that stems from negative selection out of two-year schools at the HOPE eligibility threshold.

\textsuperscript{32}An auxiliary probit regression is used to predict the probability that at least one parent completed college when parent education is missing

\textsuperscript{33}Students’ ex-ante preference for attending a two versus four-year college are from categorical survey responses from the ACT exam.

\textsuperscript{34}Model fit statistics indicate that the linear least squares model with these control variables is the optimal model for predicting the probability of attending a two-year versus four-year college. Less than 1 percent of the analytic sample had a predicted probability less than zero, and 5.8\% of the analytic sample had a predicted probability greater than one. Indicators for missing FAFSA data, missing college preferences, and missing a student’s high school code were also included as controls.

\textsuperscript{35}The estimates from interacting the predicted probability of attending a community college with $Higher_i$, the binary variable equal to one for students who surpass 20.5 ACT points, in the reduced form of Equation 2 also provides some suggestive but weak evidence that discontinuities in the outcomes vary by the likelihood of attending a community college.
8 Conclusion and Implications

There is an abundant amount of research on the impact of aid on student outcomes, but to date no study has focused exclusively on the impact of merit aid on community college students. Community colleges are a large component of higher education in the U.S., and aid may impact community college students differently than four-year university students especially as these two groups of students tend to differ in terms of academic preparedness, professional goals, and financial position. Also, to my knowledge, this is the first study to examine how financial aid impacts earnings after college. Higher earnings not only imply private benefits such as increasing the standard of living for individuals, but higher earnings also have public benefits such as increasing government revenues. Therefore, to extend the literature, I analyze the impact of eligibility for Tennessee’s HOPE scholarship on post-matriculation and post-college earnings for community college students. To overcome biases associated with unobservables such as ability being correlated with both receiving the HOPE scholarship and the outcomes of interest, I exploit a regression discontinuity design and focus on ACT scores in determining HOPE eligibility. The local impact of HOPE eligibility is found by comparing outcomes for the students who marginally surpass the required 21 ACT score for the HOPE scholarship to those that marginally fall short of 21 ACT points.

I find that HOPE eligibility does not significantly impact marginally eligible students who lack a HOPE-qualifying GPA in terms of persistence through community college, performance in school measured by GPA, obtaining an associate’s or bachelor’s degree, or the likelihood of transferring to a four-year college. However, I do find a significant but small effect on cumulative hours after two years. HOPE eligibility is also found to have no effect on earnings while enrolled, expected earnings, or actual earnings after college.

How do these results for community college students compare to the results for four-year university students? Findings surrounding four-year university students are mixed. Castleman & Long (2013) consider the impact of the Florida Student Access Grant (FSAG) which is a need-based grant while Scott-Clayton (2011) examines the impact of the West Virginia Promise scholarship, a large merit-based scholarship that is similar to the Tennessee HOPE scholarship. Both Castleman & Long (2013) and Scott-Clayton (2011) find that aid positively affects some student outcomes including cumulative credits and earning a bachelor’s degree. These findings may conflict with
the results from this paper in part because aid affects community college students differently than four-year university students. Secondly, need-based aid, such as the FSAG, targets low-income students, and aid may induce different behavioral responses among these students. Lastly, the findings may be divergent because the requirements for receiving aid are heterogeneous. For example, the West Virginia Promise requires a 3.0 high school GPA and a 21 ACT score while the Tennessee HOPE requires a 3.0 high school GPA or a 21 ACT score. This literature as a whole suggests that the impact of aid on post-matriculation outcomes for students may largely depend on the details in the structure of assignment and renewal criteria for such programs which should be considered when designing scholarship and grant programs. Sjoquist & Winters (2012) and Fitzpatrick & Jones (2012) collectively analyze the impact of large merit-based aid programs for nine and fifteen states, respectively, and they find that merit-aid programs have no effect on degree completion. While they focus almost entirely on degree completion to measure academic persistence and achievement, my results do align with these results as eligibility for the HOPE scholarship had no highly significant effects on student persistence or earnings.

In addition to program design details, what other factors may contribute to the HOPE having an insignificant local impact on community college students in Tennessee? Over the 2005 to 2009 academic years, the average HOPE award at a two-year college was about $1800 per year while the average tuition and fees at Tennessee’s community colleges over the same time period was $2,511 (in 2005 dollars). Therefore, the HOPE scholarship notably reduces the cost of attending a community college as the scholarship accounts for about 72% of tuition and fees at a community college and around 14% of the cost of attendance (COA) including tuition and fees, books and supplies, and off campus room and board (not living with family). However, some students may be receiving other scholarships in addition to the HOPE that already cover a significant portion of tuition and fees. For example, roughly two in five of the students who received the HOPE in the analytic sample also received the Pell grant which had an average annual award of $2,704 (in 2005 dollars) over the time period studied. Students who are eligible for both the Pell and the HOPE

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36 Averages and percentages are calculated by the author using tuition and fees and total cost of attendance estimates from IPEDS for Tennessee’s thirteen state community colleges for the 2005-2006 through 2009-2010 academic year.
scholarship receive the full amount of the HOPE scholarship as the Pell and HOPE scholarship together do not exceed students’ allowable aid or COA. For example, receiving the HOPE and the average Pell award is only a little over a third of the COA at a community college in Tennessee, and the HOPE’s limited impact might be due to its small share of the COA. Also, the average value of the HOPE scholarship equates to about $35 per week or around five hours of work per week earning the federal minimum wage rate (assuming 52 weeks per year). Thus, the HOPE may not necessarily provide a substantial exchange for labor hours over the course of a year which may also explain the program’s minimal impacts on community college students.

The HOPE scholarship also may not positively impact students after matriculation because students lose their HOPE scholarship by failing to meet renewal requirements. Carruthers & Özek (2014) find that over a third of Tennessee HOPE recipients at two-year and four-year colleges lost their scholarship within three years by failing to meet renewal criteria for cumulative GPA, and that losing the HOPE has a small but negative impact on credits and decreases the likelihood of continuous enrollment. In the analytic sample in this paper, less than two percent of HOPE recipients in the 2005 cohort lost their HOPE scholarship within one year, but around 30% of HOPE recipients lost their scholarship within two years. These percentages likely understate the percentage of students who lost their HOPE scholarship because losing HOPE records are missing for students who drop out of college immediately after losing the HOPE. While understanding the mechanisms through which financial aid affects students’ choices and outcomes are beyond the scope of this paper, losing the HOPE scholarship may help explain why the HOPE scholarship does not have lasting local impacts on community college students in Tennessee.

Lastly, it is important to acknowledge that the findings of this paper come with a caveat. Regression discontinuity is known for having strong internal validity, but regression discontinuity lacks external validity in that the estimated effects of HOPE eligibility are local around the discontinuity. HOPE eligibility does not significantly impact marginal students near the 21 ACT threshold with non-qualifying HOPE GPAs, but HOPE eligibility may impact students who have substan-

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39Data on students losing the HOPE scholarship are not available after 2008, so losing HOPE statistics are only calculated for the 2005 cohort.
tially higher ACT scores. Further research is needed to determine if HOPE eligibility significantly impacts students of higher ability in contrast to marginally eligible students, and future research in addition to the existing research will continue to be influential for policymakers in designing and implementing aid programs for both four-year university students and community college students.
References


**Best ACT Score**

Discontinuity estimate: 0.1450  
Standard error: 0.0259  
t-statistic: 5.60

**First ACT Score**

Discontinuity estimate: 0.0025  
Standard error: 0.0261  
t-statistic: 0.10

**Figure 1:** McCrary (2008) density test for ACT scores, entering freshman in academic years 2005-2009 at Tennessee public community colleges ($n = 72,640$)
Discontinuity (standard error)

**Figure 2**: HOPE eligibility by first ACT score for low GPA students 0.273 (0.012) and high GPA students 0.016 (0.010)
<table>
<thead>
<tr>
<th>(I) All Students</th>
<th>(II) Low GPA Students</th>
<th>(III) High GPA Students</th>
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<td>HOPE Eligible</td>
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<td>Number of Semesters</td>
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<td>Cumulative Hours after 1 Year</td>
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<td>Cumulative Hours after 2 Years</td>
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<td>(1,323.719)</td>
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<td>Expected Annual Wage</td>
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<td>45,128.210</td>
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<td></td>
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<td>2006 Cohort</td>
<td>0.199</td>
<td>0.205</td>
</tr>
<tr>
<td>2007 Cohort</td>
<td>0.198</td>
<td>0.195</td>
</tr>
<tr>
<td>2008 Cohort</td>
<td>0.220</td>
<td>0.207</td>
</tr>
<tr>
<td>2009 Cohort</td>
<td>0.224</td>
<td>0.214</td>
</tr>
<tr>
<td>First ACT Score</td>
<td>19.585</td>
<td>18.671</td>
</tr>
<tr>
<td></td>
<td>(2.651)</td>
<td>(2.373)</td>
</tr>
<tr>
<td>Maximum ACT Score</td>
<td>20.417</td>
<td>19.185</td>
</tr>
<tr>
<td></td>
<td>(2.977)</td>
<td>(2.500)</td>
</tr>
<tr>
<td>Observations</td>
<td>53,301</td>
<td>23,655</td>
</tr>
</tbody>
</table>

Notes: Column I lists the mean for all entering freshman in academic years 2005-2009 at Tennessee public community colleges scoring within five points of the 20.5 ACT threshold. Column II and III split the sample into students with a missing or proxy high school GPA that is less than 3.0 and students with a proxy high school GPA greater than 3.0. Standard deviations are in parentheses for continuous variables.
<table>
<thead>
<tr>
<th></th>
<th>(I) Low GPA Students</th>
<th>(II) High GPA Students</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Male</strong></td>
<td>0.056</td>
<td>0.581</td>
</tr>
<tr>
<td></td>
<td>(0.042)</td>
<td>(0.774)</td>
</tr>
<tr>
<td><strong>Black</strong></td>
<td>0.121***</td>
<td>1.588</td>
</tr>
<tr>
<td></td>
<td>(0.042)</td>
<td>(1.158)</td>
</tr>
<tr>
<td><strong>Hispanic</strong></td>
<td>0.002</td>
<td>-0.129</td>
</tr>
<tr>
<td></td>
<td>(0.010)</td>
<td>(0.153)</td>
</tr>
<tr>
<td><strong>Other nonwhite</strong></td>
<td>-0.004</td>
<td>0.038</td>
</tr>
<tr>
<td></td>
<td>(0.023)</td>
<td>(0.273)</td>
</tr>
<tr>
<td><strong>Lower-income</strong></td>
<td>-0.025</td>
<td>0.617</td>
</tr>
<tr>
<td></td>
<td>(0.050)</td>
<td>(0.942)</td>
</tr>
<tr>
<td><strong>2006 Cohort</strong></td>
<td>0.023</td>
<td>-0.448</td>
</tr>
<tr>
<td></td>
<td>(0.038)</td>
<td>(0.603)</td>
</tr>
<tr>
<td><strong>2007 Cohort</strong></td>
<td>0.058</td>
<td>0.318</td>
</tr>
<tr>
<td></td>
<td>(0.041)</td>
<td>(0.539)</td>
</tr>
<tr>
<td><strong>2008 Cohort</strong></td>
<td>-0.033</td>
<td>0.772</td>
</tr>
<tr>
<td></td>
<td>(0.042)</td>
<td>(0.614)</td>
</tr>
<tr>
<td><strong>2009 Cohort</strong></td>
<td>-0.036</td>
<td>-0.058</td>
</tr>
<tr>
<td></td>
<td>(0.022)</td>
<td>(0.409)</td>
</tr>
<tr>
<td><strong>Observations</strong></td>
<td>23,655</td>
<td>29,646</td>
</tr>
</tbody>
</table>

Notes: The table lists the estimated discontinuity at 20.5 ACT points for control variables. Discontinuities are estimated using Equation 2. Estimations are limited to students whose first ACT score is within five points of the 20.5 threshold. Column I lists results for students with missing high school GPA proxies or high school GPA proxies below 3.0. Column II lists results for students with high school GPA proxies above 3.0. Robust standard errors, clustered by first ACT score, are in parentheses. *** p<0.01, ** p<0.05, * p<0.10
### Table 3: The impact of HOPE eligibility on post-matriculation outcomes

<table>
<thead>
<tr>
<th></th>
<th>(I) Low GPA Students</th>
<th>(II) High GPA Students</th>
<th>(III) First Stage: HOPE Eligibility</th>
<th>R-squared</th>
<th>Two Stage Least Squares: Effect of HOPE on Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>HOPE Eligibility</td>
<td>Mean 0.503</td>
<td>0.273***</td>
<td>0.016</td>
<td>0.189</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.012)</td>
<td>(0.010)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R-squared</td>
<td>Mean 0.189</td>
<td>0.021</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Semesters</td>
<td>6.116</td>
<td>0.362</td>
<td>2.919</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.285)</td>
<td>(3.000)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cumulative Hours after 1 Year</td>
<td>18.865</td>
<td>1.197</td>
<td>-11.886</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1.211)</td>
<td>(14.388)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cumulative Hours after 2 Years</td>
<td>37.097</td>
<td>3.367*</td>
<td>-11.486</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1.749)</td>
<td>(31.237)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Last Observed GPA</td>
<td>2.529</td>
<td>0.007</td>
<td>-1.565</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.079)</td>
<td>(1.974)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transferred to Four-Year College</td>
<td>0.381</td>
<td>0.012</td>
<td>0.570</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.049)</td>
<td>(0.552)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Associate’s Degree within 3 Years(^1)</td>
<td>0.094</td>
<td>0.015</td>
<td>-0.852</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.026)</td>
<td>(0.989)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bachelor’s Degree within 5 Years(^2)</td>
<td>0.147</td>
<td>-0.044</td>
<td>1.357</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.044)</td>
<td>(1.887)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any Earnings While Enrolled</td>
<td>0.884</td>
<td>-0.021</td>
<td>0.341</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.030)</td>
<td>(0.514)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Quarterly Earnings While Enrolled</td>
<td>1,351.873</td>
<td>-128.399</td>
<td>-377.972</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1,347.476)</td>
<td>(1,322.390)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expected Annual Wage</td>
<td>49,504.838</td>
<td>542.046</td>
<td>25,007.112</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2,487.106)</td>
<td>(18,836.656)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any Earnings in 5(^{th}) Year After Enrollment(^3)</td>
<td>0.728</td>
<td>-0.010</td>
<td>0.507</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.062)</td>
<td>(1.430)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Quarterly Earnings in 5(^{th}) Year(^3)</td>
<td>2,645.878</td>
<td>112.896</td>
<td>893.101</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(363.400)</td>
<td>(8,772.576)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>53,301</td>
<td>23,655</td>
<td>29,646</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: The table lists the estimates of the effect of passing the 20.5 ACT threshold on HOPE eligibility (first stage, Equation 1) and the local average treatment effect of HOPE on student outcomes (two stage least squares, Equation 2). \(^1\) Estimations for an associate’s degree within 3 years are limited to cohorts 2005-2008. \(^2\) Estimations for a bachelor’s degree within five years are limited to cohorts 2005-2006. \(^3\) Any earnings and average quarterly earnings in 5\(^{th}\) year after initial enrollment are limited to students who exit school prior to the 5\(^{th}\) year with or without a degree and cohorts 2005-2006. Robust standard errors, clustered by first ACT score, are in parentheses. *** p<0.01, ** p<0.05, * p<0.10
Figure 3: Intent-to-treat impact of HOPE on student outcomes for low GPA students, reduced form discontinuities

<table>
<thead>
<tr>
<th>Variable</th>
<th>Number of Semesters</th>
<th>Cumulative Hours after 1 Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discontinuity (Standard Error)</td>
<td>0.099 (0.079)</td>
<td>0.326 (0.335)</td>
</tr>
</tbody>
</table>

Cumulative Hours after 2 Years

<table>
<thead>
<tr>
<th>Variable</th>
<th>Discontinuity (Standard Error)</th>
<th>0.918 (0.497)</th>
</tr>
</thead>
</table>

Last Observed GPA

<table>
<thead>
<tr>
<th>Variable</th>
<th>Discontinuity (Standard Error)</th>
<th>0.002 (0.022)</th>
</tr>
</thead>
</table>

Transferred to Four-Year College

<table>
<thead>
<tr>
<th>Variable</th>
<th>Discontinuity (Standard Error)</th>
<th>0.003 (0.014)</th>
</tr>
</thead>
</table>

Associate’s Degree within 3 Years

<table>
<thead>
<tr>
<th>Variable</th>
<th>Discontinuity (Standard Error)</th>
<th>0.004 (0.007)</th>
</tr>
</thead>
</table>
Bachelor’s Degree within 5 Years

Discontinuity (Standard Error)
-0.014 (0.014)

Any Earnings While Enrolled

Discontinuity (Standard Error)
-0.006 (0.008)

Average Quarterly Earnings While Enrolled

Discontinuity (Standard Error)
-35.003 (38.008)

Expected Annual Wage

Discontinuity (Standard Error)
146.089 (682.722)

Any Earnings in 5th Year After Enrollment

Discontinuity (Standard Error)
-0.003 (0.022)

Average Quarterly Earnings in 5th Year

Discontinuity (Standard Error)
40.645 (133.343)
### TABLE 4: Robustness checks for outcomes

<table>
<thead>
<tr>
<th></th>
<th>(I) Baseline</th>
<th>(II) With Controls</th>
<th>(III) Optimal Bandwidth</th>
<th>(IV) Quadratic</th>
<th>(V) Cubic</th>
<th>(VI) Seven-Point Bandwidth</th>
<th>(VII) Two-Point Bandwidth</th>
<th>(VIII) Discontinuity At 18.5 Points</th>
<th>(IX) Discontinuity At 22.5 Points</th>
<th>(X) Baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Semesters</td>
<td>0.362 (0.285)</td>
<td>0.296 (0.276)</td>
<td>0.319 (0.397)</td>
<td>0.192 (0.405)</td>
<td>0.750</td>
<td>0.211 (0.487)</td>
<td>0.118 (0.232)</td>
<td>0.065* (0.368)</td>
<td>0.553 (0.027)</td>
<td>0.137 (0.917)</td>
</tr>
<tr>
<td>Cumulative Hours after 1 Year</td>
<td>1.197 (1.211)</td>
<td>1.234 (1.204)</td>
<td>2.777** (1.241)</td>
<td>3.722** (1.759)</td>
<td>3.032</td>
<td>0.015 (2.220)</td>
<td>2.945* (0.973)</td>
<td>-6.286 (1.782)</td>
<td>20.78 (4.643)</td>
<td>-11.886 (2.484)</td>
</tr>
<tr>
<td>Cumulative Hours after 2 Years</td>
<td>3.367* (1.749)</td>
<td>3.505** (1.729)</td>
<td>3.643* (2.037)</td>
<td>3.848* (2.091)</td>
<td>5.442** (2.029)</td>
<td>1.609 (1.361)</td>
<td>5.112** (1.915)</td>
<td>-1.721 (6.819)</td>
<td>2.992 (4.527)</td>
<td>-11.486 (4.257)</td>
</tr>
<tr>
<td>Last Observed GPA</td>
<td>0.007 (0.079)</td>
<td>0.059 (0.077)</td>
<td>0.015 (0.117)</td>
<td>0.054 (0.138)</td>
<td>-0.071</td>
<td>-0.052 (0.175)</td>
<td>-0.000 (0.064)</td>
<td>-0.211 (0.113)</td>
<td>0.368 (0.037)</td>
<td>-1.565 (0.251)</td>
</tr>
<tr>
<td>Transferred to Four-Year College</td>
<td>0.012 (0.049)</td>
<td>0.001 (0.049)</td>
<td>0.014 (0.041)</td>
<td>-0.066 (0.108)</td>
<td>0.046</td>
<td>0.029 (0.141)</td>
<td>-0.021 (0.035)</td>
<td>0.280 (0.109)</td>
<td>-0.104 (0.210)</td>
<td>0.570 (0.166)</td>
</tr>
<tr>
<td>Associate’s Degree within 3 Years</td>
<td>0.015 (0.026)</td>
<td>0.020 (0.025)</td>
<td>0.027 (0.035)</td>
<td>0.052 (0.050)</td>
<td>0.061</td>
<td>0.011 (0.068)</td>
<td>0.063 (0.020)</td>
<td>-0.112 (0.091)</td>
<td>-0.281* (0.168)</td>
<td>-0.852 (0.168)</td>
</tr>
<tr>
<td>Bachelor’s Degree within 5 Years</td>
<td>-0.044 (0.044)</td>
<td>-0.040 (0.044)</td>
<td>-0.038 (0.045)</td>
<td>-0.030 (0.085)</td>
<td>-0.037</td>
<td>-0.007 (0.118)</td>
<td>-0.059 (0.033)</td>
<td>-0.022 (0.039)</td>
<td>-0.197 (0.118)</td>
<td>1.357 (0.299)</td>
</tr>
<tr>
<td>Any Earnings While Enrolled</td>
<td>-0.021 (0.030)</td>
<td>-0.024 (0.030)</td>
<td>-0.003 (0.036)</td>
<td>0.041 (0.047)</td>
<td>0.056</td>
<td>-0.024 (0.050)</td>
<td>0.040 (0.026)</td>
<td>-0.059 (0.040)</td>
<td>0.015 (0.013)</td>
<td>0.341 (0.012)</td>
</tr>
<tr>
<td>Average Quarterly Earnings While Enrolled</td>
<td>-128.399 (34.478)</td>
<td>-131.366 (132.558)</td>
<td>-96.315 (148.105)</td>
<td>60.790 (238.857)</td>
<td>-148.010</td>
<td>-178.390 (257.146)</td>
<td>-109.582 (116.052)</td>
<td>-1,357.810* (212.214)</td>
<td>-138.941 (706.934)</td>
<td>-377.972 (516.019)</td>
</tr>
<tr>
<td>Expected Annual Wage</td>
<td>542.046 (2,487.106)</td>
<td>-92.274 (2,453.841)</td>
<td>845.254 (1,631.276)</td>
<td>-193.687 (4,738.596)</td>
<td>-1,062.106</td>
<td>954.642 (6,304.992)</td>
<td>-992.645 (7,798.974)</td>
<td>-5,921.074 (7,257.954)</td>
<td>-27.010.172 (9,277.954)</td>
<td>25,007.112 (13,223.390)</td>
</tr>
<tr>
<td>Average Earnings in 5th Year</td>
<td>-0.010 (0.062)</td>
<td>-0.014 (0.061)</td>
<td>-0.013 (0.073)</td>
<td>-0.057 (0.110)</td>
<td>-0.239</td>
<td>0.012 (0.188)</td>
<td>-0.084 (0.050)</td>
<td>-0.050 (0.111)</td>
<td>-0.144 (0.852)</td>
<td>0.507 (0.446)</td>
</tr>
<tr>
<td>Average Quarterly Earnings in 5th Year</td>
<td>112.996 (363.400)</td>
<td>129.443 (352.077)</td>
<td>-28.232 (410.127)</td>
<td>-9.923 (569.128)</td>
<td>-471.818</td>
<td>-102.372 (770.905)</td>
<td>-322.262 (314.143)</td>
<td>-7,155.986 (587.394)</td>
<td>1,269.279 (11,807.761)</td>
<td>893.101 (2,707.170)</td>
</tr>
</tbody>
</table>

Notes: The table lists the estimates of the local average treatment effect of HOPE on student outcomes. Column I contains the baseline two stage least squares findings for low GPA students. Columns II-IX also estimate the impact of HOPE on low GPA students, but each column differs from the baseline specification in one respect. Column II adds controls for gender, race, lower-income status, and cohort indicators. Column III uses a triangle kernel (Nichols, 2011) with a plugged in optimal bandwidth that was calculated according to Imbens & Kalyanaraman (2012). Column IV and V use a second order polynomial and a third order polynomial, respectively, for the function of the gap between i’s ACT score and the 20.5 threshold. Column VI expands the bandwidth to seven ACT points, and column VII contracts the bandwidth to two ACT points. Columns VIII and IX test for discontinuities in the outcomes at 18.5 and 22.5 ACT points, respectively, which are not associated with HOPE eligibility. Column X contains falsification estimates for the students with high school GPA proxies above 3.0, who should not have significant discontinuities at the 20.5 threshold. Robust standard errors, clustered by first ACT score, are in parentheses. ** * p<0.01, * * p<0.05, * p<0.10
TABLE 5: Heterogeneity by lower-income status

<table>
<thead>
<tr>
<th></th>
<th>(I) Baseline</th>
<th>(II) Lower-income</th>
<th>(III) Higher-income</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low GPA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Semesters</td>
<td>0.362</td>
<td>0.371</td>
<td>0.294</td>
</tr>
<tr>
<td></td>
<td>(0.285)</td>
<td>(0.314)</td>
<td>(0.421)</td>
</tr>
<tr>
<td>Cumulative Hours after 1 Year</td>
<td>1.197</td>
<td>1.072</td>
<td>1.525</td>
</tr>
<tr>
<td></td>
<td>(1.211)</td>
<td>(1.510)</td>
<td>(1.389)</td>
</tr>
<tr>
<td>Cumulative Hours after 2 Years</td>
<td>3.367*</td>
<td>3.230*</td>
<td>3.603</td>
</tr>
<tr>
<td></td>
<td>(1.749)</td>
<td>(1.944)</td>
<td>(2.492)</td>
</tr>
<tr>
<td>Last Observed GPA</td>
<td>0.007</td>
<td>-0.024</td>
<td>0.040</td>
</tr>
<tr>
<td></td>
<td>(0.079)</td>
<td>(0.116)</td>
<td>(0.143)</td>
</tr>
<tr>
<td>Transferred to Four-Year College</td>
<td>0.012</td>
<td>0.084</td>
<td>-0.076</td>
</tr>
<tr>
<td></td>
<td>(0.049)</td>
<td>(0.066)</td>
<td>(0.069)</td>
</tr>
<tr>
<td>Associate’s Degree within 3 Years(^1)</td>
<td>0.015</td>
<td>-0.004</td>
<td>0.040</td>
</tr>
<tr>
<td></td>
<td>(0.026)</td>
<td>(0.036)</td>
<td>(0.041)</td>
</tr>
<tr>
<td>Bachelor’s Degree within 5 Years(^2)</td>
<td>-0.044</td>
<td>-0.038</td>
<td>-0.047</td>
</tr>
<tr>
<td></td>
<td>(0.044)</td>
<td>(0.042)</td>
<td>(0.074)</td>
</tr>
<tr>
<td>Any Earnings While Enrolled</td>
<td>-0.021</td>
<td>0.012</td>
<td>-0.065</td>
</tr>
<tr>
<td></td>
<td>(0.030)</td>
<td>(0.044)</td>
<td>(0.041)</td>
</tr>
<tr>
<td>Average Quarterly Earnings While Enrolled</td>
<td>-128.399</td>
<td>138.583</td>
<td>-427.015*</td>
</tr>
<tr>
<td></td>
<td>(134.476)</td>
<td>(126.753)</td>
<td>(243.374)</td>
</tr>
<tr>
<td>Expected Annual Wage</td>
<td>542.046</td>
<td>2,860.897</td>
<td>-2,500.799</td>
</tr>
<tr>
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<td>(2,487.106)</td>
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<td>Any Earnings 5(^{th}) Year After Enrollment(^3)</td>
<td>-0.010</td>
<td>0.184**</td>
<td>-0.233**</td>
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<td>(0.062)</td>
<td>(0.086)</td>
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<td>Average Quarterly Earnings in 5(^{th}) Year(^3)</td>
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<td>532.627</td>
<td>-352.872</td>
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Notes: The table lists the estimates of the local average treatment effect of HOPE on student outcomes by lower-income status. \(^1\) Estimations for an associate’s degree within 3 years are limited to cohorts 2005-2008. \(^2\) Estimations for a bachelor’s degree within five years are limited to cohorts 2005-2006. \(^3\) Any earnings and average quarterly earnings in 5\(^{th}\) year after initial enrollment are limited to students who exit school prior to the 5\(^{th}\) year with or without a degree and cohorts 2005-2006. Robust standard errors, clustered by first ACT score, are in parentheses. *** p<0.01, ** p<0.05, * p<0.10
Table 6: Omit lower percentiles for the predicted probability of attending a two-year college

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<td>10th</td>
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<td>30th</td>
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<td>0.348</td>
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<td>0.170</td>
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<td>(0.333)</td>
<td>(0.312)</td>
<td>(0.332)</td>
<td>(0.339)</td>
<td>(0.307)</td>
<td>(0.324)</td>
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<td>0.624</td>
<td>0.652</td>
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<td>0.192</td>
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<td>(1.337)</td>
<td>(1.240)</td>
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<td>(1.310)</td>
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<td>Cumulative Hours after 2 Years</td>
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<td>2.958</td>
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<td>(1.983)</td>
<td>(2.527)</td>
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<td>(0.099)</td>
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<td>0.012</td>
<td>0.016</td>
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<td>0.014</td>
<td>0.017</td>
<td>0.013</td>
<td>0.003</td>
<td>-0.002</td>
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<td>(0.038)</td>
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<td>Bachelor’s Degree within 5 Years2</td>
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<td>-0.027</td>
<td>-0.022</td>
<td>-0.001</td>
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<td>0.009</td>
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<td>(0.036)</td>
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<td>(0.040)</td>
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<td>(0.040)</td>
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<td>-0.031</td>
<td>-0.029</td>
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<td>(0.036)</td>
<td>(0.037)</td>
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<td>(0.035)</td>
<td>(0.036)</td>
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<td>(140.264)</td>
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<td>(146.913)</td>
<td>(158.206)</td>
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<td>(182.812)</td>
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<td>0.005</td>
<td>0.038</td>
<td>0.009</td>
<td>0.039</td>
<td>0.039</td>
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<td>(0.068)</td>
<td>(0.067)</td>
<td>(0.064)</td>
<td>(0.067)</td>
<td>(0.071)</td>
<td>(0.067)</td>
<td>(0.074)</td>
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<td>Average Quarterly Earnings in 5th Year3</td>
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<td>406.023</td>
<td>684.566*</td>
<td>767.430**</td>
<td>704.727**</td>
<td>654.139*</td>
<td>468.872</td>
<td>328.820</td>
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<td>(372.441)</td>
<td>(404.560)</td>
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<td>20,106</td>
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<td>16,558</td>
<td>15,375</td>
<td>14,193</td>
<td>13,010</td>
<td>11,827</td>
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</table>

Notes: The table lists the estimates of the local average impact of HOPE on student outcomes. Column I contains the two stage least squares baseline findings. Columns II-XI omit students with the lowest predicted probability of attending a two-year school in ascending order. 1 Estimations for an associate’s degree within 3 years are limited to cohorts 2005-2008. 2 Estimations for a bachelor’s degree within five years are limited to cohorts 2005-2006. 3 Any earnings and average quarterly earnings in 5th year after initial enrollment are limited to students who exit school prior to the 5th year with or without a degree and cohorts 2005-2006. Robust standard errors, clustered by first ACT score, are in parentheses. **p<0.01, *p<0.05, *p<0.10
Appendix

In this appendix, I present a graphical analysis for the discontinuity in the percentage of black students at the 20.5 threshold. I also show that the baseline results are robust to varying bandwidths and discuss the heterogeneity of the results by gender and race.

9 Test for Discontinuity in Control Variables

Discontinuity estimates for control variables are discussed in Section 4.5 and presented in Table 2. The majority of the estimates are small and insignificant for the analytic sample with one exception. The percentage of black students increases at the HOPE threshold. The graphical analysis for this control variable is presented in Figure 4. Similar to Figure 3, the mean value of each outcome for students with the same ACT score is plotted for all ACT scores within five points of the 20.5 threshold. The size of the circles in the scatter plots increase proportionate to the number of students who received a specific ACT score. Discontinuities are estimated by replacing the dependent variable with the control variable in the reduced form equation of Equation 2. The plotted fitted lines on either side of the threshold are the predicted values from the estimation, and the discontinuity or reduced form intent-to-treat effect is listed. The percentage of black students decreases as ACT score increases, but there does not visually look like there is a discontinuity in the percentage of black students at the threshold. Moreover, it appears that the relationship describing the gap between $i$’s ACT score and the 20.5 threshold is more likely to be a quadratic rather than a linear function. I estimate the discontinuity in the percentage of black students using both a quadratic and a cubic rather than using a linear specification in Equation 2, and the percentage of black students no longer registers as significant in either case. Therefore, it is unlikely that the significant discontinuity in the percentage of black students found in Table 2 is due to omitted variables that may threaten internal validity of the results. In addition, I demonstrate that the baseline findings are robust to including all controls in Section 6 in the main text.
10 Robustness Checks for Outcomes at Varying Bandwidths

I demonstrate the robustness of the baseline results by using various bandwidths in Table 7. Column I contains the baseline two stage least square findings for low GPA students similar to those reported in Column I in Table 4. Columns II through VIII also estimate the local impact of HOPE on low GPA students, but a different bandwidth is used in each column. In the main text, I include the optimal bandwidth, a seven-point bandwidth, and a two-point bandwidth in the robustness checks in Table 4. Here, I also report these estimates, but I demonstrate that the baseline findings are also robust to using a one-point, three-point, four-point, and six-point bandwidth. Cumulative hours after two years remains significant when using a three-point and four-point bandwidth, but it is not significant when using a one-point or six-point bandwidth. Cumulative hours after one year continues to exhibit some inconsistent significant discontinuities, but the coefficient for this outcome remains insignificant for many of the different bandwidths. All of the other outcome variables that are insignificant in the baseline results remain consistently insignificant when using the various bandwidths which demonstrates the robustness of the overall zero local impact of HOPE eligibility on the student outcomes.40

11 Heterogeneity by Gender and Race

In Table 8, I examine whether the baseline findings are heterogeneous across gender, race, and parents’ income. Similar to Table 5 in the main text, Column I lists the baseline results for low GPA students and Columns II and III list the results for lower-income and higher-income students, respectively. Column IV-VII present estimates for a subsample of low GPA students based on gender and race. As demonstrated in Column IV, cumulative hours after two years remains significant for males, similar to lower-income students, but the point estimate remains modest for this subgroup. All of the other student outcomes of interest remain insignificant, similar to the baseline findings, for males, females, and white students. However, there is suggestive evidence of persistence and degree effects on non-white students as can be seen in Column VII in Table 8. It appears that HOPE eligibility might have a larger and positive impact on non-white students in terms of

40Average quarterly earnings while enrolled is significant at the ten percent level when a one-point bandwidth is used, but this significant coefficient represents about one percent of the table and may be significant by chance.
transferring to a four-year university, earning an associate’s degree within three years, and earning a bachelor’s degree within five years.

Figure 5 consists of a graphical analysis for each outcome variable that exhibits a significant discontinuity for non-white students in Table 8. Similar to Figure 3, the plotted fitted lines on both sides of the threshold are the predicted outcome values from estimating the reduced form equation except the intent-to-treat estimations are limited to the subsample of non-white students. Transferring to a four-year college and earning an associate’s degree within three years increases in ACT score while earning a bachelor’s degree within five years and average quarterly earnings in the fifth year after initial enrollment seem relatively constant across ACT scores for non-white students. All four of the graphs exhibit some noise in the data above the 20.5 ACT threshold which is likely due to a small sample size. In addition, the suggestive evidence of persistence and degree effects on non-white students is weakened as there visually does not appear to be a large significant discontinuity in any of the outcome variables in the graphical analyses, especially after considering the scales on the vertical axes.

In addition, I test the robustness of the baseline results for non-white students to various specifications and bandwidths in Table 9. Column I lists the baseline results for low GPA, non-white students which are the same as reported in Column VII of Table 8. Similar to the baseline robustness checks in Table 4, Columns II through X all differ from the baseline specification in one respect (e.g. adding controls, changing the size of the bandwidth, or using a quadratic or cubic rather than a linear function of the gap between i’s ACT score and the 20.5 threshold for \( f(\cdot) \) and \( g(\cdot) \) in Equation 2). The coefficients for transferring to a four-year college, earning an associate’s degree within three years, earning a bachelor’s degree within five years, and average quarterly earnings in the fifth year all remain significant when controls are added in Column II and when a seven-point rather than five-point bandwidth is used in Column VI. However, all of these outcomes are insignificant when a two-point bandwidth is used in Column VII and when a quadratic and cubic function is used for the gap between i’s ACT score and the 20.5 threshold in Column IV and V, respectively. Therefore, while the results in Table 8 suggest that HOPE eligibility has positive persistence and degree effects on non-white students, these results are not strong enough to ascribe the discontinuities to a causal effect of HOPE rather than noise and are not robust to
different specifications and bandwidths.
FIGURE 4: Intent-to-treat impact of HOPE on controls for low GPA students, reduced form discontinuities

Black
Discontinuity (Standard Error)
0.033 (0.012)
### TABLE 7: Robustness checks for outcomes at varying bandwidths

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<th></th>
<th>(I) Baseline Low GPA</th>
<th>(II) Optimal Bandwidth</th>
<th>(III) One-Point Bandwidth</th>
<th>(IV) Two-Point Bandwidth</th>
<th>(V) Three-Point Bandwidth</th>
<th>(VI) Four-Point Bandwidth</th>
<th>(VII) Six-Point Bandwidth</th>
<th>(VIII) Seven-Point Bandwidth</th>
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</thead>
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<td>0.319</td>
<td>0.215</td>
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<td>(0.429)</td>
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<td>(0.309)</td>
<td>(0.287)</td>
<td>(0.249)</td>
<td>(0.232)</td>
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<td>Cumulative Hours after 1 Year</td>
<td>1.197</td>
<td>2.777**</td>
<td>0.621</td>
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<td>2.776*</td>
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<td>(1.977)</td>
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<tr>
<td>Cumulative Hours after 2 Years</td>
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<td>3.643*</td>
<td>3.015</td>
<td>5.112***</td>
<td>3.827**</td>
<td>3.207*</td>
<td>2.252</td>
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<td>(1.761)</td>
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<td>(1.361)</td>
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<td>Last Observed GPA</td>
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<td>0.015</td>
<td>-0.048</td>
<td>-0.000</td>
<td>0.093</td>
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<td>(0.087)</td>
<td>(0.069)</td>
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<tr>
<td>Transferred to Four-Year College</td>
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<td>0.014</td>
<td>0.088</td>
<td>-0.021</td>
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<td>(0.077)</td>
<td>(0.058)</td>
<td>(0.042)</td>
<td>(0.035)</td>
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<td>Associate’s Degree within 3 Years(^1)</td>
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<td>0.037</td>
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<td>(0.031)</td>
<td>(0.023)</td>
<td>(0.020)</td>
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<td>Bachelor’s Degree within 5 Years(^2)</td>
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<td>(0.040)</td>
<td>(0.039)</td>
<td>(0.033)</td>
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<td>(0.026)</td>
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<td>Average Quarterly Earnings While Enrolled</td>
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<td>(2,857.228)</td>
<td>(2,077.843)</td>
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<tr>
<td>Any Earnings 5(^{th}) Year After Enrollment(^3)</td>
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<td>-0.013</td>
<td>-0.140</td>
<td>-0.084</td>
<td>-0.071</td>
<td>0.016</td>
<td>0.003</td>
<td>0.012</td>
</tr>
<tr>
<td></td>
<td>(0.062)</td>
<td>(0.073)</td>
<td>(0.180)</td>
<td>(0.111)</td>
<td>(0.088)</td>
<td>(0.078)</td>
<td>(0.054)</td>
<td>(0.050)</td>
</tr>
<tr>
<td>Average Quarterly Earnings in 5(^{th}) Year(^3)</td>
<td>112.896</td>
<td>-28.232</td>
<td>-398.090</td>
<td>-322.262</td>
<td>60.670</td>
<td>21.423</td>
<td>48.968</td>
<td>-102.372</td>
</tr>
<tr>
<td>Observations</td>
<td>23,655</td>
<td>35,782</td>
<td>4,866</td>
<td>9,365</td>
<td>14,087</td>
<td>18,997</td>
<td>28,000</td>
<td>31,654</td>
</tr>
</tbody>
</table>

Notes: The table lists the estimates of the local average treatment effect of HOPE on student outcomes. Column I contains the baseline two stage least squares findings for low GPA students. Columns II-VIII also estimate the local average treatment effect of HOPE on low GPA students, but a different bandwidth is used in each column. Column II uses a triangle kernel (Nichols, 2011) with a plugged in optimal bandwidth that was calculated according to Imbens & Kalyanaraman (2012) for each outcome of interest. Column III through VI use a bandwidth of one point to seven points respectively. Any earnings and average quarterly earnings in 5\(^{th}\) year after initial enrollment are limited to students who exit school prior to the 5\(^{th}\) year with or without a degree and cohorts 2005-2006. Robust standard errors, clustered by first ACT score, are in parentheses. \(p<0.01\), \(p<0.05\), \(p<0.10\).
**TABLE 8: Heterogeneity by gender, race, and lower-income status**

<table>
<thead>
<tr>
<th></th>
<th>(I) Baseline</th>
<th>(II) Lower-income</th>
<th>(III) Higher-income</th>
<th>(IV) Male</th>
<th>(V) Female</th>
<th>(VI) White</th>
<th>(VII) Non-white</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of Semesters</strong></td>
<td>0.362</td>
<td>0.371</td>
<td>0.294</td>
<td>0.483</td>
<td>0.222</td>
<td>0.286</td>
<td>0.919</td>
</tr>
<tr>
<td></td>
<td>(0.285)</td>
<td>(0.314)</td>
<td>(0.421)</td>
<td>(0.363)</td>
<td>(0.393)</td>
<td>(0.272)</td>
<td>(0.835)</td>
</tr>
<tr>
<td><strong>Cumulative Hours after 1 Year</strong></td>
<td>1.197</td>
<td>1.072</td>
<td>1.525</td>
<td>1.229</td>
<td>1.064</td>
<td>1.424</td>
<td>1.200</td>
</tr>
<tr>
<td></td>
<td>(1.211)</td>
<td>(1.510)</td>
<td>(1.389)</td>
<td>(1.080)</td>
<td>(2.300)</td>
<td>(1.474)</td>
<td>(1.495)</td>
</tr>
<tr>
<td><strong>Cumulative Hours after 2 Years</strong></td>
<td>3.367*</td>
<td>3.230*</td>
<td>3.603</td>
<td>3.727**</td>
<td>2.719</td>
<td>3.435</td>
<td>5.085</td>
</tr>
<tr>
<td></td>
<td>(1.749)</td>
<td>(1.944)</td>
<td>(2.492)</td>
<td>(1.617)</td>
<td>(3.302)</td>
<td>(2.178)</td>
<td>(3.895)</td>
</tr>
<tr>
<td><strong>Last Observed GPA</strong></td>
<td>0.007</td>
<td>-0.024</td>
<td>0.040</td>
<td>0.158</td>
<td>-0.157</td>
<td>0.041</td>
<td>0.076</td>
</tr>
<tr>
<td></td>
<td>(0.079)</td>
<td>(0.116)</td>
<td>(0.143)</td>
<td>(0.102)</td>
<td>(0.168)</td>
<td>(0.085)</td>
<td>(0.219)</td>
</tr>
<tr>
<td><strong>Transferred to Four-Year College</strong></td>
<td>0.012</td>
<td>0.084</td>
<td>-0.076</td>
<td>-0.014</td>
<td>0.050</td>
<td>-0.034</td>
<td>0.206**</td>
</tr>
<tr>
<td></td>
<td>(0.049)</td>
<td>(0.066)</td>
<td>(0.069)</td>
<td>(0.056)</td>
<td>(0.076)</td>
<td>(0.050)</td>
<td>(0.087)</td>
</tr>
<tr>
<td><strong>Associate’s Degree within 3 Years</strong></td>
<td>0.015</td>
<td>-0.004</td>
<td>0.040</td>
<td>0.011</td>
<td>0.024</td>
<td>0.008</td>
<td>0.104**</td>
</tr>
<tr>
<td></td>
<td>(0.026)</td>
<td>(0.036)</td>
<td>(0.041)</td>
<td>(0.032)</td>
<td>(0.049)</td>
<td>(0.029)</td>
<td>(0.052)</td>
</tr>
<tr>
<td><strong>Bachelor’s Degree within 5 Years</strong></td>
<td>-0.044</td>
<td>-0.038</td>
<td>-0.047</td>
<td>-0.031</td>
<td>-0.062</td>
<td>-0.078</td>
<td>0.204**</td>
</tr>
<tr>
<td></td>
<td>(0.044)</td>
<td>(0.042)</td>
<td>(0.074)</td>
<td>(0.037)</td>
<td>(0.086)</td>
<td>(0.051)</td>
<td>(0.095)</td>
</tr>
<tr>
<td><strong>Any Earnings While Enrolled</strong></td>
<td>-0.021</td>
<td>0.012</td>
<td>-0.065</td>
<td>0.007</td>
<td>-0.059</td>
<td>-0.020</td>
<td>-0.024</td>
</tr>
<tr>
<td></td>
<td>(0.030)</td>
<td>(0.044)</td>
<td>(0.041)</td>
<td>(0.037)</td>
<td>(0.054)</td>
<td>(0.029)</td>
<td>(0.082)</td>
</tr>
<tr>
<td><strong>Average Quarterly Earnings While Enrolled</strong></td>
<td>-128.399</td>
<td>138.583</td>
<td>-427.015*</td>
<td>-113.653</td>
<td>-149.060</td>
<td>-98.232</td>
<td>-260.431</td>
</tr>
<tr>
<td></td>
<td>(134.476)</td>
<td>(126.753)</td>
<td>(243.374)</td>
<td>(183.797)</td>
<td>(252.475)</td>
<td>(161.877)</td>
<td>(211.974)</td>
</tr>
<tr>
<td><strong>Expected Annual Wage</strong></td>
<td>542.046</td>
<td>2,860.897</td>
<td>-2,500.799</td>
<td>832.206</td>
<td>128.372</td>
<td>-211.255</td>
<td>3,437.752</td>
</tr>
<tr>
<td></td>
<td>(2,487.106)</td>
<td>(2,807.866)</td>
<td>(3,870.399)</td>
<td>(2,696.458)</td>
<td>(3,315.112)</td>
<td>(2,449.387)</td>
<td>(3,866.150)</td>
</tr>
<tr>
<td><strong>Any Earnings in 5th Year After Enrollment</strong></td>
<td>-0.010</td>
<td>0.184**</td>
<td>-0.233**</td>
<td>-0.115</td>
<td>0.144</td>
<td>0.017</td>
<td>-0.207</td>
</tr>
<tr>
<td></td>
<td>(0.062)</td>
<td>(0.086)</td>
<td>(0.103)</td>
<td>(0.089)</td>
<td>(0.116)</td>
<td>(0.057)</td>
<td>(0.166)</td>
</tr>
<tr>
<td><strong>Average Quarterly Earnings in 5th Year</strong></td>
<td>112.896</td>
<td>532.627</td>
<td>-352.872</td>
<td>-50.402</td>
<td>354.217</td>
<td>444.502</td>
<td>-1,804.277**</td>
</tr>
<tr>
<td><strong>Observations</strong></td>
<td>23,655</td>
<td>10,639</td>
<td>13,016</td>
<td>11,813</td>
<td>11,842</td>
<td>18,850</td>
<td>4,805</td>
</tr>
</tbody>
</table>

Notes: The table lists the estimates of the local average treatment effect of HOPE on student outcomes by gender, race, and lower-income status. 1 Estimations for an associate’s degree within 3 years are limited to cohorts 2005-2008. 2 Estimations for a bachelor’s degree within five years are limited to cohorts 2005-2006. 3 Any earnings and average quarterly earnings in 5th year after initial enrollment are limited to students who exit school prior to the 5th year with or without a degree and cohorts 2005-2006. Robust standard errors, clustered by first ACT score, are in parentheses. ** p<0.01, * p<0.05, * p<0.10
Figure 5: Intent-to-treat impact of HOPE on student outcomes for non-white low GPA students, reduced form discontinuities

<table>
<thead>
<tr>
<th></th>
<th>Discontinuity (Standard Error)</th>
<th>Discontinuity (Standard Error)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transferred to Four-Year College</td>
<td>0.073 (0.033)</td>
<td>0.035 (0.017)</td>
</tr>
</tbody>
</table>

Average for Non-white: Transferred to Four-Year
Fit, 5pt Bandwidth (n=4805 students)

Average for Non-white: Associate’s Degree Within 3 Years
Fit, 5pt Bandwidth (n=3555 students)

Bachelor’s Degree within 5 Years
Discontinuity (Standard Error) 0.070 (0.032)

Average for Non-white: Bachelor’s Degree Within 5 Years
Fit, 5pt Bandwidth (n=1612 students)

Average Quarterly Earnings in 5th Year
Discontinuity (Standard Error) -640.923 (308.221)

Average for Non-white: Avg Quarterly Earnings in 5th Year
Fit, 5pt Bandwidth (n=1010 students)
TABLE 9: Robustness checks for outcomes for non-white students

<table>
<thead>
<tr>
<th></th>
<th>(I) Baseline: Non-white Low GPA</th>
<th>(II) With Controls</th>
<th>(III) Optimal Bandwidth Quadric</th>
<th>(IV) Cubic</th>
<th>(V) Seven-Point Bandwidth</th>
<th>(VI) Two-Point Bandwidth</th>
<th>(VII) Discontinuity At 18.5 Points</th>
<th>(VIII) Discontinuity At 22.5 Points</th>
<th>(IX) Baseline High GPA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Semesters</td>
<td>0.919 (0.835)</td>
<td>0.869 (0.793)</td>
<td>0.776 (0.834)</td>
<td>0.273 (1.364)</td>
<td>0.865 (1.530)</td>
<td>0.759 (0.686)</td>
<td>-0.007 (1.468)</td>
<td>2.249 (3.031)</td>
<td>2.575 (1.906)</td>
</tr>
<tr>
<td>Cumulative Hours after 1 Year</td>
<td>1.200 (1.495)</td>
<td>1.176 (1.492)</td>
<td>1.580 (3.172)</td>
<td>1.105 (3.255)</td>
<td>4.555 (4.878)</td>
<td>1.239 (1.308)</td>
<td>1.928 (3.579)</td>
<td>-0.545 (8.439)</td>
<td>2.193 (6.605)</td>
</tr>
<tr>
<td>Cumulative Hours after 2 Years</td>
<td>5.085 (3.895)</td>
<td>5.035 (3.735)</td>
<td>2.170 (4.802)</td>
<td>2.565 (7.746)</td>
<td>1.804 (10.645)</td>
<td>3.997 (3.168)</td>
<td>-2.571 (8.140)</td>
<td>0.167 (17.130)</td>
<td>10.627 (11.322)</td>
</tr>
<tr>
<td>Last Observed GPA</td>
<td>0.076 (0.219)</td>
<td>0.056 (0.212)</td>
<td>0.050 (0.274)</td>
<td>-0.116 (0.351)</td>
<td>0.460 (0.460)</td>
<td>0.180 (0.173)</td>
<td>-0.333 (0.336)</td>
<td>-0.420 (0.746)</td>
<td>0.770 (0.770)</td>
</tr>
<tr>
<td>Transferred to Four-Year College</td>
<td>0.206** (0.087)</td>
<td>0.207** (0.088)</td>
<td>0.147* (0.087)</td>
<td>-0.131 (0.167)</td>
<td>0.145 (0.303)</td>
<td>0.146** (0.061)</td>
<td>-0.127 (0.194)</td>
<td>0.200 (0.378)</td>
<td>0.089 (0.301)</td>
</tr>
<tr>
<td>Associate’s Degree within 3 Years</td>
<td>0.104** (0.087)</td>
<td>0.100** (0.088)</td>
<td>0.102 (0.084)</td>
<td>0.097 (0.112)</td>
<td>0.355 (0.137)</td>
<td>0.103*** (0.039)</td>
<td>0.082 (0.109)</td>
<td>0.099 (0.194)</td>
<td>0.035 (0.173)</td>
</tr>
<tr>
<td>Bachelor’s Degree within 5 Years</td>
<td>0.204** (0.095)</td>
<td>0.201** (0.094)</td>
<td>0.214 (0.133)</td>
<td>0.286 (0.157)</td>
<td>0.170 (0.175)</td>
<td>0.170** (0.075)</td>
<td>0.143 (0.155)</td>
<td>-0.335 (0.394)</td>
<td>0.284 (1.014)</td>
</tr>
<tr>
<td>Any Earnings While Enrolled</td>
<td>-0.024 (0.082)</td>
<td>-0.024 (0.085)</td>
<td>-0.040 (0.087)</td>
<td>-0.068 (0.153)</td>
<td>-0.000 (0.179)</td>
<td>-0.047 (0.068)</td>
<td>-0.021 (0.140)</td>
<td>-0.072 (0.363)</td>
<td>0.156 (0.185)</td>
</tr>
<tr>
<td>Average Quarterly Earnings While Enrolled</td>
<td>-260.431 (211.974)</td>
<td>-287.050 (240.887)</td>
<td>-224.050 (226.740)</td>
<td>-45.974 (285.679)</td>
<td>422.995 (539.926)</td>
<td>-310.751* (174.798)</td>
<td>275.082 (359.089)</td>
<td>-357.224 (1297.157)</td>
<td>472.916 (-415.330)</td>
</tr>
<tr>
<td>Expected Annual Wage</td>
<td>3,437.752 (3,866.150)</td>
<td>3,624.39 (3,738.076)</td>
<td>2,591.573 (3,497.917)</td>
<td>-4,989.138 (6,548.839)</td>
<td>-15,765.385 (14,049.066)</td>
<td>-2,081.441 (174,798)</td>
<td>-10,913.492 (359,089)</td>
<td>-6,491.291 (1,297,157)</td>
<td>-617,103 (815,330)</td>
</tr>
<tr>
<td>Any Earnings 5th Year After Enrollment</td>
<td>-0.207 (0.166)</td>
<td>-0.204 (0.158)</td>
<td>-0.184 (0.216)</td>
<td>0.245 (0.341)</td>
<td>0.040 (0.432)</td>
<td>-0.021** (0.134)</td>
<td>0.040 (0.134)</td>
<td>-0.271** (0.436)</td>
<td>0.168 (12.832)</td>
</tr>
<tr>
<td>Average Quarterly Earnings in 5th Year</td>
<td>-1,804.277** (835.411)</td>
<td>-1,784.521** (852.769)</td>
<td>-1,664.228 (1,113.193)</td>
<td>-816.755 (1,329.129)</td>
<td>-15,765.385 (695,665)</td>
<td>-1,288.847 (1,560,230)</td>
<td>-19,239.314 (12943,797)</td>
<td>-13,760,000 (15,069,065)</td>
<td>-1,462 (825,431)</td>
</tr>
</tbody>
</table>

Notes: The table lists the estimates of the local average treatment effect of HOPE on student outcomes. Column I contains the baseline two stage least squares findings for non-white students. Columns II-X differ from the baseline specification in one respect. Column II adds controls for gender, race, lower-income status, and cohort indicators. Column III uses a triangle kernel (Nichols, 2011) with a plugged in optimal bandwidth that was calculated according to Imbens & Kalyanaraman (2012). Column IV and V use a second order polynomial and a third order polynomial, respectively, for the function of the gap between i’s ACT score and the 20.5 threshold. Column VI expands the bandwidth to 7 ACT points, and column VII contracts the bandwidth to 2 ACT points. Columns VIII and IX test for discontinuities in the outcomes at 18.5 and 22.5 ACT points, respectively, which are not associated with HOPE eligibility. Column X contains falsification estimates for the students with high school GPA proxies above 3.0, who should not have significant discontinuities at the 20.5 threshold. Robust standard errors, clustered by first ACT score, are in parentheses. ** p<0.01, * p<0.05, * p<0.10