Losing HOPE: Financial Aid and the Line between College and Work*

Celeste K. Carruthers and Umut Özek†

September 2013

Abstract

Although a wealth of research has shown that financial aid reduces hurdles to college enrollment, broad-based merit aid programs have not yielded large gains in educational attainment. One overlooked explanation for this puzzle is the fact that many students lose merit scholarships midway through college, perhaps hindering their ability and willingness to stay enrolled. Using longitudinal data on four cohorts of Tennessee public college students, we find that failing to renew merit scholarships decreases credit loads, decreases the likelihood of declaring a major, increases earnings, and increases the likelihood of leaving college without a degree for the workforce. Together, findings demonstrate that losing financial aid weakens students' engagement with college, particularly at the extensive margin.

Keywords: Merit Aid, Higher Education, Labor Force Participation

JEL: I23, H42, H75, J22

*We thank the Tennessee Higher Education Commission for providing access to data used in this study. We are grateful to Joshua Price, Tim Sass, Mai Seki, Mark Showalter and participants of the 2012 Southern Economic Association meetings, the 2013 CALDER meetings, and the 2013 Association for Education Finance and Policy meetings for valuable comments and suggestions. All errors are our own.

†Carruthers (corresponding author): Department of Economics, Stokely Management Center, University of Tennessee. Knoxville, TN 37996-0570. Email: carruthers@utk.edu. Özek: Center for Analysis of Longitudinal Data in Educational Research, American Institutes for Research. 1000 Thomas Jefferson Street, NW, Washington, D.C. 20007. Email: uozek@air.org.

1 Introduction

Students in public colleges and universities rarely face the full cost of their enrollment. In addition to public funds that flow directly to colleges and universities, students themselves are subsidized with an assortment of financial aid packages and low-interest loans. Generally financed by state and federal governments, such aid is motivated by multifaceted positive externalities of higher education (Oreopoulos & Salvanes, 2011) as well as credit constraints that pose hurdles to college enrollment. Financial aid is intended to increase access to college, increase persistence and progression through college, and increase the likelihood of college completion. Voluminous research has shown that financial aid awards can significantly increase the likelihood that a student attends college,[1] although this is certainly not true of all financial aid vehicles.[2] In a review of this area of research, Deming & Dynarski (2010) point to transparent financial aid programs as being the most effective at increasing college enrollment.

A smaller but quickly expanding literature examines how financial aid affects student persistence, behavior, and graduation, conditional on postsecondary enrollment. Castleman & Long (2012) find that need-based eligibility for Florida Student Assistance Grants significantly increases credit accumulation and degree receipt. By contrast, Fitzpatrick & Jones (2012) and Sjoquist & Winters (2012) find little to no effect of exposure to broad-based merit aid on degree receipt across states. Cohodes & Goodman (2012) show that a Massachusetts scholarship for high-achieving students has the unintended effect of reducing the likelihood of degree receipt by incentivizing students to attend in-state public colleges rather than higher-quality private or out-of-state colleges. Scott-Clayton (2011) demonstrates that West Virginia's PROMISE

[1] *Inter alia,* Dynarski (2000); Seftor & Turner (2002); Dynarski (2003); Kane (2003); Cornwell et al. (2006); Carrell & Sacerdote (2013)

[2] Hansen (1983); Rubin (2011); Bruce & Carruthers (2013)

scholarship increases credits earned, grade-point averages, and the likelihood of receiving a bachelor's degree. The impact of PROMISE on persistence appears to be driven in part by structural incentives, because scholarship-holders are more likely to meet college credit and courseload benchmarks that are tied to scholarship renewal. Cornwell et al. (2005) show that renewal requirements for Georgia's HOPE scholarship result in strategic course withdrawals and credit reductions among marginal students.

Although it is clear that students respond to the threat of losing scholarships, surprisingly little is known about what happens after scholarship loss. Dee & Jackson (1999) and Henry et al. (2004) provide descriptive profiles of students who lose Georgia's HOPE scholarship. Scholarship loss tends to be associated with lower credit accumulation and a decreased likelihood of degree receipt (Henry et al., 2004), as well as more difficult science, engineering, and computing programs (Dee & Jackson, 1999).

Yet to date, it remains unclear how financial aid affects the substitution of college for work, much less whether the *loss* of financial aid reverses that substitution. Broad-based merit aid programs are often criticized for predominantly benefitting students who would have enrolled and completed college without additional aid. If so, typical scholarship holders would be insensitive to the loss of aid, and the behaviors highlighted by Cornwell et al. (2005) and Scott-Clayton (2011) may be driven by a non-pecuniary aversion to losing financial aid more so than financial pressure. This, in turn, would imply that building more "nudges" into scholarship programs would a cost-effective improvement to merit aid. But if losing one's scholarship results in substantially weaker engagement with college and a shift toward work, this would stand as further evidence that scholarships relieve financial constraints to attending and progressing through college.

We find evidence for both views of merit aid. Our setting is the Tennessee system of public

colleges and universities, where a large merit-based financial aid program has collected more than $2 billion for a broad base of eligible students. We find that the overall effect of losing merit aid on credit loads is small, and that the replacement rate from labor market earnings is just 7-16 percent of the value of lost aid. Yet losing aid has a comparatively large effect on the extensive margin, leading to a 5-7 percentage point decline in college enrollment *per se*. This can help to explain why merit aid has had little impact on college completion. Any extra-marginal students who enroll because of aid may well be at the highest risk of losing aid, and in turn, of leaving college.

College-going students in Tennessee qualify for the state's HOPE scholarship – a fixed transfer which covers a large share of tuition and fees at in-state public and private colleges – with modestly above-average high school performance or a modestly above-average ACT score. Although the merit thresholds for obtaining HOPE are well within reach for most college-ready students, the thresholds for *retaining* HOPE once enrolled are effectively much higher. We examine the college and work behavior of more than 90,000 Tennessee college students who entered college between 2003 and 2006. Out of more than 40,000 students who held lottery-financed HOPE scholarships, 42 percent eventually lost their scholarship by failing to meet benchmarks for cumulative grade point averages. We utilize two-way fixed effects models to estimate the effect of losing the HOPE scholarship on post-enrollment and labor outcomes, holding constant students' idiosyncratic ability and trends common to all students who lose HOPE.

This study does not speak to the normative value of scholarship retention policies, but rather, the untapped opportunity to learn about the role of postsecondary financial aid in shaping the tradeoff between college and work by examining student choices after financial aid is withdrawn.

Put in other words, the event of losing one's HOPE scholarship provides unique identifying variation in financial aid after college enrollment. In addition to measures of college and workforce participation, we examine students' choice of major in the wake of losing HOPE. If scholarships offset long-term debt, losing financial aid may push students into more lucrative majors. We find, however, that scholarship loss coincides with migration *out* of traditionally high-return majors and decreases the likelihood of declaring *any* major.

We conclude that financial aid in the form of a HOPE scholarship helps to define the line between college and work, particularly at the extensive margin. These observations are not limited to students who stand to lose the scholarship. While losing HOPE leads to less engagement with college and more engagement with the labor force, the converse is true for members of the last entering cohort before HOPE who – unlike any student to follow – earned HOPE after enrolling.

The remainder of the paper is organized as follows. Section 2 describes the policy landscape surrounding this application. Section 3 describes the data and empirical strategy we use to the address the question of how financial aid affects students' commitment to college. Section 4 discusses findings, and Section 5 concludes.

2 Policy Background

The HOPE scholarship accounts for the bulk of the Tennessee Education Lottery Scholarship Program (TELS), which was initiated after a 2002 statewide referendum approved lottery-financed postsecondary scholarships. The first HOPE scholarships were distributed in the fall of 2004 to eligible entering freshmen as well as sophomores from the 2003 cohort who met the post-enrollment conditions of a one-time grandfather clause. This 2003 cohort who had the opportunity to *gain* the HOPE scholarship is important to our empirical strategy because their

behavior sheds light on the extent to which results drawn from scholarship loss generalize to students presented with financial aid after enrollment.

Beginning with 2004 entrants, students were eligible to receive a HOPE grant if they enrolled in a Tennessee public college (two-year or four-year) or in an in-state private nonprofit college within 16 months of high school graduation. As of the 2008-2009 academic year, the basic HOPE scholarship provided up to $4,000 per year to eligible students attending four-year institutions and up to $2,000 per year to students in two-year community colleges, covering about 70 percent of required tuition and fees. Students must attain either a 21 on the ACT or an overall weighted high school grade point average of 3.0 in order to be eligible for a HOPE scholarship. Part-time students are eligible for pro-rated HOPE grants, and $1,000 - 1,500 supplements are awarded to lower-income students or high-achieving students with high school grade point averages of at least 3.75 and ACT scores of at least 29 points.

Over most of the window of time this study focuses on, college students retain the HOPE scholarship by maintaining continuous enrollment and a college GPA of 2.75 after 24 attempted hours and 3.0 after 48, 72, and 96 attempted hours, up to five calendar years from the date of initial enrollment. The GPA threshold for 48 accumulated credits was reduced from 3.0 to 2.75 beginning with the fall of 2008. Students are able to reinstate withdrawn HOPE scholarships one time by meeting the appropriate renewal criteria. In practice, this affects a very small number of students. Others are able to regain their scholarships through idiosyncratic appeals processes at each university.[3]

[3]Additional criteria and exceptions applicable to the present-day TELS are described in full at http://www.tn.gov/collegepays.

3 Data and Empirical Strategy

3.1 Data

This study makes use of 2003-2008 longitudinal data on four cohorts of Tennessee postsecondary students who enter college between the summer of 2003 and the fall of 2006. Administrative data provided by the Tennessee Higher Education Commission (THEC) cover fall and spring terms for all two-year and four-year public colleges in the state. We omit students who appear to be dual-enrolled in high school and college, and we limit the analysis to college students who fit the profile of first-time freshman, the scholarship's target group. Specifically, we focus on students ever identified as "freshman" in one administrative field and no older than 21 upon entering college. We further limit the sample by excluding students who lose HOPE scholarships for reasons other than missing a GPA benchmark, since triggers like non-continuous or part-time enrollment encompass some of the outcomes we are interested in.[4] The final sample tracks the enrollment and work behavior of more than 90,000 unique students enrolled between the fall 2003 term and the fall 2008 term, the last term for which we observe scholarship data.

THEC enrollment files are used to identify postsecondary students' institution, attempted credit load, cumulative grade point average, major, gender, race/ethnicity, and HOPE scholarship status. Quarterly earnings data from the Tennessee Department of Labor and Workforce Development are merged to students' postsecondary profile to identify labor force participation and earnings between 2003 and 2008, including quarters when students are not enrolled. Earnings data are limited to in-state employees covered by Unemployment Insurance, which excludes self-employed workers, federal workers, and some agricultural workers. These exceptions are

[4]The post-enrollment GPA criteria is most frequent the cause of HOPE loss, describing over three-quarters of instances where a HOPE scholarship is withdrawn. Results are robust to the exclusion of a small number of students with multiple recorded reasons for scholarship loss.

much less likely to apply to traditional college students than the working population at large. We align spring terms with the first two quarters of each calendar year and fall terms with the last two quarters and express all earnings in inflation-adjusted 2005 dollars. Rather than test for the impact of HOPE loss on *any* earnings, we define a labor force participation threshold equal to minimum wage earnings at halftime, i.e., 500 hours per six months. We omit terms where students are working but have not yet entered college, terms after terminal degree receipt, and for non-completers, we exclude working terms that occur more than two years after the last enrolled term. The result is a postsecondary panel of college and work outcomes tracking individual students from their initial enrollment through the first of three possible outcomes: fall 2008, degree completion, or two years after exit from college without a degree.

The panel of college and work data is merged with students' Free Application for Federal Student Aid (FAFSA) record, which is available for 95 percent of the sample, as well as full histories of ACT exams dating back to 2002 (available for 79 percent on average, much less so for the earliest cohort). FAFSA and ACT data, together, provide rich detail on household income, which we use as a control in some specifications. Lastly, we identify required tuition and fees for each institution and academic year using the Integrated Postsecondary Education Data System.

Table 1 lists summary statistics for college and labor outcomes describing the panel of students. Column I summarizes the entire college-work panel, Columns II-IV describe students while they are enrolled, and Columns V-VII describe work outcomes for former students (non-completers, necessarily) who are in the workforce but not in college. Outcome variables of interest are students' college enrollment *per se*, term-by-term attempted credit load, major, the likelihood of changing a major, the likelihood of at least halftime earnings, and the quantity of earnings in a given term. Across the panel, 82.5 percent of student-terms are spent actively

enrolled in college. Enrolled students attempt 13.1 hours per term, on average, and four-year students generally enroll for more credits than two-year students. More than three-quarters of student-terms are associated with earnings, although just 45.9 percent surpass the halftime earnings threshold. Enrolled four-year students typically earn $2,213 per half-year and two-year students earning $3,414 per half-year. Not surprisingly, non-completers in the workforce generally earn much more than their enrolled counterparts (Columns V-VII).

Majors are observed as two-digit Classification of Instructional Program (CIP) fields,[5] with 21.7 percent of students "undeclared." We define major changers as students in term t whose primary major is a different two-digit CIP code from the previous term, $t-1$. Changing majors is a frequent occurrence, such that 14.5 percent of enrolled students are in a new major each year. Of those, about one-third have switched from the null undeclared category to a specific field. We organize two-digit CIP majors into thirteen broad fields including "undeclared." The most popular fields, aside from the undeclared option, are business, general studies (nearly unique to two-year schools), health-related fields, and social sciences.

Losing the HOPE scholarship is fairly common, as illustrated by additional descriptive statistics found in Table 2. There, we show that 13.1 percent of the panel describes students who previously held the HOPE scholarship but lost it by failing to meet GPA benchmarks. Note that this understates the propensity for first-time scholarship holders to lose the scholarship because just a small share of the 2003 cohort gain HOPE with their first-year college performance. Out of more than 40,000 students who ever hold the scholarship in these data, 42 percent eventually lose HOPE support.

[5]We observe the six-digit CIP code for each student's major (e.g., "14.0701 Chemical Engineering") but focus on broader two-digit majors (like "14. Engineering") for the sake of comparability across institutions.

The remainder of Table 2 describes time-varying and time-invariant characteristics of students. More than half are in a four-year college or university, and each semester's tuition and fees average $2,407 for four-year students and $1,191 for two-year students. Working non-completers are matched to data on college sector and tuition from the last college they attended. With that in mind, Columns VI and VII do not suggest that more costly colleges are more or less represented among exiters.

Grade point averages are an important feature of the identification strategies to follow, both as controls in fixed effect estimates and running variables in regression discontinuity designs. GPA data are backward-looking, meaning that the GPA observed in term t refers to grades through $t-1$. Cumulative grade point averages are not observed when students are not enrolled. We carry students' last observed GPA forward to unenrolled terms. Even so, GPA data, imputed or not, are missing for a non-trivial share of terms. As we show in Table 2, GPA is more likely to be missing for students who have left college. Many of them leave after just one semester, in which case we never observe a grade point average. We use what information is available on college GPA (including whether or not GPA data are missing) to control for student performance and estimate the effect of scholarship loss on student outcomes, relative to students with similar grade point averages at similar points in their college sequence.

3.2 Methods: Estimating the Effect of Losing HOPE on Postsecondary and Labor Outcomes

Across- and within-student variation in HOPE receipt is used to identify the effect of losing the scholarship on postsecondary and labor outcomes described in Section 3.1 and Table 1. First, we employ a "within" fixed effects estimator to discern the impact of losing HOPE on student

behavior, controlling for student fixed effects. Then, regression discontinuity designs are used to sharply identify the change in student behavior following the loss of HOPE merit aid. Fixed effects and regression discontinuity methodologies have complementary strengths in this context. Fixed effects estimators are well-suited to examine the extensive margins of college and labor force participation, where GPA running variables are not well defined, and fixed effects results encompass students well removed from the renewal thresholds. Regression discontinuity estimators, relying on a sharper identification boundary, support the internal validity of fixed effect estimators and provide estimates of local average treatment effects.

3.2.1 Fixed effects estimation

First, we stack cohort panels by students' sequence of enrollment and estimate the following:

$$Y_{it} = \alpha_0 + \alpha_i + \alpha_t + \delta \mathbf{1}(losthope_{it}) + \mathbf{Z}_{it}\gamma + (t - t_0)\mathbf{1}(before)_{it}\eta_1$$

$$+(t - t_0)\mathbf{1}(after)_{it}\eta_2 + \beta_t GPA_{it} + \varepsilon_{it}, \quad (1)$$

where Y_{it} represents an outcome for individual i in his or her t^{th} semester. The parameter α_i is an individual fixed effect and α_t is a fixed effect for the t^{th} semester in students' time series. The treatment of interest, $\mathbf{1}(losthope)_{it}$, is equal to one in all terms after HOPE loss. That is, $\mathbf{1}(losthope)_{it}$ is equal to zero up to and including the last term with HOPE aid, and equal to one thereafter. Students who never receive the scholarship and students who never lose the scholarship have $\mathbf{1}(losthope)_{it} = 0$ for all terms. The vector $\mathbf{Z}_{it}$ contains time-varying student characteristics that might affect postsecondary progression and labor force participation: college grade point average, an indicator for missing grade point average, an indicator for fall terms, tuition and fees, and an indicator for enrollment in a four-year college. $\mathbf{Z}_{it}$ also contains a linear function of time to capture underlying trends in postsecondary outcomes that affect all students. We denote term t_0

as the first term without HOPE for students who lose the scholarship, such that parameters η_1 and η_2 estimate trends in student outcomes leading up to HOPE loss and following HOPE loss, respectively. Finally, $\beta_t GPA_{it}$ allows the relationship between GPA and student outcomes to vary by time, and moreover, leads Equation 1 to identify the effect of HOPE loss in a student's t^{th} semester as relative to outcomes from other students with the same GPA in their t^{th} semester.

Equation 1 is limited to students in the 2004-2006 cohorts, who entered college when the HOPE merit scholarship program was fully implemented. Identifying variation stems from within-student changes in HOPE status (for these cohorts, the only change would be the *loss* of HOPE aid), conditional on α_t shocks common to all students in their t^{th} semester, as well as from across-student differences in HOPE status as of the t^{th} semester, conditional on α_i heterogeneity.

The coefficient on $\mathbf{1}(losthope_{it})$ in Equation 1 returns the average effect of losing aid across scholarship holders within the 2004-2006 cohorts, but does little to quantify the impact of scholarship funds themselves. The basic HOPE grant is supplemented for low-income students as well as those who qualify with exceptionally high ACT scores and high school performance. Additionally, nominal HOPE grants grew from \$1,500-\$4,000 to \$2,000-\$5,500 over the short window of time we consider. We exploit variation in the inflation-adjusted value of HOPE scholarships across students and time to identify the impact of each \$1,000 in merit aid. Specifically, we complement Equation 1 with the following:

$$Y_{it} = \alpha_0 + \alpha_i + \alpha_t + \delta \mathbf{H}_{it} + \mathbf{Z}_{it}\gamma + (t - t_0) * \mathbf{1}(before)_{it}\eta_1$$

$$+(t - t_0)\mathbf{1}(after)_{it}\eta_2 + \beta_t GPA_{it} + \varepsilon_{it}, \tag{2}$$

where $\mathbf{H}_{it}$ is the amount of inflation-adjusted HOPE scholarship funds student i holds in term t, and other variables are defined as before. Equation 2 is estimated for the 2004-2006 cohort, but

also the 2003 cohort in isolation. Unlike students who entered college later, the 2003 cohort had the opportunity to *gain* the HOPE scholarship beginning with the fall 2004 term, so long as they met the 24-credit 2.75-point GPA benchmark. Examining the 2003 cohort on its own allows us to test whether Equation 1 and 2 results are limited to the *loss* of aid, or rather, if findings generalize to include the award of aid as well.

It may be the case that students who lose the scholarship are of fundamentally lower ability and motivation, and if so, it is highly plausible that these students are less prepared for college and more apt to substitute work for college. Student fixed effects control for time-invariant heterogeneity of this nature, and results for the 2003 grandfathered cohort help to describe the extent to which results generalize to students of higher ability. Another threat to internal validity, however, is the idea that students who lose the HOPE scholarship are following a fundamentally different trajectory than students who retain the scholarship, or that the loss of a scholarship coincides with other unobserved factors affecting college performance. We address this possibility in two ways. First, the interaction $\beta_t GPA_{it}$ controls for cumulative student performance as of semester t in each students' college sequence. Second, we address dynamic trends by controlling for $(t - t_0)\mathbf{1}(before)_{it}$ and $(t - t_0)\mathbf{1}(after)_{it}$ in Equations 1 and 2, that is, a linear function of the gap between the current term and the first term without the HOPE scholarship. Coefficients on these terms provide insight regarding the pre- and post-loss trajectory of student outcomes, and allow the δ coefficient on $\mathbf{1}(losthope)_{it}$ to be identified as the short-term deviation from pre-loss levels of student outcomes.

3.2.2 Regression discontinuity estimation

GPA thresholds for HOPE renewal present the opportunity to more sharply identify the impact of losing HOPE on college and workforce outcomes. Requirements that HOPE scholars enroll full time and meet GPA targets at multiples of 24 credits typically lead to HOPE renewal actions after even-numbered semesters. Just over half of students in the analytic sample who lose the HOPE scholarship do so following their second semester in college. We focus on students holding HOPE scholarships in their second, fourth, and sixth semesters and employ a regression discontinuity design centered around the appropriate GPA threshold for HOPE renewal. We test whether students who just miss the threshold react fundamentally different than students who just meet the threshold. As a starting point, consider the following:

$$Y_{it} = \theta_0 + \delta \mathbf{1}(losthope_{it}) + \theta_1(g_{it} - \bar{g}_t)\mathbf{1}(below)_{it} + \theta_2(g_{it} - \bar{g}_t)\mathbf{1}(above)_{it} + \epsilon_{it}$$

$$t = 3, 5, 7 \tag{3}$$

where Y_{it} and $\mathbf{1}(losthope)_{it}$ are outcomes and HOPE loss indicators, respectively, for student i in his or her t^{th} semester. The variable g_{it} is i's grade point average in semester $t = 3, 5, 7$. Grade point averages are cumulative and backward-looking, so the semester t GPA encompasses coursework and grades through semester $t - 1$. The term $\bar{g}_t$ is the relevant HOPE renewal threshold. The threshold is 2.75 for $t = 3$ and 3.0 for $t = 7$. The $t = 5$ threshold is 3.0 for terms prior to fall 2008 and 2.75 thereafter. Indicators $\mathbf{1}(below)_{it}$ and $\mathbf{1}(above)_{it}$ denote grade point averages below and above the relevant threshold. Since crossing the threshold is not perfectly predictive of losing HOPE, we estimate the model by two-stage least squares with $\mathbf{1}(below)_{it}$ serving as the excluded instrument in the first-stage equation for $\mathbf{1}(losthope_{it})$ (Hahn et al., 2001). Note that the backward-looking nature of grade point averages, combined with the absence

of GPA data for students who are not enrolled, limits this analysis to students who return to college in the term immediately following the benchmark semester, with or without HOPE. We are thus unable to estimate the effect of HOPE loss on the likelihood of immediate departure from college. Instead, we use this framework to estimate the effect of losing HOPE on the likelihood of continued enrollment, through at least two terms following benchmark semesters.

Students are well aware of GPA thresholds for scholarship renewal, and the distributions of grade point averages in third, fifth, and seventh semesters exhibit significant heaping just above the thresholds.[6] This is problematic for treatment effects estimated by δ to the extent that factors leading to awareness of the threshold and reaction to the threshold are correlated with the outcomes of interest. The direction of bias is ambiguous. Students who work to earn a GPA just over the threshold when, in the absence of HOPE, they would have earned something less may be comparatively motivated individuals who are more engaged with college than their peers. In that case, supra-threshold outcomes would be higher than they would be the absence of HOPE and regression discontinuity treatment effects for college outcomes could be biased downward, favoring less motivated students who make weaker efforts to pass the renewal threshold. Alternatively, students who just surpass the threshold may be reacting to the renewal criteria in less productive ways, by taking a lighter courseload in semester $t-1$ or strategizing major choice to increase the likelihood of retaining HOPE. These possibilities have support from the literature (Cornwell et al., 2005; Sjoquist & Winters, 2013), and if supra-threshold outcomes are suppressed by such students, results for college engagement will be biased upward.

The question of what students *would have done* in the absence of a HOPE scholarship

[6]Local linear density estimators informed by McCrary (2008) strongly reject the hypothesis that GPA varies smoothly over the renewal threshold for post-HOPE cohorts but not pre-HOPE cohorts.

program is one we address directly in order to proceed with regression discontinuity estimates. First, we use a pre-HOPE cohort of students who enter college in 2002 to estimate credit loads and earnings by ordinary least squares at semester t based on gender, race, family income, ACT score, distance from home, indicators for spring and summer entrants, current tuition and fees, a time trend, and an indicator for fall semesters. Forward-looking, binary enrollment outcomes are estimated by probit, controlling for the same covariates. Parameter estimates are applied to post-HOPE cohorts to proxy for counterfactual outcomes each term ($\hat{Y}_{it}$).

Define $\tilde{Y}_{it}$ to be a student outcome net of expectations based on observables. For continuous outcomes – credit loads and earnings – we let the change in residual outcomes serve as the dependent variable in a fuzzy regression discontinuity design ($\tilde{Y}_{it} = \Delta(Y_{it} - \hat{Y}_{it})$). This procedure is not suitable for enrollment outcomes, however, because by necessity all students in the analytical sample are enrolled in term t and the benchmark term $t-1$. Therefore the enrollment outcome of interest is residual *future* enrollment in $t+1$. That is, we define $\tilde{Y}_{it}$ to be $Y_{it+1} - \hat{Y}_{it+1}$ for enrollment. Then, for residual changes in credit loads and earnings, and for residual future enrollment, we estimate the following by two-stage least squares with $\mathbf{1}(below)_{it}$ instrumenting for $\mathbf{1}(losthope_{it})$:

$$\tilde{Y}_{it} = \theta_0 + \delta \mathbf{1}(losthope_{it}) + \theta_1(g_{it} - \bar{g}_t)\mathbf{1}(below)_{it} + \theta_2(g_{it} - \bar{g}_t)\mathbf{1}(above)_{it} + \epsilon_{it}$$

$$t = 3, 5, 7 \tag{4}$$

Results tell us how the student behavior varies over the GPA threshold, relative to expectations based on observable components of Y_{it} data generating processes. Equation 4 is limited to students within 0.75 points of the relevant threshold. Results described in Section 4.2 show that treatment effects remain statistically significant after student outcomes are adjusted for

expectations. Students who just miss a GPA target exhibit lower credit hours and higher earnings in the following term, and they are more apt to leave college.

Results to follow are quantitatively robust to variants of the empirical strategy described by Equations 1 and 2, including the exclusion of students who lose HOPE for multiple reasons, additional controls for calendar term fixed effects, the exclusion of semester-GPA interactions, and non-linear forms for pre-loss and post-loss trends. Additionally, we estimate Equations 1 and 2 where the dependent variable is the *change* in student outcomes, controlling for student fixed effects. Regression discontinuity results are robust to several modifications of Equation 4 and the estimating sample. See Appendix A for details on all robustness and falsification tests.

4 Results

4.1 The impact of losing HOPE on enrollment, credit loads, and earnings

Figure 1 illustrates some of the stylized facts about student behavior in semesters proximate to HOPE loss. The figure plots mean attempted credits (panel I) and enrollment rates (panel II) for students who ever lose the HOPE scholarship, by the number of terms until or since their first term without the scholarship. The marker to the left of the dashed line in Figure 1 describes the term where a low GPA triggered the withdrawal of HOPE scholarships, and the marker at the dashed line represents the first term without HOPE aid. An immediate decrease in credit loads and immediate decrease in enrollment are evident in the first semester without HOPE. Equations 1 and 2 essentially test whether these observations are robust to additional controls for student characteristics, broad institutional factors and trends, and unobserved student-level heterogeneity.

Table 3 lists Equation 1 and 2 estimates for the effect of HOPE loss and other time-varying factors on enrollment and credits attempted per term. Column I indicates that the likelihood of

college enrollment declines by 7.0 percentage points immediately after HOPE loss, more than 8 percent of the mean. The small, negative coefficient on "Terms since HOPE loss" indicates that enrollment continues to decline after scholarship loss, consistent with Figure 1. For students who stay enrolled, Column IV shows that course loads decline by 1.11 credits in a student's first term without HOPE support, representing 8.4 percent of the 13.1-credit mean.

Other results in Columns I and IV are worthy of note. Since Equation 1 includes student fixed effects, the coefficient on the "Four-year college" binary indicator is largely driven by students transferring between two-year to four-year institutions. Transferring to a four-year college is estimated to increase attempted credits per term but decrease the likelihood of continued enrollment by a large share. This is consistent with work showing that students transferring from community colleges are much less likely to persist and earn degrees than students who start in four-year colleges (Long & Kurlaender, 2008).

Our last observation from Columns I and IV is the result that a $1,000 increase in biannual tuition and fees increases credit loads by 1.64 hours, and meaningfully increases the likelihood of enrollment as well. At face value, the effect of tuition appears to be an unconventionally positive price elasticity, but given the fixed costs of enrolling each term, this finding may indicate that higher tuition pushes students to accelerate their progress toward graduation. Enrolling in more classes can be a rational response to higher tuition when tuition schedules nonlinearly favor full-time enrollment. Pausing to consider this possibility, Figure 2 plots coefficients from 13 specifications of Equation 1, where the dependent variable is the likelihood of enrolling for h credits, $h \in [3, 15]$. Losing HOPE aid increases the propensity to enroll for less than 12 credit hours (the typical full-time course load) and decreases the likelihood of enrolling for more than 12 credits. By contrast, higher tuition leads to substantial bunching at 12 credits, suggesting that

raising the direct price of college leads students to take more advantage of nonlinear tuition schedules.

Columns II and V of Table 3 list estimates from Equation 2, with the value of students' HOPE scholarships representing the financial aid treatment in place of $\mathbf{1}(losthope_{it})$. As with Columns I and IV, estimates are limited to the 2004-2006 cohorts who enrolled when merit scholarships were fully implemented, and within-student identifying variation in financial aid is limited to scholarship loss. At the extensive margin, each $1,000 of HOPE aid withdrawn decreases the likelihood of enrollment by 5.4 percentage points. Similarly, each $1,000 of withdrawn HOPE aid yields 1.72 fewer credits, on average. These findings are an odd contrast to the effect of tuition: for instance, each $1,000 rise in required tuition and fees leads to 1.49 *additional* credits per term and a significantly *higher* likelihood of enrollment. Conditional on college enrollment, why would a reduction in grants have the opposite effect as an increase in price, since both imply additional out-of-pocket spending on college? The HOPE scholarship is a conditional cash transfer, its withdrawal is expected to have a pure income effect on the intensive margin, and in the absence of HOPE, students have weaker incentives to enroll full-time. Rising tuition, on the other hand, can conceivably result in more intense enrollment in the short term if full-time enrollment is incentivized in the tuition schedule and if taking on more credits per term reduces the number of future terms that students need to commit to college. A related idea is the notion that students who are more apt to lose HOPE, and thus, are contributing more to variation in the HOPE treatment, are perhaps *less* inherently committed to completing college than the student body as a whole.

Columns III and VI of Table 3 lists estimates from Equation 2 for the subset of the panel that began college in 2003. A portion of these students were eligible for HOPE scholarships beginning

with the fall of 2004, via a grandfather clause tied to completing 24 credits with at least a 2.75 grade point average. Thus, the 2003 cohort stood to gain and lose HOPE scholarships. For this cohort, each $1,000 of HOPE funds leads to 0.857 additional credits, much less than the impact on later cohorts. But like the later cohorts, incremental HOPE aid has 5.4-point impact on enrollment *per se*.

Findings reported in Table 3 indicate that losing HOPE decreases college engagement in terms of enrollment and credit load. A sensible substitute to time spent in college is time spent in work. Table 4 shows that although losing HOPE is associated with very little change in labor force participation beyond halftime (Columns I-III), the term following scholarship loss is linked to $114 in additional earnings (Column IV). This is a large increase over pre-loss trends, but the discrete change in earnings following HOPE loss is only 4.2 percent of mean half-year earnings for enrolled students. Columns V - VI show that Each $1,000 of HOPE aid withdrawn leads to just $69 - 158 in additional earnings in the short term, a 7-16 percent replacement rate.

4.2 Additional evidence from GPA renewal thresholds

In this section we exploit discrete renewal criteria tied to cumulative grade point averages to estimate the impact of losing HOPE on credit loads, earnings, and the likelihood of continued enrollment. Because the cumulative GPA running variable is backward-looking and undefined for students who have left college, results are necessarily limited to students who return to college after meeting or failing to meet the renewal criteria. For this reason, we are unable to estimate discontinuities in the likelihood of enrolling immediately after HOPE support is withdrawn. Instead, we analyze the likelihood of enrollment in the succeeding term, i.e., two terms after a critical benchmark semester. Findings are listed in Table 5.

GPA thresholds are strongly predictive of students' HOPE status. The probability of losing HOPE after benchmark semesters is 59.5 percentage points higher upon passing the threshold from above. Nevertheless, some students with grades meeting the threshold lose the scholarship for other reasons and some students below the threshold retain the scholarship through appeals processes.

Column I lists results for Δ*credit load*$_{it}$, the actual, observed change in credit load from one benchmark term to the next. Losing HOPE via the GPA threshold is associated with 0.420 fewer credit hours. Column II lists results for the residual change in credit hours, netting out students' expected term-to-term change based on pre-HOPE behavior. The treatment effect is even larger than (but not significantly different from) the unadjusted change in credit hours: losing HOPE reduces student credit loads by 0.512 credits, on average, across the first three major benchmarks. One explanation for the difference between Column I and II is the idea that students who successfully manipulate the threshold do so in part by taking fewer credits than expected in the critical semester determining eligibility for renewal. Unreported analysis support this idea. This behavior, in turn, leads to a larger than expected change in credits among students just meeting the threshold.

Columns III and IV of Table 5 lists regression discontinuity results for earnings, and conclusions are in directional agreement with those estimated by fixed effects. Controlling for expected in-school earnings leads to a somewhat larger treatment effect on earnings, which are estimated to fall by $263 per term for students just failing to meet the renewal threshold.

Columns V and VI report results for discontinuities in residual enrollment in the term following HOPE loss, i.e., two terms after benchmark semesters. The unadjusted propensity to enroll is 7.2 percentage points lower for students who just miss the threshold. Column VI lists

discontinuity estimates for residual future enrollment ($Y_{it} - \hat{Y}_{it}$), where $\hat{Y}_{it}$ is estimated using observable student and institutional characteristics alongside parameter estimates from probit regressions on students who enter college in 2002, before HOPE. Adjusting for expected enrollment in this way reduces the treatment effect of losing HOPE to 4.7 percentage points, which is nevertheless a substantial impact on the extensive margin.

Table 5 results reinforce and add texture to conclusions from fixed effects estimators. Losing the HOPE scholarship leads to a significant decrease in college participation along the extensive and intensive margins and increases activity in the labor force. The magnitude of regression discontinuity estimates, however, are quite different than the magnitude of impacts from fixed effects estimators: local treatment effects are lower than fixed effects estimates for credit loads and enrollment but higher for earnings. This suggests that students with grade point averages farther below the threshold decrease credit loads by more, leave college at higher rates, and increase earnings by less than students who just miss the renewal threshold.

Figure 3 plots residual enrollment against the gap between grade point average and relevant renewal thresholds. The discontinuity estimated by Equation 4 is evident at the renewal threshold. Students who just miss the HOPE renewal criteria are noticeably less likely to remain enrolled two terms later, and the likelihood of continued enrollment drops steeply at points farther from the threshold.

4.3 HOPE loss and the choice of major

The basic HOPE scholarship covers over 70 percent of tuition and fees in Tennessee public colleges and universities over the window of time this study considers. If HOPE scholarships offset student borrowing, and if students are averse to holding debt, losing HOPE may induce

students to favor majors with a higher perceived yield or more secure employment prospects in the labor market. Rothstein & Rouse (2011) show that the introduction of a "no loans" policy at a selective university increased participation in relatively low-yield public service fields. Variation in the "no loans" policy is across cohorts, however, and it is not clear *a priori* if an analogous substitution across fields will be observed for students who lose financial aid midway through college.

Table 6 lists Equation 1 estimates for the effect of losing HOPE on the propensity to change majors as well as the likelihood of selecting one of thirteen broad fields. The estimating sample includes the 2004-2006 cohorts, many of whom started college with HOPE aid. Turning first to Column I, we find that losing HOPE increases the likelihood of changing majors by 1.4 percentage points, 10 percent of the mean migration rate between majors. The remaining columns of Table 6 highlight the fields students migrate between in the wake of losing HOPE. Losing HOPE has a small, negative, but statistically significant impact on the likelihood of majoring in business, engineering, general studies, health-related fields, and science. Conversely, losing HOPE has a small positive impact on the likelihood of declaring an education major or recreation major. The effect of HOPE loss on major choice appears to be a shift *away* from traditionally well paying fields, and point estimates represent a non-trivial share of average participation in each major. We caution, however, that Equation 1 is not designed to parse the *pull* of particular majors from the *push* from others, and that it may be the case that some majors have GPA requirements as high or higher than the HOPE threshold.

The most striking feature of results reported in Table 6 is the effect of HOPE loss on the null "undeclared" option (Column II). The likelihood of being undeclared is 7.0 percentage points higher in the term immediately following failure to renew HOPE, ot 32 percent of the

unconditional likelihood of being undeclared. Potential mechanisms behind the choice to remain or become undeclared are not well understood,[7] but delays in identifying a path through college can conceivably derail the completion of college itself. Together with the effects of HOPE loss on credit loads, the observation that losing HOPE slows major choice further shapes the conclusion that financial aid strengthens commitment to college, and losing financial aid weakens that commitment.

5 Concluding Remarks

Tennessee is one of several states with generous merit aid packages available to a broad base of new enrollees but often withdrawn at comparatively stringent renewal benchmarks. The fact that many students lose merit aid before completing college is well-known, but to date little has been done to examine the impact of scholarship loss on student persistence or work behavior. Our findings shed light on the role of financial aid after enrollment by identifying student reactions to the frequent occurrence of *losing* financial aid. We identify the causal effect of scholarship loss of students' credit loads, major choices, and labor outcomes for four recent cohorts of students in Tennessee public colleges and universities. We find strong evidence that financial aid helps students define the line between college and work, and specifically, that losing financial aid shifts that line in such a way that students become less engaged with college and more engaged with work. Students attempt fewer credits after losing the scholarship and participate more in the workforce. Students do not appear to strategize their choice of major in response to HOPE loss. Instead, they are significantly less likely to declare *any* major, underscoring the idea that the loss

[7] A wealth of research has sought to identify the effect of future earnings on major choice (e.g., Wiswall & Zafar (2011); Zafar (2011)) but to our knowledge, no study has specifically examined the intersection of aid and the transition between the undeclared state and particular majors.

of financial aid can erode commitment to college.

To date, broad-based merit aid programs have benefitted millions of students across more than a dozen states[8] but have not registered an equivalent impact on educational attainment overall (Fitzpatrick & Jones, 2012; Sjoquist & Winters, 2012). One explanation for these incongruous observations is that merit aid predominantly benefits students whose college completion would not be affected by a change in aid, and that the comparatively small number of extra-marginal students who enroll because of aid are the least likely to complete. Our findings offer support for these ideas with an important, often overlooked corollary: many students who are eligible for broad-based merit aid lose their scholarships midway through college, and so the treatment effect of additional aid can be short-lived.

Losing the Tennessee HOPE scholarship decreases the likelihood of continued enrollment by 4.7 - 7.0 percentage points in the short-term. By comparison, the impact of scholarship loss on students who stay enrolled is somewhat small. For these students, enrollment declines by about one credit: one-third of a typical class and just 8.4 percent of the mean. Collectively, findings are consistent with credit constraints that necessitate a work-college substitution, particularly at the boundary between any enrollment and no enrollment.

The operative constraints appear to be so binding in the short term – or, myopia is so pronounced among college students – that students sacrifice considerable lifetime earnings for small gains in immediate earnings. The nominal value of a HOPE scholarship is worth much less than the "sheepskin" effects of degree completion (Jaeger & Page, 1996), or for non-completers, the returns to college persistence (Flores-Lagunes & Light, 2010). Thus, students who leave

[8] In 2011-2012, eleven (sixteen) states had merit-only aid programs accounting for at least three-quarters (half) of aid expenditures (NASSGAP, 2013).

college in the wake of losing $1,500 - $5,500 in annual HOPE aid likely do so at great expense to future earnings. These findings have policy implications for scholarship retention models, although we emphasize that parsing the motivational and strategic effects of renewal criteria is beyond the scope of this study. Rather, our findings have practical implications for how advisers and financial aid administrators can potentially improve student outcomes after the loss of merit aid (by pointing students toward other aid options, for instance). More broadly, we provide evidence that merit scholarships have meaningful bearing on the commitment to college after enrollment. Losing financial aid has the immediate effect of pushing students out of college – completely or partially – and into the workforce.

A Robustness Checks

Tables 7 - 9 organize results from robustness and specification checks. Table 7 and Table 8, respectively, compare "lost HOPE" and scholarship value coefficient estimates across several variants of Equations 1 and 2. Table 9 contains sensitivity and falsification test results for the Equation 4 regression discontinuity design.

Column I of Tables 7 and 8 repeats baseline Equation 1 results for enrollment, credit load, the existence of at least halftime earnings, and the inflation-adjusted value of earnings (see Tables 3 and 4 in the main text). Columns II - V each deviate from Equation 1 in one respect. Cluster-robust standard errors are found below each coefficient estimate.

Main results omit students who lose the HOPE scholarship for reasons other than GPA (change in enrollment status, for instance), according to administrative records. These triggers overlap with some of the outcomes of interest, so we focus on estimating the effect of losing HOPE via the GPA criteria. A portion of students lose the scholarship for more than one reason, including GPA. Column II of Table 7 lists estimates of the effect of losing HOPE on enrollment and labor force outcomes when we omit these students. Results are fundamentally unchanged in both statistical and economic significance.

The Column III specification adds calendar-based term fixed effects to the Equation 1 model, which also includes fixed effects for students' semester sequence. The Column IV specification removes semester-GPA interactions ($\beta_t GPA_{it}$) interactions from Equation 1. Column III and IV results and inferences are in broad agreement with those of Column I.

The last two specification checks are responses to the possibility that dynamic trends in student outcomes are correlated with the propensity to lose HOPE. The baseline Equation 1

specification address these threats with controls for linear time trends unique to students who lose the HOPE scholarship. Column V reports results with additional controls for a quadratic time trend prior to HOPE loss. Coefficients suggest a much stronger impact of HOPE loss on enrollment than preferred specifications would indicate, and a weaker impact on labor market outcomes.

With Column IV ambiguities in mind, we estimate the term-to-term change in continuous outcomes, controlling for student fixed effects and other time-varying factors from previous models:

$$\Delta Y_{it} = \alpha_0 + \alpha_i + \alpha_t + \delta \mathbf{1}(losthope_{it}) + \mathbf{Z}_{it}\gamma + (t - t_0)\mathbf{1}(before)_{it}\eta_1$$

$$+(t - t_0)\mathbf{1}(after)_{it}\eta_2 + \beta_t GPA_{it} + \varepsilon_{it}, \tag{5}$$

In Equation 5, fixed effects control for unobserved individual, linear time trends in outcomes of interest. Variables $(t - t_0)\mathbf{1}(before)_{it}$ and $(t - t_0)\mathbf{1}(after)_{it}$ control for trends in the change in Y_{it} across terms leading up to and following HOPE loss. Column VI lists results for the "lost HOPE" coefficient estimated by Equation 5. In agreement with the Column V model controlling for pre-loss quadratic trends, the Column VI impact of HOPE loss on credit loads is estimated to be much larger than that of Column I. We take this as further evidence that the *sign* of treatment effects is robust to student trends, but question the magnitude of Column V-VI treatment effect estimates. Column V suggests that losing HOPE decreases credit loads by 2.6 credits, on average. This diverges widely from comparatively modest descriptive statistics (Figure 1 points to a half-credit decline, on average) and regression discontinuity estimates (also about a half-credit).

Table 8 repeats these five robustness checks for the effect of scholarship value. The sign and significance of results are strongly consistent across specifications. As in Table 7, the magnitude

of effects on enrollment outcomes are noticeably larger in Columns V-VI.

In Table 9, the last set of robustness checks pertain to regression discontinuity estimates for attempted credit loads, earnings, and enrollment (Equation 4). Baseline two-stage least squares results from Table 5 are repeated in the first row of Table 9. Cluster-robust standard errors are below each coefficient. Recall that baseline regression discontinuity results are drawn from specifications of Equation 4 with linear functional forms, limited to students within 0.75 points of their relevant GPA threshold. The succeeding three rows are robustness checks, listing fuzzy regression discontinuity results under modifications that should not affect results. First, the bandwidth is widened to include students within 1.0 points of the threshold, then narrowed to 0.50 points. Third, quadratic functional forms are used in place of linear functional forms to allow for more flexible relationships between GPA gaps and student outcomes, at the risk of letting outcomes farther from the threshold hold more weight in discontinuity estimates. Across these robustness checks, we find little deviation from the magnitude or significance of baseline results.

The last two rows of Table 9 list results from falsification tests for discontinuities 0.50 points above or below actual thresholds. These false thresholds have no meaning for HOPE renewal, but as round multiples of 0.25, they may have bearing on other scholarships, departmental requirements, or university policies that affect outcomes of interest. The magnitude of any significant discontinuities at false thresholds, therefore, will permit comparisons of the collective effect of these other incentives to the effect of losing HOPE. We find little evidence of significant impacts on outcomes of interest at other round GPA thresholds. Two likely spurious exceptions are found at 0.50 GPA points higher than the HOPE renewal threshold. In contrast to the HOPE threshold, students who fall just short of the higher threshold exhibit $44 fewer earnings and a one percentage-point higher tendency to enroll the following term.

References

Bruce, D. J., & Carruthers, C. K. (2013). Jackpot? The Impact of Lottery Scholarships on Enrollment in Tennessee. Working Paper.

Carrell, S. E., & Sacerdote, B. (2013). Late Interventions Matter Too: The Case of College Coaching New Hampshire. Working Paper No. 19031, National Bureau of Economic Research, Cambridge, MA.

Castleman, B. L., & Long, B. T. (2012). Looking Beyond Enrollment: The Causal Effect of Need-Based Grants on College Access, Persistence, and Graduation. Working Paper.

Cohodes, S., & Goodman, J. (2012). First Degree Earns: The Impact of College Quality on College Completion Rates. Harvard Kennedy School Faculty Research Working Paper Series No. RWP12-033.

Cornwell, C., Mustard, D. B., & Sridhar, D. J. (2006). The Enrollment Effects of Merit-Based Financial Aid: Evidence from Georgia's HOPE Program. *Journal of Labor Economics*, *24*(4), 761 – 786.

Cornwell, C. M., Lee, K. H., & Mustard, D. B. (2005). Student Responses to Merit Scholarship Retention Rules. *Journal of Human Resources*, *40*, 895–917.

Dee, T. S., & Jackson, L. A. (1999). Who Loses HOPE? Attrition from Georgia's College Scholarship Program. *Southern Economic Journal*, *66*(2), 379 – 390.

Deming, D., & Dynarski, S. (2010). Into College and Out of Poverty? Policies to Increase the Postsecondary Attainment of the Poor. In P. Levine, & D. Zimmerman (Eds.) *Targeting*

Investments in Children: Fighting Poverty When Resources are Limited, (pp. 283–302). Chicago: University of Chicago Press.

Dynarski, S. (2000). Hope for Whom? Financial Aid for the Middle Class and Its Impact on College Attendance. *National Tax Journal*, *53*(3), 629 – 661.

Dynarski, S. M. (2003). Does Aid Matter? Measuring the Effect of Student Aid on College Attendance and Completion. *American Economic Review*, *93*(1), 279 – 288.

Fitzpatrick, M. D., & Jones, D. (2012). Higher Education, Merit-Based Scholarships and Post-Baccalaureate Migration. Working Paper No. 18530, National Bureau of Economic Research, Cambridge, MA.

Flores-Lagunes, A., & Light, A. (2010). Interpreting Degree Effects in the Returns to Education. *Journal of Human Resources*, *45*(2), 439–467.

Hahn, J., Todd, P. E., & van der Klauuw, W. (2001). Identification and Estimation of Treatment Effects with a Regression Discontinuity Design. *Econometrica*, *69*, 201–209.

Hansen, W. L. (1983). The Impact of Student Financial Aid on Access. In J. Froomkin (Ed.) *The Crises in Higher Education*. New York: Academy of Political Science.

Henry, G., Rubenstein, R., & Bugler, D. (2004). Is HOPE enough? Impacts of receiving and losing merit-based financial aid. *Educational Policy*, *18*(5), 686–709.

Jaeger, D. A., & Page, M. E. (1996). Degrees Matter: New Evidence on Sheepskin Effects in the Returns to Education. *Review of Economics and Statistics*, *78*(4), 733 – 740.

Kane, T. (2003). A Quasi-Experimental Estimate of the Impact of Financial Aid on College-Going. Working Paper No. 9703, National Bureau of Economic Research, Cambridge, MA.

Long, B. T., & Kurlaender, M. (2008). Do Community Colleges Provide a Viable Pathway to a Baccalaureate Degree? Working Paper No. 14367, National Bureau of Economic Research, Cambridge, MA.

McCrary, J. (2008). Manipulation of the Running Variable in the Regression Discontinuity Design: A Density Test. *Journal of Econometrics*, *142*, 698–714.

NASSGAP (2013). 43rd Annual Survey Report on State-Sponsored Student Financial Aid: 2011-2012 Academic Year. *National Association of State Student Grant and Aid Programs*.

Oreopoulos, P., & Salvanes, K. G. (2011). Priceless: The Nonpecuniary Benefits of Schooling. *Journal of Economic Perspectives*, *25*(1), 159–184.

Rothstein, J., & Rouse, C. E. (2011). Constrained After College: Student Loans and Early Career Occupational Choices. Working Paper No. 13117, National Bureau of Economic Research, Cambridge, MA.

Rubin, R. B. (2011). The Pell and the Poor: A Regression-Discontinuity Analysis of On-Time College Enrollment. *Research in Higher Education*, *52*(7), 675 – 692.

Scott-Clayton, J. (2011). On Money and Motivation: A Quasi-Experimental Analysis of Financial Incentives for College Achievement. *Journal of Human Resources*, *46*, 614–646.

Seftor, N. S., & Turner, S. E. (2002). Back to School: Federal Student Aid Policy and Adult College Enrollment. *Journal of Human Resources*, *37*(2), 336 – 352.

Sjoquist, D. L., & Winters, J. V. (2012). State Merit-based Financial Aid Programs and College Attainment. Working Paper.

Sjoquist, D. L., & Winters, J. V. (2013). State Merit-based Programs and College Majors: A Focus on STEM. Working Paper.

Wiswall, M., & Zafar, B. (2011). Determinants of college major choice: identification using an information experiment. Federal Reserve Bank of New York, Staff Reports: 500.

Zafar, B. (2011). How Do College Students Form Expectations? *Journal of Labor Economics*, *29*(2), 301 – 348.

Table 1: Descriptive statistics: 2003-2006 cohorts of Tennessee public postsecondary students

	I	II	III	IV	V	VI	VII
		Enrolled Students			Working Non-completers		
						Started in	Started in
Sample	Panel	All	Four-year	Two-year	All	Four-year	Two-year
Dependent variables							
Actively enrolled in college	0.825						
Credit load (attempted credits this term)	13.085	13.085	14.212	11.36			
	(3.459)	(3.459)	(2.629)	(3.843)			
At least half-time earnings	0.459	0.407	0.333	0.52	0.708	0.697	0.712
Earnings while enrolled	3.187	2.688	2.213	3.414	5.541	5.315	5.623
(half-year, 2005$, thousands)	(3.504)	(3.104)	(2.783)	(3.413)	(4.247)	(4.081)	(4.303)
Different major from last term	0.145	0.145	0.166	0.113			
Undeclared major	0.217	0.217	0.279	0.122			
Agriculture major	0.014	0.014	0.023	0.002			
Business major	0.112	0.112	0.139	0.072			
Education major	0.017	0.017	0.025	0.005			
Engineering major	0.045	0.045	0.056	0.028			
Health-related major	0.100	0.100	0.062	0.158			
Humanities major	0.056	0.056	0.092	0.000			
General studies major	0.221	0.221	0.005	0.552			
Recreation major	0.012	0.012	0.020	0.000			
Science major	0.048	0.048	0.074	0.008			
Social science major	0.094	0.094	0.143	0.018			
Skilled trades major	0.026	0.026	0.025	0.027			
Visual/performing arts major	0.038	0.038	0.056	0.010			
n_{it} (student-years)	555,474	458,295	277,171	181,124	97,179	26,076	71,103

NOTES: Standard deviations are in parentheses below means of continuous variables. "Halftime earnings" is a binary variable equal to one if nominal, half-year earnings meet or exceed 500 hours at the minimum wage. Earnings are in inflation-adjusted 2005 dollars.

Table 2: Descriptive statistics: 2003-2006 cohorts of Tennessee public postsecondary students

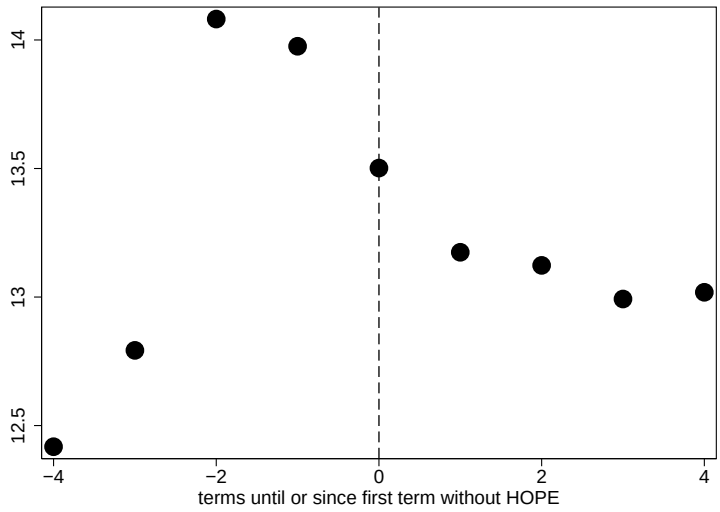
	I	II	III	IV	V	VI	VII
					Working Non-completers		
		Enrolled Students				Started in	Started in
Sample	Panel	All	Four-year	Two-year	All	Four-year	Two-year
Independent variables - time-varying							
Lost HOPE	0.131	0.130	0.147	0.105	0.134	0.251	0.091
Scholarship value (in thousands)	0.538	0.650	0.970	0.162	0.008	0.022	0.003
	(0.857)	(0.903)	(0.995)	(0.393)	(0.122)	(0.199)	(0.076)
Terms until HOPE loss (negative)	-0.171	-0.202	-0.220	-0.176	-0.022	-0.014	-0.024
	(0.682)	(0.736)	(0.756)	(0.703)	(0.273)	(0.211)	(0.293)
Terms since HOPE loss	0.268	0.253	0.299	0.182	0.338	0.598	0.242
	(0.942)	(0.914)	(1.002)	(0.755)	(1.062)	(1.349)	(0.917)
Four-year public	0.546	0.605	1.000	0.000	0.268	1.000	0.000
Cumulative GPA	2.063	2.190	2.404	1.864	1.461	1.573	1.419
	(1.325)	(1.314)	(1.256)	(1.332)	(1.209)	(1.085)	(1.249)
Missing GPA	0.058	0.0510	0.046	0.059	0.093	0.116	0.084
Tuition and fees (000s)	1.855	1.926	2.407	1.191	1.521	2.382	1.206
	(0.623)	(0.618)	(0.215)	(0.049)	(0.531)	(0.185)	(0.042)
Student characteristics - time-invariant							
Male	0.444	0.440	0.445	0.433	0.460	0.482	0.451
Black	0.755	0.766	0.755	0.783	0.705	0.662	0.721
White	0.188	0.177	0.186	0.164	0.24	0.27	0.229
Family income $<$ 60,000	0.483	0.471	0.441	0.516	0.541	0.554	0.536
Missing family income	0.115	0.099	0.060	0.157	0.191	0.120	0.217
ACT score	20.616	20.965	22.243	19.01	18.966	20.418	18.434
	(4.227)	(4.249)	(4.112)	(3.673)	(3.695)	(3.679)	(3.555)
Missing ACT	0.044	0.029	0.008	0.061	0.112	0.053	0.134
Spring entrant	0.094	0.085	0.055	0.132	0.138	0.085	0.157
Summer entrant	0.034	0.035	0.034	0.036	0.032	0.030	0.033
Distance from home	0.555	0.582	0.760	0.310	0.427	0.650	0.345
(00s of miles)	(0.940)	(0.973)	(1.143)	(0.522)	(0.757)	(1.002)	(0.625)
Missing distance	0.030	0.018	0.010	0.029	0.087	0.085	0.087
n_{it} (student-years)	543,259	439,899	261,518	178,381	103,360	29,290	74,070

NOTES: Standard deviations are in parentheses below means of continuous variables. Other independent variables include an indicator for fall terms, a linear trend, student fixed effects, semester sequence fixed effects, and interactions between semester sequence fixed effects and cumulative GPA. Scholarship values, tuition, and fees are in inflation-adjusted 2005 dollars.

Figure 1: Descriptive statistics: Credit load and college enrollment propensity, relative students' first term without the HOPE scholarship

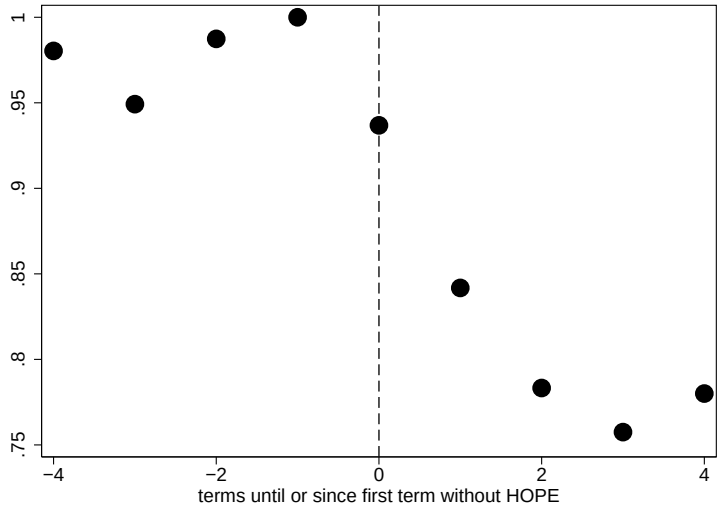
I

Credit load



II

Likelihood of college enrollment



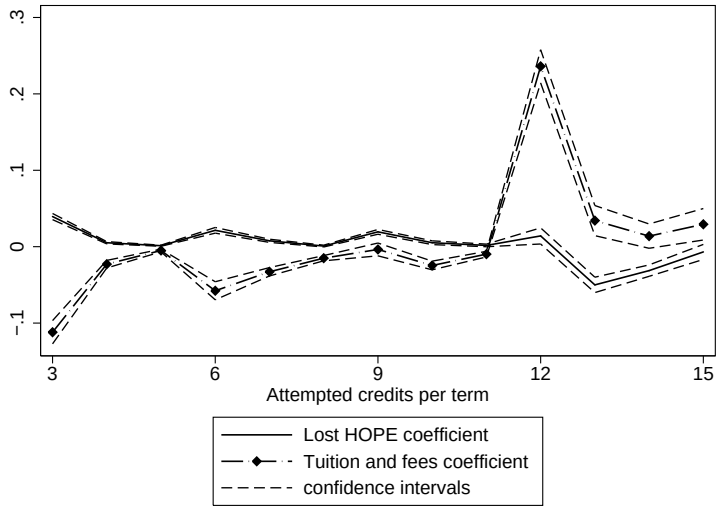
NOTES: Figures plot hours attempted (panel I) and the fraction of students enrolled (panel II), relative to their first term without the HOPE scholarship.

Table 3: The impact of losing HOPE on college enrollment and credit loads

	I	II	III	IV	V	VI
Outcome	$\mathbf{1}(enrolled)_{it}$			$\mathbf{1}(credit\ load)_{it}$		
Equation	(1)	(2)	(2)	(1)	(2)	(2)
Cohorts	2004-2006	2004-2006	2003	2004-2006	2004-2006	2003
Lost HOPE	-0.070***			-1.112***		
	(0.003)			(0.038)		
Scholarship value (000s)		0.054***	0.054***		1.717***	0.857***
		(0.001)	(0.002)		(0.021)	(0.036)
Terms until HOPE loss	0.081***	0.084***	0.041***	0.347***	0.765***	0.381***
	(0.001)	(0.001)	(0.002)	(0.021)	(0.017)	(0.033)
Terms since HOPE loss	-0.017***	-0.017***	-0.003	-0.031***	0.096***	0.019
	(0.001)	(0.001)	(0.002)	(0.011)	(0.011)	(0.025)
Four-year public	-0.410***	-0.441***	-0.362***	1.439***	0.341***	1.523***
	(0.010)	(0.010)	(0.017)	(0.147)	(0.129)	(0.212)
Tuition and fees (000s)	0.443***	0.438***	0.373***	1.635***	1.485***	0.787***
	(0.008)	(0.008)	(0.015)	(0.118)	(0.103)	(0.181)
Observations	389,219	389,219	166,255	327,913	327,913	130,382
Adjusted R-squared	0.25	0.25	0.34	0.13	0.19	0.1

NOTES: The table lists coefficient estimates for Equations 1 and 2 for credit load, i.e., attempted credit hours, in term t as well as the linear probability of any college enrollment in term t. Unlisted control variables include student and semester sequence fixed effects, cumulative GPA, interactions between semester sequence indicators and cumulative GPA, an indicator for fall terms, a linear trend, and indicators for missing data. Robust standard errors, clustered at the student level, are reported in parentheses.
*** indicates statistical significance at 99% confidence (with respect to zero), ** at 95%, and * at 90%.

Figure 2: The impact of HOPE loss versus the impact of a $1,000 tuition increase on hours of enrollment



NOTES: The figure plots coefficients and confidence intervals from 13 separate estimates of Equation 1, where the dependent variable is the likelihood of enrolling for h hours, $h \in [3, 15]$.

Table 4: The impact of losing HOPE on labor force participation and earnings

	I	II	III	IV	V	VI
Outcome	$\mathbf{1}(\textit{halftime earnings})_{it}$			$earnings_{it}(000s)$		
Equation	(1)	(2)	(2)	(1)	(2)	(2)
Cohort	2004-2006	2004-2006	2003	2004-2006	2004-2006	2003
Lost HOPE	0.014***			0.114***		
	(0.005)			(0.025)		
Scholarship value (000s)		-0.010***	-0.005		-0.069***	-0.158***
		(0.002)	(0.004)		(0.010)	(0.022)
Terms until HOPE loss	0.014***	0.014***	0.014***	-0.006	-0.002	0.012
	(0.002)	(0.002)	(0.003)	(0.012)	(0.011)	(0.023)
Terms since HOPE loss	0.003**	0.003**	0.002	0.061***	0.062***	0.005
	(0.001)	(0.001)	(0.003)	(0.011)	(0.010)	(0.025)
Four-year public	-0.076***	-0.070***	-0.198***	0.492***	0.531***	0.278
	(0.014)	(0.014)	(0.023)	(0.085)	(0.085)	(0.174)
Tuition and fees (000s)	-0.046***	-0.045***	0.075***	-1.143***	-1.136***	-1.043***
	(0.011)	(0.011)	(0.020)	(0.068)	(0.068)	(0.151)
Observations	389,219	389,219	166,255	389,219	389,219	166,255
Adjusted R-squared	0.06	0.06	0.06	0.13	0.13	0.14

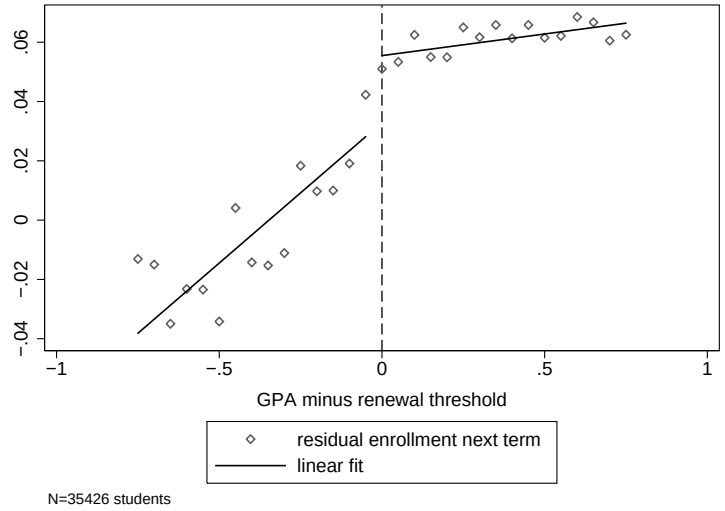
NOTES: The table lists coefficient estimates of Equations 1 and 2 for the linear probability of having at least halftime earnings while enrolled and half-year earnings while enrolled. Unlisted control variables include student and semester sequence fixed effects, cumulative GPA, interactions between semester sequence indicators and cumulative GPA, an indicator for fall terms, a linear trend, and indicators for missing data. Robust standard errors, clustered at the student level, are reported in parentheses.
*** indicates statistical significance at 99% confidence (with respect to zero), ** at 95%, and * at 90%.

Table 5: Regression discontinuity evidence: The impact of losing HOPE on credit load, earnings, and continued enrollment

	I	II	III	IV	VII	VIII
Outcome	$\mathbf{1}(creditload)_{it}$		$earnings_{it}(000s)$		$enrolled_{it+1}$	
First stage						
$\mathbf{1}(below)_{it}$	0.595***	0.595***	0.595***	0.595***	0.595***	0.595***
	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)
Two-stage least squares estimates:						
Observed outcome	✓		✓		✓	
Residual outcome		✓		✓		✓
$\mathbf{1}(lost\ HOPE)_{it}$	-0.420***	-0.512***	0.215***	0.263***	-0.072***	-0.047***
	(0.061)	(0.083)	(0.056)	(0.063)	(0.007)	(0.008)
$(g_{it} - \bar{g})\mathbf{1}(above)_{it}$	-0.151***	-0.231***	-0.023	0.021	2.70E-04	-0.005
	(0.054)	(0.067)	(0.065)	(0.070)	(0.004)	(0.006)
$(g_{it} - \bar{g})\mathbf{1}(below)_{it}$	0.079	-0.294**	-0.055	0.127	0.067***	0.078***
	(0.098)	(0.135)	(0.084)	(0.094)	(0.011)	(0.012)
Observations	35,426	35,426	35,426	35,426	35,426	35,426

NOTES: The table lists regression discontinuity estimates for observed and residual changes in credit load and earnings, as well as observed and residual enrollment propensity the following term (Equation 4). Residual outcomes are net of predicted values based on student characteristics, institutional characteristics, and parameter estimates from students who entered college before HOPE. Robust standard errors, clustered by 0.05-point GPA bins, are reported in parentheses.
*** indicates statistical significance at 99% confidence (with respect to zero), ** at 95%, and * at 90%.

Figure 3: Residual likelihood of enrollment next term, by distance from GPA threshold



NOTES: Figures plot the residual propensity to enroll the following term, relative to the appropriate GPA threshold for recent HOPE renewal. HOPE scholarships are renewed by coursework through term $t-1$, decisive grade point averages are observed for enrolled students in term t, and regression discontinuity designs are used to estimate the impact of losing HOPE on the residual likelihood of continued enrollment the following term, $t+1$, netting out expected enrollment based on observable student and institutional characteristics.

Table 6: The impact of losing HOPE on choice of major

Major outcome	I Change major	II Undeclared	III Agriculture	IV Business	V Education	VI Engineering	VII General studies
Lost HOPE	-0.019*** (0.005)	0.070*** (0.004)	-0.001 (0.001)	-0.006** (0.003)	0.003** (0.001)	-0.010*** (0.002)	-0.034*** (0.003)

Major	VIII Health-related	IX Humanities	X Recreation	XI Science	XII Social science	XIII Skilled trades	XIV Visual and performing arts
Lost HOPE	-0.017*** (0.003)	-4.80E-04 (0.003)	0.004*** (0.001)	-0.011*** (0.002)	0.003 (0.003)	0.001 (0.001)	-0.002 (0.002)

NOTES: The table lists coefficient estimates of Equation 1 for the linear probability of having an undeclared major or declaring a major in one of thirteen broad major groups. Unlisted control variables include pre-loss and post-loss trends, student and semester sequence fixed effects, cumulative GPA, interactions between semester sequence indicators and cumulative GPA, an indicator for fall terms, a linear trend, and indicators for missing data. Robust standard errors, clustered at the student level, are reported in parentheses.
*** indicates statistical significance at 99% confidence (with respect to zero), ** at 95%, and * at 90%.

Table 7: Robustness checks: The impact of losing HOPE on enrollment and labor force outcomes

	I	II	III	IV	V	VI
Specification and sample details						
Baseline	✓					
Omitting students with multiple reasons for loss		✓				
Omitting $\beta_t GPA_{it}$ controls			✓			
Calendar-time fixed effects				✓		
Quadratic pre-loss trends					✓	
Estimating ΔY_{it}						✓
$\mathbf{1}(enrolled)_{it}$	-0.028***	-0.030***	-0.033***	-0.029***	-0.125***	
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	
$creditload_{it}$	-1.623***	-1.674***	-1.769***	-1.666***	-2.635***	-2.355***
	(0.052)	(0.053)	(0.052)	(0.052)	(0.068)	(0.053)
$\mathbf{1}$(*working halftime*)$_{it}$	0.015***	0.015***	0.016***	0.023***	0.010	
	(0.005)	(0.005)	(0.005)	(0.005)	(0.007)	
$earnings_{it}$	0.111***	0.115***	0.125***	0.155***	0.073**	0.103***
	(0.026)	(0.026)	(0.026)	(0.026)	(0.034)	(0.028)
Observations (n_{it})	389,219	381,086	389,219	389,219	389,219	313,458

NOTES: The table lists coefficient estimates for the "lost HOPE" parameter in Equation 1 under six different specifications. Baseline results reported in Tables 3 and 4 are listed in Column I. Columns II-VI each differ from the baseline model in one respect. The Column II specification omits students who lost the scholarship for multiple reasons, including GPA. The Column III model adds calendar-based term fixed effects. The Column IV specification omits semester-GPA interactions. Column V reports results with controls for quadratic pre-loss trends. Last, Column VI lists results for Equation 5, estimating the change in each outcome, controlling for student fixed effects and other variables from Equation 1. Earnings are adjusted for inflation. Robust standard errors, clustered at the student level, are reported in parentheses.
*** indicates statistical significance at 99% confidence (with respect to zero), ** at 95%, and * at 90%.

Table 8: Robustness checks: The impact of scholarship value on enrollment and labor force outcomes

	I	II	III	IV	V	VI
Specification and sample details						
Baseline	✓					
Omitting students with multiple reasons for loss		✓				
Omitting $\beta_t GPA_{it}$ controls			✓			
Calendar-time fixed effects				✓		
Quadratic pre-loss trends					✓	
Estimating ΔY_{it}						✓
$\mathbf{1}(enrolled)_{it}$	0.054***	0.054***	0.059***	0.055***	0.077***	
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	
$creditload_{it}$	2.296***	2.335***	2.404***	2.321***	2.849***	1.446***
	(0.026)	(0.026)	(0.026)	(0.025)	(0.029)	(0.024)
$\mathbf{1}$(*working halftime*)$_{it}$	-0.010***	-0.011***	-0.013***	-0.014***	-0.010***	
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	
$earnings_{it}$	-0.069***	-0.070***	-0.110***	-0.086***	-0.066***	-0.034***
	(0.010)	(0.010)	(0.010)	(0.010)	(0.012)	(0.010)
Observations (n_{it})	389,219	381,086	389,219	389,219	389,219	313,458

NOTES: The table lists coefficient estimates for the "scholarship value" parameter in Equation 2 under six different specifications. Baseline results reported in 3 and 4 are listed in Column I. Columns II-VI each differ from the baseline model in one respect. The Column II specification omits students who lost the scholarship for multiple reasons, including GPA. The Column III model adds calendar-based term fixed effects. The Column IV specification omits semester-GPA interactions. Column V reports results with controls for quadratic pre-loss trends. Last, Column VI lists results for Equation 5, estimating the change in each outcome, controlling for student fixed effects and other variables from Equation 2. Earnings are adjusted for inflation. Robust standard errors, clustered at the student level, are reported in parentheses.
*** indicates statistical significance at 99% confidence (with respect to zero), ** at 95%, and * at 90%.

Table 9: Robustness and falsification checks: Regression discontinuity estimates of the impact of scholarship loss on credit load, earnings, and enrollment

	I	II	III
Outcome	$creditload_{it}$	$earnings_{it}$	$\mathbf{1}(\textit{enrollment next term})_{it}$
Baseline	-0.512***	0.263***	-0.047***
	(0.083)	(0.063)	(0.008)
Wider bandwidth	-0.446***	0.240***	-0.045***
	(0.082)	(0.051)	(0.007)
Narrower bandwidth	-0.544***	0.360***	-0.046***
	(0.093)	(0.067)	(0.010)
Quadratic	-0.565***	0.406***	-0.050***
	(0.085)	(0.063)	(0.011)
GPA threshold +	0.102	-0.044*	0.010**
	(0.068)	(0.025)	(0.004)
GPA threshold -	0.122	0.064	0.014
	(0.119)	(0.077)	(0.012)

NOTES: The table lists regression discontinuity estimates under six difference specifications (rows) for credit load, inflation-adjusted earnings, and enrollment the following term (columns). Baseline specifications are found in Table 5 and described by Equation 4, with linear functional forms for the relationship between outcomes and GPA on either side of the threshold, up to 0.75 points from the threshold. The table also lists results with a wider bandwidth (1.0 GPA points on either side of the threshold), narrower bandwidth (0.50 points), and quadratic functional forms. The last two rows hold results from falsification checks: tests for reduced-form discontinuities at GPA thresholds 0.50 points above or below the actual threshold, within a window of 0.50 points. Robust standard errors, clustered by 0.05-point GPA bins, are reported in parentheses.
*** indicates statistical significance at 99% confidence (with respect to zero), ** at 95%, and * at 90%.