Marginal Effects of Merit Aid for Low-Income Students*

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Abstract

Financial aid from the Susan Thompson Buffett Foundation (STBF) provides comprehensive support to a college population similar to that served by a host of state aid programs. In conjunction with STBF, we randomly assigned aid awards to thousands of Nebraska high school graduates from low-income, minority, and first-generation college households. Randomly-assigned STBF awards boost bachelor's (BA) degree completion for students targeting four-year schools by about 8 points. Degree gains are concentrated among four-year applicants who would otherwise have been unlikely to pursue a four-year program. Degree effects are mediated by award-induced increases in credits earned towards a BA in the first year of college. The extent of initial four-year college engagement explains impact differences by target campus and across covariate subgroups. The projected lifetime earnings impact of awards exceeds marginal educational spending for all of the subgroups examined in the study. Projected earnings gains exceed funder costs for urban students and for students with relatively weak academic preparation.
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I. Introduction

American governments and private organizations spent $184 billion on financial aid to undergraduates in 2019. Government grant aid amounted to about $3,250 per full-time undergraduate, while private and institutional grants came to almost $5,600 per student.[1] Yet, the consequences of this vast expenditure for college enrollment and degree completion remain unclear. Causal effects of aid are difficult to identify for at least two reasons. First, aid decisions are confounded with student characteristics like family background and ability. Second, naturally-occurring variation in aid rules often changes aid packages by only a few hundred dollars. It's hard to say whether the response to such modest changes predict those of withdrawing or adding more substantial awards.

This paper gauges the effects of grant aid on degree completion using a randomized field experiment that allocated scholarships to 3,700 high school seniors who graduated from 2012-16. The experiment was conducted in partnership with the Susan Thompson Buffett Foundation (STBF), which funds about eleven percent of Nebraska high school seniors who go on to attend a Nebraska public college.[2] Characterized by modest merit cutoffs, a focus on applicants to public colleges and strict family income eligibility caps, the STBF program targets an economically-disadvantaged population judged capable of college-level work. Three-quarters of those in the experimental sample are eligible for need-based federal Pell grant aid, one-third are nonwhite, and fewer than a third have a parent with a bachelor's degree (BA). STBF awards are unusually comprehensive, paying college costs for up to five years at any Nebraska public four-year college and up to three years at any Nebraska public two-year college. Because STBF grant aid can be applied to any part of a student's total cost of attendance—tuition, fees, books, room and board, personal expenses, and transportation—STBF awards are offset little by clawbacks or caps that affect other sorts of post-secondary aid.

For whom and by how much does STBF aid boost degree completion? Random assignment of STBF awards shows that aid boosts six-year BA completion rates for students targeting four-year schools by about 8 points (on a base of 64 percent). Degree gains are concentrated in groups of four-year applicants who are unlikely to have otherwise enrolled in four-year programs and who have

[1] These statistics are from https://research.collegeboard.org/ (accessed May 2020). The federal government also loaned an average of $4,090 per undergraduate in 2019.

[2] Authors' calculations from data obtained from STBF and Coordinating Commission for Postsecondary Education (2013).

low predicted BA completion rates. This inverse relationship between baseline expected completion rates and the causal effect of aid on BAs is not a mechanical ceiling effect: even in the subgroups most likely to graduate, completion rates are below 80 percent. Aid to applicants targeting two-year schools does not increase associate degrees but may increase BAs. The latter effect is positive but not significantly different from zero.

Our analysis explains degree gains among applicants targeting BA programs with the aid of a simple causal model. Specifically, we show that degree effects can be explained by the effect of awards on credit units earned towards a BA in the first year of study. STBF aid is effective to the extent that it promotes early and deep engagement with a four-year college program. This early engagement mediator accounts for heterogeneous effects by target campus (e.g., whether a student targets a University of Nebraska campus in Omaha or Lincoln) and across covariate subgroups defined by characteristics like race and ACT scores.[3]

We use an over-identification test to evaluate the hypothesis that early four-year engagement is the *sole* channel through which aid affects degree completion. While other stories cannot be ruled out, the null hypothesis that attributes bachelor's degree gains to this single causal pathway fits remarkably well. The results reported here also show no significant difference in the effects of aid accompanied by academic support services (delivered through a program called Learning Communities) and the effects of financial awards alone. Results comparing recipients of aid plus academic support services with other award recipients should be seen as preliminary, however, since they rely on data for only two cohorts.[4]

The paper concludes with a provisional comparison of program costs and anticipated earnings gains for STBF award recipients. This analysis highlights the gap between the private and social costs of marginal degrees. On average, scholarship awards to students targeting bachelor's degrees cost the funder a total of $\$32,250$ over six years, while raising direct costs of attendance (tuition plus books and supplies) by only $\$2,390$. Viewed through this lens, most funder spending is a transfer. At the same time, the estimated lifetime earnings gains generated by scholarship awards

[3]By "engagement", we mean four-year college credits taken in the first year after high school. Other studies use this term to capture emotional, behavioral, and cognitive involvement in learning (Appleton, Christenson and Furlong 2008). Cole et al. (2020), who study the STBF Learning Communities program, measure engagement by how frequently students ask questions and connect with peer mentors.

[4]Larger samples, available in years to come, should generate more precise estimates of the causal impact of Learning Community services.

seem likely to exceed the sum of incremental educational costs and foregone earnings for each of the subgroups examined here (defined by race, gender, academic preparation, and Pell eligibility). The comparison of expected gains with funder costs is more mixed, but gains are likely large enough to outweigh costs for award recipients whose degree attainment is most strongly affected by scholarship awards. This includes urban applicants, applicants who indicate they prefer a four-year college but are also considering two-year colleges, and applicants with weaker academic preparation. From the funder's point of view, award targeting increases program efficiency markedly.

II. Background

II.A. The STBF Scholarship Program

STBF has been funding Nebraskan college students since 1965, and supported around 4,000 students in 2020. STBF is the largest private provider of post-secondary grant aid in Nebraska; more than half of Pell-eligible Nebraska seniors who apply for federal aid also apply for an STBF scholarship.[5]

STBF financial support is awarded on the basis of need and merit to Nebraska-resident high school seniors and Nebraska high school graduates. Both public and private school graduates are eligible, as are GED holders. Aid can be applied toward cost of attendance (including tuition, fees, and room and board) at any public two-year or four-year college in Nebraska. Award amounts are campus-specific. STBF sets a maximum award amount for each institution which is roughly equal to tuition and fees plus a $500 book allotment. For example, 2013 awards provided $8,500 per academic year for full-time students at the University of Nebraska's Lincoln campus, where tuition and fees amounted to $8,060. Awards are pro-rated for part-time students. Recipients' total grant aid is capped at the federally recognized cost of attendance (COA). Conditional on good academic standing (award recipients are expected to maintain at least a 2.0 GPA), STBF awards are renewable for five years, three of which can be used at a two-year college.[6]

[5] Authors' calculations from data obtained by request from the Federal Student Aid office.

[6] STBF awards renew annually conditional on awarded students earning a GPA of at least 2.0 and at the Foundation's discretion otherwise. Nebraska public colleges require a 2.0 cumulative GPA to graduate. Grade reports are from schools rather than students. Award recipients are encouraged to update their FAFSAs annually.

Scholarship eligibility is limited to applicants with a FAFSA-determined expected family contribution (EFC) below $10,000 and a high school GPA above 2.5.[7] Scholarship applicants complete an online application (typically due around February 1st), submitting their FAFSA, high school transcript, an essay, and recommendation letters from adults in their community. Scholarship decisions are announced in mid-April. Applicants are asked to identify a first-choice target school at which they hope to use the scholarship (such as the University of Nebraska at Omaha). This is non-binding, but highly predictive of award winners' college choices. Online Appendix A.1 details the application and scholarship renewal process further.

STBF aid has much in common with major public programs for post-secondary support. Like the federal government's Pell program, STBF awards are based in part on financial need. Like many state aid programs, STBF considers a variety of applicant features including financial need and indicators of college readiness. STBF awards are more comprehensive than Pell grants and available to many applicants with EFCs above the Pell cutoff, though some state programs approach STBF levels of aid. Generous state benchmarks include the CalGrant program examined by Kane (2003) and Bettinger et al. (2019), and the Texas Longhorn Opportunity Scholarship and Century Scholars programs evaluated by Andrews, Imberman and Lovenheim (2020). Combined with Pell, the Texas programs cover all tuition and fees at The University of Texas and Texas A&M. Like STBF awards, the Texas programs target low-income college-bound high school students and provide a range of academic support services to recipients who enroll at a covered campus.

Many recipients of STBF awards (known as Buffett Scholars) attend the University of Nebraska, known locally as "NU." Scholarship winners who attend one of NU's three main campuses—Lincoln (UNL), Omaha (UNO), or Kearney (UNK)—are required to participate in STBF-funded Learning Community (LC) programs during their first and second years of college. These programs, detailed in Kezar and Kitchen (2020), incorporate a mix of college classes for STBF-funded students, social activities, peer mentoring, and academic advising. Many LC participants at UNK and UNL live in dedicated residence halls.[8]

[7] By way of comparison, the 2013 Pell-eligibility threshold was $5,081. EFC cutoffs for STBF awards were $15,000 in 2012, the first year of the experiment.

[8] Some award recipients after 2013 were offered aid without required LC participation through a new award program described below. Impact evaluations of LC programs and LC-type services include Bloom and Sommo (2015), Angrist, Lang and Oreopoulos (2009), Bettinger and Baker (2014), Weiss et al. (2015), and Levin and García (2018).

1. Related Work. This study builds on decades of empirical work examining causal effects of post-secondary financial aid. Since the pioneering investigation by Fuller, Manski and Wise (1983), economists have explored the hypothesis that college aid aid is mostly inframarginal, leaving recipients' college outcomes unchanged.

Online Appendix Table A1 summarizes many econometric analyses of grant aid.[9] This table shows a wide range of estimated aid effects, even when computed for the same programs (as do the research summaries in Dynarski and Scott-Clayton 2008; Deming and Dynarski 2010; Page and Scott-Clayton 2016). Most relevant for our purposes are studies using experimental and quasi-experimental methods. In the latter category, econometric investigations of the effects of Pell grants typically exploit discontinuities in the Pell award formula via a regression discontinuity (RD) design. Recent RD estimates from Scott-Clayton and Schudde (2019) and Denning, Marx and Turner (2019) suggest that Pell aid has a modest effect on persistence and degree completion. Early contributions by Hansen (1983) and Kane (1996), by contrast, show little effect of the introduction of the Pell program on student outcomes.

Regression discontinuity investigations are not limited to investigations of Pell grants. Castleman and Long (2016), for example, uses a RD design to examine the impact of Florida's Student Access Grant. The resulting estimates show that grants increase college enrollment, particularly in four-year institutions, as well as increasing BA completion. Bettinger et al. (2019) finds that California's CalGrant significantly increases bachelor's degree completion, but does not impact initial college enrollment.

Other studies use difference-in-difference-style analyses of state aid program roll-outs to identify causal aid effects. In an influential implementation of this approach, Dynarski (2000) finds that Georgia's HOPE Program increased both college enrollment and college completion. Applying similar methodology, Barr (2019) estimates positive post-911 GI Bill effects on both college enrollment and graduation.

The wide range of results arising from observational studies is exemplified by Cohodes and Goodman (2014), which finds that Massachusetts' Adams Scholarship *decreased* bachelor's degree completion. These negative effects appear to reflect diversion of scholarship recipients from insti-

[9] A related literature looks at the impact of family income on college enrollment. For example, Bulman et al. (2021) finds that lottery windfalls increase college enrollment only if they are sufficiently large, while Hilger (2016) estimates small negative enrollment effects of parental job loss.

tutions with higher graduation rates to less competitive (on average) public colleges. Evidence on state merit aid since Dynarski (2000) is also mixed. Fitzpatrick and Jones (2016) and Sjoquist and Winters (2015), for example, find little or no effect of state merit scholarship programs on enrollment and completion. As we discuss at length below, a key channel for STBF impact appears to operate through initial enrollment. Our results are therefore aligned with earlier work showing aid impacts in one of two configurations: (a) both initial enrollment and college completion rise, or (b) neither enrollment nor completion rise.[10] Also suggestive of the importance of early college engagement, Carruthers and Ozek (2016) finds that the loss of financial aid leaves degree completion rates unchanged.

Consistent with our emphasis on the timing of award impact, programs that focus on academic performance and post-enrollment progress have so far yielded modest and/or subgroup-specific graduation effects, if any. Interventions in this domain include West Virginia PROMISE scholarships evaluated in Scott-Clayton (2011); Scott-Clayton and Zafar (2019) and the incentive schemes examined in Angrist, Lang and Oreopoulos (2009), Angrist, Oreopoulos and Williams (2014). The incentive-heavy WV Promise six-year BA completion effects faded ten years beyond the award date.

Recent randomized evaluations provide an important point of comparison for our study. One of the most noteworthy of these examines the Wisconsin Scholars Grant (WSG), a program that offered $3,500 per year to Pell-eligible Wisconsin residents enrolled as full-time freshmen at four-year colleges. WSG receipt leaves degree completion rates unchanged (Anderson et al. 2019). It is noteworthy, however, that because WSG awards are made to already-enrolled first-year students, they cannot affect first-year enrollment. Similarly, Mayer, Patel and Gutierrez (2015) reports that aid contingent on academic performance given to low-income parents enrolled at two-year schools and already receiving financial support accelerates degree completion but does not increase it. Harris and Mills (2021) reports results from a program offering financial aid to Milwaukee high school students enrolled at in-state colleges; this aid affected neither college enrollment nor bachelor's degree completion.

The Accelerated Study in Associate Programs (ASAP) initiative, which targets already-enrolled community college students, appears to be highly effective at increasing degree completion and shortening time to degree in a randomized trial. ASAP is unusual, however, in that its low-income

[10] Bettinger et al. (2019) is a notable exception.

recipients receive a wide array of support services, including some targeting non-academic needs (see Scrivener et al. 2015 and Miller et al. 2020). Deming and Walters (2017) also finds large positive effects of college spending—broadly defined—on enrollment and degree completion.

How does the STBF program and our evaluation of it fit into this literature? First, STBF awards are unusually comprehensive (though some state programs offering aid at public institutions are almost as generous). Program awards are also made early enough to change the entire post-secondary path for college-bound high school students. And STBF awards include an incentive component that may or may not be important. Finally, aid evaluations using random assignment are rare.

II.B. Research Design and Sample Construction

Among five cohorts of scholarship applicants aiming to enroll in the fall of 2012 through the fall of 2016, a subset of STBF awards were allocated by random assignment. Applications were given a score based on students' college-readiness, financial need, and other factors important to the Foundation. The highest-scoring applicants (roughly 15 percent of the applicant pool) were guaranteed awards, while the lowest-scoring applicants (roughly 10 percent) were removed from consideration. The rest were subject to random assignment, with award rates determined by a variety of constraints on award counts at the target schools in each cohort. Because award rates differ by application year and target school, regression estimates discussed below control for a full set of target-school by application-year dummies to reflect differing award rates. We refer to these controls as "strata dummies."

In the 2013–16 cohorts (the second through fifth cohorts), treated applicants targeting NU campuses received one of two types of scholarships. The first, described to recipients as "Susan T. Buffett Scholarships" combined financial aid with an obligation to participate in LCs. The second, "College Opportunity Scholarships" (COS), consisted of financial aid only.[11] This second arm of the study was designed to reveal any incremental treatment effects due to LC participation. In practice, awards with and without an LC component generate similar effects on college enrollment and degree completion. Our ability to distinguish effects of the two types of awards is limited,

[11]Named scholarships may be more prestigious than the same amount of generic grant aid. The Buffett Scholars program is well-known in Nebraska, while College Opportunity Scholarships were new in 2013 and not publicized beyond those offered one. COS awards might therefore be expected to have less of a motivating prestige effect.

however, by the size of the COS treatment sample. Most of the analysis below therefore pools the two treatment groups.

The five cohorts involved in the randomized study include 3,699 treated applicants (applicants offered aid) and 4,491 controls. Among treatment and control applicants, 6,845 indicated a four-year college as their target school were they to be funded; the rest indicated that they would prefer a two-year school. A breakdown of the number of applicants in the treatment and control groups by application year and target campus appears in Table A2 in the Online Appendix. Of the 6,845 applicants targeting a four-year campus, 2,197 were offered STBF scholarships and 862 were offered COS awards (where STBF awards are defined here as those mandating LC participation among NU students). Of the 1,345 applicants targeting two-year schools, 640 were offered scholarships. We analyze scholarship effects separately by target school program length, referring to applicants targeting NU and other four-year colleges as in the "four-year strata," and those targeting community colleges as in the "two-year strata." The primary analyses pool all five experimental cohorts, two of which have not yet completed the experiment–so that the number of cohorts differs across outcomes, e.g., enrollment versus completion. Online Appendix B reports a set of comparable (albeit less precise) results computed using samples of balanced cohorts.

II.C. Data and Descriptive Statistics

Data for this project come from the STBF online application, linked with administrative records from Nebraska's public colleges and from the National Student Clearinghouse (NSC), which covers most American post-secondary schools. Scholarship application records cover a rich set of baseline characteristics, including high school transcripts, ACT scores, and demographic and financial information from the FAFSA.[12] Over 90 percent of STBF applicants who ultimately enrolled in college attended a Nebraska public post-secondary school. These colleges and universities provided information on their students' enrollment, aid packages, and academic outcomes. To capture enrollment at private and out-of-state colleges, we supplemented school-provided data on post-secondary outcomes with information from the NSC. Appendix A provides additional information about data sources and data processing.

[12]Data on the race of 2012 and 2013 applicants come from the Nebraska Department of Motor Vehicles.

The first three columns of Table I compare eligible scholarship applicants with national and statewide samples of high school seniors.[13] STBF applicants are from households with an average income equal only to about half the average for the broader population of Nebraska high school seniors. Compared to the average Nebraska high school senior, STBF applicants are more likely to be female and less likely to have a parent who attended college. ACT scores among STBF applicants are similar to those of other Nebraska ACT test-takers, though applicants are more likely to have taken the ACT.[14]

Consistent with the criteria used to evaluate applications, STBF's top-scoring applicants (those guaranteed awards) have academic credentials well above the smaller group of applicants that did not qualify for inclusion in the experimental sample. This can be seen in columns 4 and 5 in Table I, which contain statistics for the top- and lowest-scoring applicants. Applicants guaranteed STBF awards without random assignment had lower family incomes and less-educated parents than applicants in the experimental group, statistics for which appear in column 6. The group guaranteed awards also includes a higher proportion of Hispanic applicants. At the other end of the distribution, applicants disqualified before random assignment have lower high school grades and ACT scores than those subject to random assignment.

Finally, the last column of Table I, which reports strata-adjusted differences in characteristics by treatment status for applicants in the experimental group, suggests the set of applicants randomly selected for an award is indeed comparable to the randomly-selected control group. Table A3 in the Online Appendix reports similar balance statistics computed within target-school strata.

III. Gauging Award Impacts

STBF paid $8,200 on average towards the first year of study for treated students targeting a four-year program. Panel A of Figure I shows that these awards boosted applicants' first-year financial aid packages from $13,300 to $19,200. Importantly, Panel B shows that while a dollar awarded raised total aid by only 52 cents, the gap between funder cost and amount received is due almost entirely to a reduction in loans. In fact, for every dollar awarded, grant aid rose 96 cents,

[13] Data in column 1 comes from SEER (gender and race), ACS(family income and parent education status), and an ACT National Profile Report (ACT 2012).

[14] The high rate of ACT-taking in the sample is indicative of the fact that scholarship applicants are actively thinking about attending college. Although we believe the sample is broadly representative of students traditionally served by grant aid programs, it misses students who do not apply to college or for aid.

with concomitant declines of 33 cents in loans and 5 cents in earnings through work-study programs. Figure A1 in the Online Appendix reports award effects on aid for applicants in two-year strata. Consistent with the much lower cost of two-year programs, Figure A1 shows average first-year award amounts of around $3,800. Here too, STBF awards increased grant aid substantially, in this case by one extra dollar for each dollar awarded.[15]

III.A. Effects on Enrollment and Degrees

The reduced-form analysis discussed in this section ignores considerations of initial award take-up. As 93 percent of applicants who receive an award accept it, this is innocuous. The more structured analysis outlined in the next section uses randomized award offers to construct two-stage least squares (2SLS) estimates of the effect of mediating post-secondary choices, such as the type of college attended in the first year enrolled, on degree completion.

Reduced-form treatment effects on post-secondary outcomes, Y_i, are regression estimates of coefficient ρ in the equation

$$Y_i = X_i'\delta + \rho A_i + \varepsilon_i, \tag{1}$$

where A_i indicates a scholarship was offered to applicant i. The covariate vector X_i includes saturated controls for application year and target institution, the strata variables that determine experimental award rates. Equation (1) is estimated using the 8,190 randomized applicants who applied between 2012–2016.

Students applying to the STBF scholarship program are highly motivated to attend college. All but 4 percent of control-group applicants in four-year strata enrolled in college in the fall semester following their award application. Even so, as can be seen at the top of column 2 in Table II, STBF awards boosted any-college enrollment rates among four-year applicants by a statistically significant 2.3 percentage points. Moreover, while award offers had only modest effects on any-college enrollment in the four-year strata, they appear to have increased enrollment in four-year programs by 10 points (on a base of 83 percent). Much of this gain is attributable to a 6.7 point decline in enrollment at two-year schools.

[15] Award effects on loans are small among applicants in two-year strata because two-year students borrow relatively little.

Like many state-funded financial aid schemes, the STBF program is meant to encourage in-state public college enrollment. The estimates in Panel B of Table II show that STBF awards increased Nebraska public college enrollment among four-year applicants by almost 7 points, a gain driven by an even larger effect on NU enrollment. Paralleling the award-induced decline in any two-year enrollment, awards induced a marked decline in Nebraska community college enrollment. The estimates in Panel B also show a modest award-induced drop in out-of-state and private college enrollment.[16]

Columns 3 and 4 in Table II report estimates of the impact of regular awards (with mandatory LC participation) and COS awards (without mandated LCs) for applicants in the 2013-2016 cohorts who targeted an NU campus. (Only students in these cohorts were eligible for COS awards.) These estimates are computed by replacing A_i in equation (1) with dummies for each version of the NU treatment. Because regular award recipients are exposed to LC participation only once enrolled, it seems reasonable to expect the two award schemes to affect initial enrollment similarly. Initial enrollment effects of COS and regular awards are indeed similar.

The initial enrollment gains generated by award offers made to applicants in four-year strata led to a persistent increase in college enrollment. This is apparent in Figure II, which plots treatment and control enrollment rates each semester after random assignment.[17] The sample used to compute each point omits applicants who had completed a college degree by the time the enrollment outcome was recorded. Conditional on not having earned a degree, college enrollment in the treated group is sharply higher than college enrollment in the control group 2-5 years after random assignment. The figure therefore suggests that awards reduced college dropout rates

STBF award offers boosted college enrollment rates more for applicants in two-year strata than for applicants in four-year strata. In particular, the estimate at the top of column 6 in Table II shows a gain of 5.8 points in any-college enrollment for the two-year group (compared with a control mean of 90 percent, reported in column 5). Four-year enrollment gains are much smaller, however, for applicants in two-year strata: awards increase the probability that a two-year targeting applicant enrolls in a four-year program by only 4 points. The estimates in Panel B also show awards

[16]Most STBF applicants who enrolled outside of Nebraska's public colleges and universities attended private, religiously-affiliated schools in the Midwest such as Nebraska Wesleyan University, Creighton University and Hastings College.

[17]Figure A2 in the Online Appendix plots treatment and control enrollment rates for students in two-year strata.

generated a marked gain in Nebraska public college enrollment for applicants in two-year strata, due mostly to a shift towards NU. Perhaps surprisingly, increased enrollment at NU appears to be mostly a net gain in college enrollment rather than a move away from two-year schools. The working paper (Angrist et al. 2016) presents additional estimates of award effects on college enrollment and persistence.

1. Degree Completion. STBF awards boosted six-year BA completion rates by 8.1 percentage points for applicants in four-year strata, a substantial gain relative to the control mean of 64 percent. Estimated degree completion effects for the 2012-14 cohorts (those for which six-year follow-up is now available) appear in column 2 of Table III. The overall completion effect is estimated reasonably precisely, with a standard error of 0.016.

Columns 3 and 4 juxtapose estimates of the effect of COS and regular STBF awards on degree completion, estimated for the cohort of 2013-14 applicants targeting NU (the subsample eligible for the COS treatment, for which we see degrees.) In contrast with effects on initial enrollment outcomes, here, we might expect program effects to differ. As it turns out, however, estimated COS effects (in column 4) are close to the regular-award effects (in column 3), though the COS estimates are somewhat less precise. Estimates of award by type are also close to the estimates for all four-year strata in column 2.

The award-induced increase in BAs is due partly to a shift from two-year to four-year programs. STBF awards reduced associate degree completion by 3 points for applicants in four-year strata, with similar drops seen for the 2013/14-only NU sample and among COS award winners. Most of the 8.1 point gain in BA completion, however, is due to a 5.2 point decline in the likelihood that applicants earn no degree (Degree outcomes in Table III are not mutually exclusive).

As can be seen in column 6 of Table III, awards do not appear to have increased associate degree completion among applicants in two-year strata. Estimates in this column show a modest positive award impact on BAs in two-year strata, but this estimated gain is not significantly different from zero. It seems especially noteworthy that awards made to applicants in two-year strata—comprising applicants who indicated a desire to attend two-year programs—generated no discernible rise in two-year degree completion.

Figure III plots award effects on BA completion rates in post-assignment years four through six, estimated separately by target campus for applicants in four-year strata. STBF awards appear to have increased time to completion for some. This delay is visible in a statistically significant 5-point decline in completion rates four years out for applicants targeting UNL (and a 4-point drop for applicants targeting UNK). Five years after random assignment, however, completion effects turn positive. Award offers boost completion rates most clearly for applicants targeting UNO, by 7 points five years out and 13 points six years out. Estimated effects for applicants targeting other NU campuses are smaller, though (state colleges excepted) close to the pooled estimate of 8 percentage points in year six. Estimated five- and six-year completion effects for applicants targeting state colleges are positive, but less precise than the corresponding estimates for applicants targeting NU and not significantly different from zero.

The large degree gains seen for UNO applicants play a leading role in our account of the mechanism by which awards increase completion. UNO serves a mostly low-income, disproportionately nonwhite population, and UNO-targeting award winners are less likely to enroll in a four-year college in the absence of STBF support than are applicants targeting other campuses. Consistent with the pooled estimates in Table III, a year-by-year analysis of treatment effects in four-year strata shows similar degree gains for award winners with and without mandatory participation in LCs. This is documented in Figure A3 in the Online Appendix, which plots yearly estimates of the two types of award effects. The analysis below therefore pools the LC and non-LC treatment groups when estimating effects in four-year strata.

III.B. Degree Effects by Subgroup

Panel A of Figure IV contrasts award effects in sample splits by demographic subgroup. We see degree gains of nine points for treated nonwhite applicants, with a corresponding gain of seven points for whites. Award effects are also larger for Pell-eligible applicants than for applicants with family incomes above the Pell threshold. These conditional effects align with the pattern of larger effects on UNO-targeters seen in the previous figure: nonwhite and Pell-eligible Nebraskans are over-represented in Omaha, and therefore disproportionately likely to target UNO. Online Appendix Figure A4, which reports degree effects in additional subgroup splits, shows larger award effects for

Omaha residents and for students without college-educated parents, but little difference in impact by gender.

Degree gains are larger for applicant subgroups likely to be less prepared for college, a pattern documented in Panel B of Figure IV. These plots show award-induced BA gains of 12 points among applicants with GPA below the Nebraska median, but only a 4-point gain for above-median applicants. This difference in impact is especially striking in light of the low control-group completion rate (of 42%) among applicants with below-median GPAs. Estimates by ACT score, reported in Online Appendix Figure A4, show a similar pattern. A final split in Figure IV shows estimates conditional on whether applicants indicated they were likely to attend a two-year school in the absence of STBF support. Applicants indicating a two-year fallback might be seen as ambivalent about their readiness to commit to a four-year program. The estimated BA effect for those indicating a two-year fallback is almost twice as large as the estimate for applicants who considered only four-year colleges.

Online Appendix Figure A5 shows that the subgroup differences in Figures III, IV, and A4 are driven by more than outsized effects on applicants targeting UNO. In a split between UNO targeters and all remaining four-year applicants, effects are larger in the former group, but still significantly different from zero in the latter. A final subgroup analysis appears in Online Appendix Figure A6. This figure reports results for a sample split determined by above- and below-median predicted BA completion, where completion is predicted using the covariates generating Figure IV and Online Appendix Figure A4. Award-induced BA gains are estimated to be 12 points for those with below-median predicted completion, but only 4 points for those with high predicted completion rates.

IV. Explaining Award Effects

The variation in strata and subgroup effects seen in Figures III, IV, and Online Appendix Figure A4 is explained here by a causal mediation story that hinges on the type of campus at which applicants first enroll. Specifically, we argue that an award-induced shift towards early, strong engagement with a four-year college is the primary channel by which STBF aid generates additional

bachelor's degrees. Variation in the strength of award-induced shifts into four-year programs offers a coherent account of the reduced form treatment-effect variation seen in the figures.

IV.A. College Targets and Destinies

Most award recipients in four-year strata started their college careers on a four-year campus. But many applicants not selected for an award also embarked on a four-year program. How did awards *change* the likelihood of four-year college enrollment? For applicants in four-year strata, effects on initial four-year enrollment are strongest when awards facilitate enrollment at an applicant's target campus, and when the alternative to target-campus enrollment is not a four-year program. We therefore quantify award-induced changes in initial college enrollment in two steps: first, by estimating award effects on target campus enrollment; second, by computing four-year enrollment rates among target-enrollment compliers when these applicants do not receive an award.

The effects of STBF awards on target campus enrollment largely mirror award effects on BA completion, a pattern documented in Panel A of Figure V (where bar height shows effects on target enrollment and dots mark effects on BA completion). We see, for example, that among four-year applicants, target enrollment effects are especially high for applicants targeting UNO, for Omaha residents, and for nonwhite applicants. On the other hand, target enrollment effects are similar for men and women, while BA effects also differ little by sex. With one exception (the split by Pell-eligibility), subgroup differences in target enrollment effects are consistent with the direction of differences in group-specific BA effects.

Effects on target enrollment by measures of college readiness likewise parallel the differences in degree gains seen across college-readiness subgroups. As noted above, Figure IV and Online Appendix Figure A4 show especially large degree gains for applicants with below-median ACT scores and below-median high school GPAs, as well as for students in four-year strata who considered a two-year alternative. Differences in target campus enrollment effects across these splits are also noteworthy, with larger effects in groups that appear less prepared for BA programs.

In the causal framework outlined by Angrist, Imbens and Rubin (1996), award effects on target campus enrollment can be interpreted as a target-enrollment compliance rate. To make this idea precise, let T_{ji} denote potential target enrollment when $A_i = j; j = 0, 1$. Observed target enrollment,

T_i, is determined by potential target enrollment according to:

$$T_i = T_{0i} + (T_{1i} - T_{0i})A_i.$$

Target compliers are defined as applicants for whom $T_{1i} = 1$ and $T_{0i} = 0$, that is, they enroll at their target campus when offered an award but not otherwise. Target compliers have $T_{1i} \geq T_{0i}$ and award effects on T_i equal the probability of this event.

By definition, target-enrollment compliers in four-year strata enroll in a four-year program when $A_i = 1$ (because applicants in four-year strata have a four-year target). We're interested in the likelihood that target compliers enroll in four-year programs when assigned to the control group. This is measured by computing the share of target compliers enrolled in four-year programs, the share enrolled in two-year programs, and the share unenrolled–in the event they fail to receive an award. As in Abdulkadiroglu et al. (2017), we refer to these shares as the distribution of counterfactual *destinies*. Following Abdulkadiroglu, Angrist and Pathak (2014)), destinies are estimated by 2SLS.[18]

Panel B of Figure V plots estimated destiny distributions for target compliers in four-year strata, separately by target campus and subgroup. An important finding here is the substantial heterogeneity in the fraction of compliers who enroll in four-year programs without STBF aid. In the breakdown by target campus, for example, compliers targeting UNO are least likely to find their way to a four-year program absent an STBF award. This fact, in combination with a relatively high target-campus compliance rate in the UNO group, contributes to out-sized award-induced degree gains for applicants targeting UNO. Similarly, across demographic and college-readiness subgroups, degree gains are most impressive for applicants whose counterfactual destinies are least likely to include a four-year program.

[18] Briefly let $W_i = c$ for $c \in \{4, 2, 0\}$ encode whether an STBF applicant is in a four-year program, two-year program, or unenrolled. In this case, the 3-point destiny distribution, ω_c, is given by:

$$\omega_c = \frac{E[(1 - T_i)1\{W_i = c\}|A_i = 1] - E[(1 - T_i)1\{W_i = c\}|A_i = 0]}{E[(1 - T_i)|A_i = 1] - E[(1 - T_i)|A_i = 0]},$$

computed separately for each c. This formula, an IV estimand, is derived using the fact that $W_i = (1 - T_i)1\{W_{0i} = c\} + T_i 1\{W_{1i} = c\}$, where W_{0i} and W_{1i} denote potential enrollment indexed against T_i, and the fact that the denominator is the negative of the target compliance rate. Abadie (2002) uses these facts to establish identification of marginal potential outcome distributions in an extension of the LATE Theorem (Imbens and Angrist 1994). A 2SLS version of ω_c allows for covariates.

IV.B. Measuring Mediation

The target compliance rates and college enrollment destinies exhibited in Figure V motivate a parsimonious mediation hypothesis that specifies early engagement with four-year programs as a key causal channel for STBF award effects. To make this hypothesis concrete, let f_{1i} denote the fraction of a full-time four-year course load an applicant completes in the school year immediately following random assignment (STBF defines a full load as 12 credit units per semester and 24 credit units per year). The mediation hypothesis is captured by a model in which awards boost f_{1i}, which in turn increases BA completion, Y_i. This can be written:

$$Y_i = \beta_1' X_i + \mu_1 f_{1i} + \varepsilon_{1i} \tag{2}$$

$$f_{1i} = \pi_{10}' X_i + \pi_{11} A_i + \left(\pi_{12}' X_i\right) A_i + \eta_{1i}, \tag{3}$$

where ε_{1i} in equation (2) is the random part of potential degree completion in the absence of treatment, and μ_1 is the causal effect of interest. Equation (3) is the first stage for a 2SLS procedure that uses A_i to instrument f_{1i}. The first stage residual, denoted η_{1i} in (3), is uncorrelated with A_i and X_i by construction.

Equation (3) allows the first-stage effect of award offers on f_{1i} to vary with covariates. It is convenient to write these covariate-specific first stage coefficients as:

$$\pi(X_i) = \pi_{11} + \pi_{12}' X_i.$$

Importantly, the causal relationship of interest, described by equation (2), omits interactions between f_{1i} and X_i. The reduced form implied by (2) and (3) therefore satisfies

$$\rho(X_i) \equiv E[f_{1i}|X_i, A_i = 1] - E[f_{1i}|X_i, A_i = 0] = \pi(X_i)\mu_1, \tag{4}$$

for each value of X_i. In other words, the assumptions behind (2) and (3) imply that *all* heterogeneity in reduced-form award effects by strata and subgroup is explained by differences in the extent to which offers change early four-year engagement. It bears emphasizing that (4) says more than that first year course completion is correlated with college completion (as it surely is). The moments underlying this restriction do not involve the covariance of f_{1i} with degree completion. Equation (4) restricts award effects only.

Figure VI offers a visual instrumental variables (VIV) representation of equation (4). This figure plots covariate-specific reduced-form estimates for degree outcomes against the corresponding first-stage estimates. The sample used to compute these estimates includes the 2012-14 cohorts in two-year and four-year strata. The vector X_i includes dummies indicating four-year target campuses (UNO, UNL, UNK, and state colleges), a dummy for those targeting two-year schools, and dummies for the demographic and college-readiness subgroups seen in Figures IV and A4. Because the X_i on many values, and reference groups for each interaction are arbitrary, the figure plots easily-interpreted sample average values of estimated $\hat{\rho}(X_i)$ and $\hat{\pi}(X_i)$ for all groups of interest. For example, one point in the figure has coordinates $(\hat{E}[\hat{\pi}(X_i)|F_i = 1]), \hat{E}[\hat{\rho}(X_i)|F_i = 1])$ where F_i indicates female applicants and $\hat{E}[\cdot|F_i = 1]$ denotes sample averages. Appendix B details the calculations behind this figure further, and shows that the slope of the line through the points plotted therein is an IV estimate of μ_1 identified by instrumenting f_{1i} in equation (2) using A_i and the set of interactions between X_i and A_i as instruments. The figure also plots the point determined by first stage and reduced form estimates for an IV model without interactions.[19]

The fitted line in Panel A of the figure, computed for award effects on BA completion, has a slope of 0.61 when estimated with no intercept, a proportionality restriction implied by equation (4). The relationship between first-year college success and degree completion that this estimate reflects is partly mechanical. At the same time, while success in the first year of college is necessary for degree completion, it's not sufficient. Likewise, STBF awards need not boost degree completion *only* to the extent that they improve first-year outcomes. The over-identification statistic associated with 2SLS provides a formal test of the hypothesis that all variation in $\rho(X_i)$ is explained by variation in $\pi(X_i)$, leaving no room for other effects of A_i on degree completion. This test statistic is essentially a scaled version of the R^2 for the lines plotted in Figure VI (see, e.g., Section 2.2.2 of Angrist and Pischke 2009). The addition of two-year strata reveals whether low degree impact for applicants targeting two-year schools is explained by small award effects on f_{1i} in these strata.

[19]The interaction terms underlying the figure are estimated jointly (the interaction of offer with low ACT, for example, is estimated in a model with other interactions, including that for low GPA). The figure plots fitted values from a group-size weighted regression of group-specific average reduced forms on the corresponding group-specific average first stage, omitting the estimate without interactions since this point is implied by the group-specific estimates. The estimates plotted in Figure VI and reported in Table IV (discussed below) are from reduced-form and first-stage equations that include the full vector of X_i as controls.

Over-identification test results, along with the associated 2SLS estimates and first-stage F-statistics, appear in columns 1-3 of Table IV for alternative specifications of X_i. Formal test results accord with the impression that the VIV line fits well. The large p-values associated with the over-identification test statistics suggest that—across all strata and subgroups—any deviation between sample moments and the proportionality hypothesis expressed by equation (4) can be attributed to sampling variance. The first-stage estimate for female applicants, for example, shows STBF offers boost f_{1i} by about 0.11. This in turn boosts BA completion by about .069, so the implied IV estimate for this group is 0.62, close to the slope of the line in Panel A of the VIV figure. The point for two-year strata also lands near the line, and (consistent with modest degree gains for this group) appears in the southwest corner of the figure.[20]

Combining all strata- and subgroup-specific instruments leads to the over-identified 2SLS estimate of 0.55 reported in the first column of Table IV (over-identified 2SLS estimates differ from the corresponding VIV estimates due to differences in weighting and because the set of covariate interactions in the instrument list is not saturated). The first-stage F-statistic for this heavily over-identified model is only around 11. In view of the risk of finite-sample bias in this scenario, it's noteworthy that 2SLS estimates computed using smaller instrument sets are similar. In particular, column 2 reports a 2SLS estimate of 0.58 when using subgroup interactions only, column 3 shows an estimate of 0.59 using strata interactions only, and column 4 reports a just-identified IV estimate computed using only an award dummy as an instrument. The first-stage relationship is notably stronger in these models, while the estimated effect of f_{1i} on degree completion changes little.

As a point of comparison, the OLS estimate generated by regressing a BA completion dummy on f_{1i}, controlling for X_i, appears in the last column of Table IV. At 0.57, this estimate is close to the corresponding IV estimates. The similarity between OLS and 2SLS estimates of the effect of f_{1i} on degree completion suggests, perhaps surprisingly, that there's little selection bias in the OLS. Finally, other panels in Figure VI and Table IV repeat the analyses of Panel A with different dependent variables. The VIV and 2SLS estimates in Panel B of these exhibits suggest f_{1i} boosts *overall* degree attainment by only around 0.37, a gain well below the estimated increase in BAs. As can be seen in Panel C of Table IV, the gap between BA and overall degree gains is accounted for by

[20]Figure A7 in the online appendix shows that VIV proportionality restrictions fit equally well in the sample of applicants not targeting UNO.

the fact that early engagement with four-year colleges decreases associate degrees. The VIV slope for f_{1i} effects on associate degree completion is -0.26 (almost identical to the 2SLS estimates in Panel C of Table IV). OLS estimates of the effect of f_{1i} on any degree and associate degree completion differ noticeably from the corresponding 2SLS estimates, with evidence of positive selection bias in the first.

1. Shifting College Credits. STBF awards push some applicants from non-enrollment all the way to full-time four-year college enrollment. At the same time, for applicants likely to attend a four-year program without an award, award receipt may affect the number of four-year credits earned. How much does the *intensity* of four-year college engagement contribute to the causal mediation story suggested by Figure VI and Table IV? Figure VII measures intensity changes in two ways. Panel A plots the histograms of four-year credits earned in the first post-treatment year, separately for treatment and control applicants in four-year strata (these are distributions of f_{1i} in terms of units earned rather than share of a full-time load). The figure documents a large decline in the likelihood of having earned zero four-year credits, from around 12 percent in the control group to around 4 percent in the treated group, a statistically significant decline. The histograms also show clear, treatment-induced increases in the probably of earning 24–28 four-year credits. This finding is important because 24 credits marks a full-time load.

Panel B of Figure VII provides another view of the award-induced credit shift. This panel plots scaled treatment-control differences in the probability an applicant earns at least s credits, for each value of $s \in [1, 40]$. This plot is motivated by Angrist and Imbens (1995), which shows that in causal models with an ordered treatment, an IV estimator using a dummy instrument identifies a weighted average of single-unit causal effects (called an average causal response, or ACR). In particular, the ACR averages causal effects of increasing credits from $s-1$ to s, for each s. Single-unit effects are specific to applicants who were induced by awards to move from fewer than s to at least s credits. ACR weights are given by the control-minus-treatment difference in the cumulative distribution function of credits earned in each group, divided by the corresponding first-stage effect of the instrument on the ordered treatment. These weights can be interpreted as the probability that awards cause applicants to go from fewer than s credits earned to at least s credits earned. More formally, let $f_{1i}(0)$ denote potential credits earned in the absence of treatment and let $f_{1i}(1)$

denote potential credits earned when treated. The ACR weighting function is proportional to $P[f_{1i}(0) < s \leq f_{1i}(0)]$.

In a scenario where awards move some applicants from zero four-year credits earned to 24 or more credits earned, with no one affected otherwise, the ACR weighting function is flat for $s \in [1, 24]$. To see this, note that if $f_{0i} = 0$ and $f_{1i} \geq t$ for all affected applicants, the probability $f_{1i}(0) < s \leq f_{1i}(0)$ is the same for all $0 < s \leq t$. Panel B of Figure VII is largely consistent with this, showing a reasonably flat weighting function from $s = 1$ through $s = 24$, with a modest rise in the probability of completing 14-22 credits that's also visible in the histograms in Panel A (the vertical hash marks denote $\frac{3}{4}$-time and full-time enrollment; students must be enrolled at least $\frac{3}{4}$-time to qualify for STBF support). This pattern suggests that most applicants for whom awards boost four-year engagement move from attempting no four-year credits to full-time study. Some, however, move to more intensive but still part-time study. The fact that the weighting function declines steeply for $s > 24$ suggests awards push few students beyond the threshold for full-time enrollment.

2. Dynamic Exclusion. Early engagement with a four-year program appears to be an important channel through which STBF awards increase BA completion. But this claim raises the question of why we should focus on *initial* engagement and not, say, sophomore or junior-year measures of four-year college credits earned. Is engagement in the first year of college the *key* step on the path to BA completion? Defining f_{ti} as the fraction of a full credit load earned in year t, it seems reasonable to imagine that awards boost f_{ti} for $t > 1$ as well as boosting f_{1i}. These gains, in turn, may also contribute to degree completion. We show here, however, that award-induced changes in downstream f_{ti}, as well as the consequences of these changes for BA completion, can be explained by award effects on f_{1i}. Because this model attributes all causal effects of f_{ti} to effects on f_{1i}, we say that it embeds *dynamic exclusion* restrictions.

Dynamic exclusion is captured by a model of sequential credit completion. This model is:

$$f_{ti} = \alpha_t' X_i + \psi_t f_{1i} + \xi_{ti};\ t = 2, 3, 4, \tag{5}$$

where ψ_t is the causal effect of f_{1i} on f_{ti} and ξ_{ti} is a residual assumed to be uncorrelated with A_i, conditional on covariates, X_i. Equation (5) is complemented by a causal model for the effect of f_{ti}

on degree completion that can be written:

$$Y_i = \beta_t' X_i + \mu_t f_{ti} + \varepsilon_{ti};\ t = 2, 3, 4, \tag{6}$$

where awards and award-covariate interactions are likewise assumed to be uncorrelated with ε_{ti}. Dynamic exclusion is the claim that awards and award-covariate interactions are valid instruments for f_{ti} in both (5) and (6). In other words, STBF awards boost credits earned in year t solely by virtue of boosting credits in year one. Effects of later credit completion on degrees are explained by this fact.

The orthogonality assumptions that identify equations (5) and (6) imply an illuminating cross-equation restriction. In particular, using (5) to substitute for f_{ti} in (6) reveals that the coefficient on f_{1i} in equation (2) satisfies:

$$\mu_1 = \psi_t \mu_t. \tag{7}$$

This substitution also shows the residual in equation (2) to be $\varepsilon_{1i} = \varepsilon_{ti} + \mu_t \xi_{ti}$. Dynamic exclusion therefore rationalizes the exclusion restrictions tested in Table IV.

It's worth asking whether equation (7) offers a further set of restrictions worth testing. The answer is that a Wald-type test computed by replacing parameters in (7) with the corresponding 2SLS estimates is the same as the over-identification test statistic associated with 2SLS estimation of equation (5).[21] This is distinct from the test examined in Table IV.

Table V reports 2SLS estimates of μ_t and ψ_t, along with their product, computed for different instrument sets and values of t. The instruments here are an award dummy, A_i, interacted with the same four-year strata and subgroup dummies used to compute the estimates in Table IV. In this case, the sample is limited to applicants in four-year strata since degree gains are concentrated in this group. Estimates of μ_t show strong effects of college credits earned in years 2-4 on degree

[21] Let $\hat{f}^*_{ti}$ denote fitted values from a regression of f_{ti} on instruments and covariates, with covariates then partialed out. Let $\hat{\psi}_t$ denote a 2SLS estimate of ψ_t computed using the same instruments, covariates, and sample. Instrument-error orthogonality in equation (5) implies that in large samples $\hat{\kappa}_{ti} = \hat{f}^*_{ti} - \hat{\psi}_t \hat{f}^*_{1i} \approx 0$, with an asymptotic mean-zero normal distribution; over-identification tests for (5) are derived from this distribution. It then follows that the quantity

$$E_n[Y_i \hat{\kappa}_{ti}] = E_n[Y_i \hat{f}^*_{ti}] - \hat{\psi}_t E_n[Y_i \hat{f}^*_{1i}],$$

where $E_n[\cdot]$ denotes sample averaging in a sample of size n, converges to zero. Dividing $E_n[Y_i \hat{\kappa}_{ti}]$ by the sample variance of $\hat{f}^*_{ti}$ and again using the fact that $\hat{\kappa}_{ti} \approx 0$ yields the sample analog of equation (7).

completion, while the estimated ψ_t indicate increases in f_{1i} yield large gains in four-year credits earned down the road. The latter effects range from $0.85 - 1.08$.

The product of the estimated μ_t and ψ_t suggest these parameters indeed reflect the impact of credits earned in the first year of college on later academic progress. In particular, the estimated $\mu_t\psi_t$ are remarkably close to the corresponding estimates of μ_1 shown at the top of Table IV (all around 0.58). Moreover, the over-identification test statistics associated with 2SLS estimates of equation (5) are consistent with the claim that STBF awards affect four-year credits earned in later years solely by increasing f_{1i}. This finding notwithstanding, it may be the guarantee of financial support for five years that induces otherwise hesitant prospective four-year students to fully dive in. Additional work is needed to determine whether front-loading aid is a cost-effective way to enhance aid effectiveness.

V. Cost-Benefit Perspectives

The causal effects of STBF scholarship awards on adult employment, earnings, and financial security will not be known for at least a decade. To gauge the *potential* cost-effectiveness of scholarships, this section provides a prospective cost-benefit analysis that compares predicted award-induced increases in lifetime earnings with measures of program cost overall and by demographic subgroup.

V.A. Estimating Costs

Funder spending on awards is easily measured. While a funder's award costs may affect program viability, the economic cost of an award is a distinct concept: economic costs correspond to program-induced spending net of transfers. Scholarships may increase *overall* educational spending by increasing time spent in school and by moving students into more expensive programs. We therefore use the experimental framework to measure the incremental spending induced by awards, while also reporting per capita funder spending.

To determine the impact of award offers on funder spending, we put aid disbursements, D_i, on the left hand side of the reduced-form model for treatment effects (equation 1). No aid is disbursed

to control group applicants, so the effect of STBF offers on D_i captures average funder spending on treated applicants adjusted for strata differences.

To quantify the extent of marginal educational spending—that is, spending *induced* by awards—we replace the funder cost variable, D_i, on the left-hand side of equation (1) with a measure of the cost of college attendance. We use this award induced cost of attendance later in our cost-benefit analysis in Section C. This variable, denoted COA_i, is proxied by the federally-determined cost of attendance as reported in the Institutional Characteristics File of the publicly-available Integrated Postsecondary Education Data System (IPEDS, U.S. Department of Education 2019). The imputed COA_i variable used here covers tuition, fees, and an allowance for books and supplies. We compute COA_i for all ever-enrolled applicants, including those who attend private schools or non-Nebraska public schools.[22]

The statistics for D_i and COA_i reported in Panel A of Table VI highlight the difference between STBF disbursements and marginal educational spending. Average COA_i is roughly $\$30,940$ among treated applicants in the four-year strata, close to average program disbursements in this group ($\$32,250$). On the other hand, while mean D_i is zero for controls, average control COA_i is around $\$28,550$, only modestly below average cost in the treated group.

Panel B of Table VI allocates award effects on COA_i to a component that reflects increased time in school and a component that reflects a shift towards more expensive programs. We refer to the latter as "cost-upgrading." To gauge the relative importance of these components, let COA_{1i} denote college costs incurred when applicant i is treated and let COA_{0i} denote costs incurred otherwise. Because $\{COA_{ji}; j = 0, 1\}$ is the product of years enrolled (denoted S_{ji}) and cost per year (denoted F_{ji}), we can write:

$$\begin{aligned} log(COA_{1i}) - log(COA_{0i}) &= log(S_{1i}F_{1i}) - log(S_{0i}F_{0i}) \\ &= \underbrace{log(S_{1i}) - log(S_{0i})}_{\text{extra years}} + \underbrace{log(F_{1i}) - log(F_{0i})}_{\text{extra cost per year}}. \end{aligned}$$

The first term on the second line of this expression captures incremental costs generated by more time in school, while the second captures cost upgrading, both measured in proportional terms. The

[22]This calculation omits housing and transportation costs and uses the smaller of credit-based costs or full-time tuition. Cost data are missing for one applicant. Costs of books and supplies for eight percent of applicants are imputed using averages for two- and four-year schools. We discount funder cost and cost of attendance back to Year 1 at a 3% rate.

average of each piece is obtained by putting observed time in college and per-semester spending, respectively, on the left-hand side of equation (1).

Awards increased COA_i by 16 log points on average, as shown in the first row of Panel B. The pattern of spending increases across target strata mostly parallels differences in treatment effects on BA completion and years of schooling by strata. The increase in education spending is largest for UNO-targeting applicants (27 log points), not surprisingly, since this group sees an especially strong award-induced shift towards four-year college enrollment.

The remaining entries in Panel B show that over two-thirds of marginal spending is attributable to additional years of college, with the remainder due to cost-upgrading (that is, increase COA per year enrolled). UNO-targeting applicants are the only group for whom cost-upgrading makes almost as large a contribution to marginal spending as does additional years enrolled (13 and 14 log points, respectively).[23] For applicants targeting UNL and state colleges, by contrast, estimated cost-upgrading effects are not significantly different from zero.

V.B. Projecting Lifetime Earnings Gains

We forecast the expected lifetime earnings impact of grant aid using an earnings equation fit to cross-sectional 2008-19 American Community Survey (ACS) data for Nebraska-born residents aged 18-65 with at least a high school degree (not including GED holders) and at most a bachelor's degree. Returns to schooling are estimated using a Poisson regression model on earnings data that includes zeros. Annual earnings are calculated from the ACS, inflated to current dollars using the chained Consumer Price Index for all urban consumers, and are regressed on dummies for the highest level of schooling completed (some-college-no-degree, AA degree, and BA degree, with high school degree as the reference category) and a quartic in imputed potential experience. We use estimates on time in school from Park (1994) to calculate potential experience separately by gender and race (white/nonwhite) subgroups. Online Appendix C reports the underlying regression estimates and contains additional details related to imputation.

With a three percent discount rate, BA completion is estimated to boost the PDV of lifetime earnings by $\$470,000$ on average. This is in line with estimates from Avery and Turner (2012).

[23] Log COA per year of schooling increases more than the yearly COA level partly because awards boost the share of students enrolling full-time at target campuses, thereby lowering the variance of COA. (Due to Jensen's inequality, mean log COA is declining in the variance of COA.)

Also consistent with Avery and Turner (2012), the estimated return to BA attainment is larger for men than women. Estimated earnings gains differ little by race (white/nonwhite).

These regression results are combined with the scholarship's treatment effects to determine the expected lifetime earnings impact of grant aid. To calculate control group earnings, we use means of degree attainment and imputed time in school from our ACS sample as point estimates in our estimated earnings function. Expected earnings are calculated separately for gender-by-race subgroups and then averaged using as weights the subgroups' prevalence in the control group. By adding treatment effects on degree attainment and time in school calculated by equation (1) to the ACS means, we create expected treatment group earnings. Overall, the STBF scholarship is estimated to increase discounted lifetime earnings by $\$21,150$ for each treated applicant. These estimates ignore award-induced changes in post-graduate schooling.[24] This gain exceeds the award's average impact on educational spending ($\$2,390$), but falls below the funder's average cost per awardee of $\$32,250$.

V.C. Picturing Costs and Benefits

Figure VIII puts the cost-benefit pieces together for each of the subgroups considered in Section IV. The cost-benefit comparisons in the figure take the form of intervals, with the top marker indicating funder costs and the bottom indicating marginal educational spending, that is, effects on COA. Predicted lifetime earnings gains are estimated using a similar parametric approach to the award effects in Panel C of Online Appendix Table C2. As in Avery and Turner (2012), these are computed using a discount rate of three percent.

For all groups, predicted earnings gains fall between funder costs and marginal COA, a finding that suggests STBF awards generate a positive social return on average and for all demographic subgroups. These estimates also imply that funder costs exceed award-induced earnings gains for most subgroups. However, estimated earnings gains exceed both marginal COA and funder costs for the subset of applicants with below median grades, those who chose a community college as an alternative target, those with below median ACT scores, those who indicated UNO as a target, and Omaha residents.

[24] A more detailed description of this procedure can be found in Online Appendix C.

As a benchmark, we compare the cost-effectiveness of STBF aid with that of similar public sector scholarship programs in a hypothetical scenario where the STBF program were publicly funded. Following Hendren and Sprung-Keyser (2020), this comparison uses the marginal value of public funds (MVPF), defined as the ratio of program benefits among policy beneficiaries to net costs to the government. For STBF beneficiaries, program benefits include a transfer of $\$32,250$ (equal to the transfer made from the funder to the student, seen in Table VI) plus the award-induced increase in the PDV of lifetime earnings. The latter quantity is taken to be $\$21,150$ (Online Appendix Table C2 Panel C). Assuming that incremental earnings are taxed at 20% reduces the government's cost of operating the program by $\$4,230$, while reducing the private benefit by the same amount.

The ratio of private benefits ($\$32,250 + \$21,150 - \$4,230 = \$49,170$) to public costs ($\$32,250 - \$4,230 = \$28,020$) in this scenario yields an MVPF of 1.75, which implies that one dollar of public spending on the STBF program generates $\$1.75$ of private benefits. An MVPF of 1.75 puts the STBF program near the median of estimated MVPFs of other cost-effective grant aid programs examined in Hendren and Sprung-Keyser (2020). STBF ranks especially highly among programs targeting college-bound high school students. Relevant comparisons include the Massachusetts Adams scholarship, with an MVPF of 0.72, and the Wisconsin Scholars Grant program, with an MVPF of 1.43.[25]

Based as they are on a predictive model of lifetime earnings, these cost-benefit comparisons are provisional. But they seem likely to be conservative for a number of reasons. First, they omit non-pecuniary benefits of schooling related to health, social intelligence, and marriage (documented in Oreopoulos and Salvanes 2011). Our estimated earnings gains also ignore any scholarship-induced increases in post-BA schooling and possible economic returns to reductions in college debt. Finally, the overall returns to schooling estimated here may also fall below the economic returns to education for students whose school decisions are sensitive to financial constraints (a possibility suggested by, e.g., Card 2001 and Zimmerman 2014).

[25] With a 5% discount rate, the estimated MVPF for STBF aid falls to 1.42. Other comparably structured grant aid programs covered by Hendren and Sprung-Keyser (2020) include Kalamazoo Promise and Tennessee HOPE.

VI. Summary and Conclusions

Randomized evaluation of the comprehensive STBF aid program yields results that are both encouraging and cautionary. On one hand, scholarship awards increase four-year degree attainment substantially. On the other, the bulk of award spending is a transfer flowing to applicants whose schooling behavior is unchanged by awards. Aid boosts degree completion most sharply for applicants who aspire to a BA but are unlikely to embark on a four-year program in the absence of aid. Those who benefit most include groups of applicants with below-median grades and test scores, those seeking to enroll at the urban campus of the University of Nebraska at Omaha, and those considering two-year colleges.

We explain the pattern of degree effects with a parsimonious model that makes the main mediator of award impact a credit-based measure of initial engagement with four-year college. Estimates of this model support the notion that awards induce degree completion primarily by prompting and deepening early engagement with four-year college programs. This finding suggests there may be a large payoff to other, perhaps less costly, interventions that act to enhance early engagement. Examples of inexpensive service-oriented early engagement interventions include pre-college advising and mentoring (as in Bettinger and Evans 2019 and Carrell and Sacerdote 2017) and efforts to boost SAT and ACT-taking (as in Bulman 2015 and Goodman, Gurantz and Smith 2020).

To put the early engagement hypothesis in context, it's worth noting that almost all STBF applicants start college somewhere regardless of whether they are awarded a scholarship. Yet, many are no longer enrolled two and three years out (as shown in Angrist et al. 2016). This leaves scope for STBF awards to boost four-year degree attainment by increasing persistence in college for those likely to start a four-year program even without STBF aid. The results reported here, however, weigh against the importance of persistence effects beyond those engendered by early credit completion.

Similarly, because STBF awards provide incentives for students to remain in good academic standing, we might expect award incentives to have incremental effects in each academic year, even for applicants destined to start a four-year program anyway. Our findings weigh against the importance of incentives to remain in good academic standing as well. Once aid recipients have responded to awards in year one by choosing to start and stick with a four-year school, academic

performance incentives and other downstream forces appear to matter little. This conclusion should be qualified, however, with the observation that results for a motivated, college-bound population of STBF applicants need not predict aid effects in other populations and circumstances.

A cost-benefit analysis highlights the fact that most STBF aid spending is a transfer, flowing to applicants likely to earn degrees even without an award. The flip side of high transfer cost, however, is the fact that the marginal educational spending induced by STBF awards is low. For each subgroup considered here, the projected net earnings gains from scholarship-induced schooling outweigh the corresponding marginal educational cost. Moreover, although most award money is inframarginal, the projected earnings gains for high-benefit groups (with especially low counterfactual enrollment in a four-year program) also exceeds the corresponding *funder* cost.

The findings reported here strongly suggest that increased targeting of financial aid awards is likely to enhance aid impact, thereby boosting program MVPF. Given that STBF award impact can be explained by the effect of scholarships on full-time four-year enrollment in year one, a fruitful question for subsequent research is whether front-loading financial aid might increase program effectiveness while reducing aid costs. Our results suggest that programs that encourage many students who would not do so otherwise to enroll at a four-year college are especially likely to increase BA attainment. That said, the promise of continuous aid may be necessary to induce four-year engagement. This suggests the question of the optimal timing of aid flows should be high priority for future work. Finally, Scott-Clayton and Zafar's (2019) evidence on longer-run fade-out of degree effects highlights the importance of continued follow-up and an investigation of effects on non-degree outcomes such as student debt and earnings.

Massachusetts Institute of Technology and National Bureau of Economic Research, United States

Massachusetts Institute of Technology and National Bureau of Economic Research, United States

Harvard University and National Bureau of Economic Research, United States

A. Data Appendix

A.A. Application Data

The STBF scholarship application collects detailed information on applicants' baseline characteristics. Academic measures such as GPA are gathered primarily from high school transcripts. We standardize GPAs to a 4.0 scale using the grade conversion formula provided by the University of Nebraska-Lincoln. We also consider students' ACT score. Since not all high schools report students' ACT scores on transcripts, transcript data are supplemented with self-reported scores from the application survey for 54 percent of the experimental sample.[26]

Most of the financial and demographic data used here come from applicants' Student Aid Reports (SARs). These reports are available for all STBF applicants who filed the Free Application for Federal Student Aid (FAFSA). SARs contain responses to more than 100 FAFSA questions regarding students' financial resources and family structure, including family income, parents' marital status, and parents' education. Roughly three percent of scholarship applicants are undocumented immigrants, who are ineligible for federal financial aid and therefore cannot file the FAFSA. STBF permits these students to submit an alternate form called the College Funding Estimator (CFE). The CFE is published by the EducationQuest Foundation, a non-profit organization in Nebraska, and gathers a similar, though less detailed, set of information.

Neither SARs nor CFEs report students' race, and the scholarship application did not collect this variable until the 2014 cohort. Supplemental data on race were obtained from the Nebraska Department of Motor Vehicles. Over 85 percent of the randomization sample was successfully matched to driver's license records.

A.B. Financial Aid Data

Nebraska's public colleges and universities provided detailed information on their students' financial aid packages. These data report costs of attendance, grants, loans, and Federal Work Study aid. While all schools report federal loans, most do not report private loans, which may be obtained directly from lenders without involving financial aid officers. We therefore exclude private loans

[26] In Nebraska, the majority of students take the ACT rather than the SAT. In 2012-2013, 70 percent of Nebraska high school students took the ACT, compared with the national average of 52 percent.

from our analysis. For most STBF applicants, however, federal loans offer the lowest available interest rate and therefore account for the vast majority of borrowing. Figure I reports various kinds of aid distributed in the first academic year following the scholarship application year.

1. Cost of Attendance. Publicly available IPEDS institutional characteristics data were used to estimate a sticker price of college for every student in the experimental sample. The sticker price calculation includes in-state tuition, fees, and a books and supplies stipend. The institutional characteristics dataset in each year from IPEDS has nearly full coverage of tuition and fees for schools attended by students in the experimental sample. There is only one school for which we do not have tuition and fees—this is a special case in which the student transferred to an out-of-state certificate school. This school's cost of attendance varies greatly based on certificate program, so we drop the student from the sample.

The IPEDS data are missing a books and supplies cost value for 8 percent of the sample. In these cases we impute costs using the mean books and supplies costs for students in the same calendar year and college type (four-year vs two-year and for-profit vs not for profit).

We calculate each student's sticker price by matching credits attempted per term to the cost per credit at the school attended in every year of attendance. Importantly, we use credits attempted, as opposed to credits earned because a student is charged for every credit attempted, whether or not they pass the course. As above, IPEDS has nearly full coverage of cost per credit for schools attended by the experimental sample. Every school that reports tuition also reports cost per credit. We also calculate the total cost based on credits attempted for each student at each school. When this credit-based cost exceeds the school's reported tuition, the cost variable is assigned the full-time tuition value. Each student's sticker price is then estimated by summing credits-based cost per term, a books and supplies stipend, and the school-reported fees in each academic year.

A.C. Education Outcome Variables

Over 90 percent of experimental subjects enrolled in Nebraska's public colleges and universities. We match STBF applicants to administrative data provided by these schools using names, dates of birth, and the last four digits of Social Security Numbers (SSNs). To measure enrollment at out-of-state and private institutions, we match applicants to National Student Clearinghouse (NSC) data

using names and dates of birth. Though the NSC captures more than 91 percent of enrollment nationwide (and more than 99 percent at four-year public institutions), its name-based match has limitations, as Dynarski, Hemelt and Hyman (2015) detail. Roughly four percent of experimental applicants have enrollment at Nebraska's public colleges and universities that does not appear in the NSC-matched sample. These students are disproportionately nonwhite.

1. Enrollment Measures. The enrollment outcomes used for this paper are dummy variables indicating type of institution enrolled. Table II, for example, reports effects on the probability of enrollment in year one for two- and four-year schools and schools in various sectors. We define follow-up windows to match the start and end dates of each academic year based on individually published academic calendars at each school. So *year one* covers the period from the beginning of the fall term to the end of the last summer term of an applicant's school in the year following the application (and randomization) year. When data is unavailable from the Nebraska public colleges, we use similar timing conventions from the NSC. Within each window, we force binary enrollment outcomes to be mutually exclusive. Students who enroll at both two- and four-year institutions are coded as having "any four-year" enrollment. Likewise, those who enroll at in-state public colleges do not contribute to the out-of-state or private categories.

We also track cumulative credit completion. Most credit data come from Nebraska's public colleges and universities. Credits for the seven percent of applicants who attend out-of-state or private colleges are imputed using the NSC's coarse enrollment status variable: an indicator for whether students were enrolled full-time, half-time, or less than half-time. Imputed credit is the predicted value from a regression of credits on enrollment status, degree program, academic term, and cohort. Less than two percent of applicants attend out-of-state or private schools that do not report the full-time enrollment indicator to the NSC. These students are coded as enrolled full time when the full-time enrollment share at their chosen school is at least 85 percent, as reported by IPEDS.

Annual enrollment is coded as follows. A student is coded as enrolled in year one (from the point of our research timeline) if they completed credits at some point during their first year, either in the fall, spring, or summer term. To be coded as enrolled in year 2+, a student must be coded as enrolled in fall, spring, or summer of the academic year beginning 2+ years after their STBF

application year. If a student is enrolled in year 2+, there is no requirement to be enrolled in year 1. Figures that plot term-wise enrollment show enrollment in either a fall or spring term, where the fall term includes both fall and winter terms and the spring term includes both spring and summer terms.

2. Years of Schooling Data. Years of schooling variables are term counts derived from term-wise enrollment status as reported by Nebraska's public colleges and universities, or in the NSC when the former are not available. These indicate "attempted enrollment" at an institution (as opposed to measuring credits completed). Using data from the NSC-matched sample, students are coded as enrolled in a given term if the NSC records them as enrolled at any level in any institution in a particular term.

3. Degrees Data. Degree completion indicators come from Nebraska's public colleges and universities, or the NSC when the former are not available. NSC and the colleges report completion of associate degrees and bachelor's degrees for each student, as well as the year and term in which degree requirements were met. Figures show degree completion by year and term, while tables report treatment effects on year 6 completion. Degree completion dates are likewise coded from term-wise information on completion. A student is coded as having completed a degree in year 6 if they earned a degree in either the fall, spring, or summer term of that academic year.

B. Methods: Construction of VIV Figure VI

Points plotted in Figure VI are the average reduced form and first stage coefficients associated with equations (2) and (3). The setup here allows each element of X_i to interact with A_i in the instrument list, but higher-order terms (such as an interaction between strata, GPA, and A_i) are omitted. Because the reference groups for dummy variables need not be of intrinsic interest, the figure plots sample average values of $\hat{\rho}(X_i)$ and $\hat{\pi}(X_i)$, conditioning on membership in the groups for which degree effects are plotted in Figures III, IV, and Online Appendix Figure A4. Interaction terms appear together in the instrument list, but the averages in the figure are plotted one covariate at a time.

A simplified example illuminates the nature of these average effects. Suppose there are three strata, coded $S_i \in \{1, 2, 3\}$ and a single Bernoulli covariate, F_i. The corresponding covariate vector is $X_i = [S_{1i}\ S_{2i}\ F_i]'$ where $S_{ji} = 1[S_i = j]$. So the reference group for S_i is 3.

The reduced form in this case can be written:

$$\begin{aligned} Y_i &= X_i'\delta + \rho_0 A_i + \theta_1 S_{1i} A_i + \theta_2 S_{2i} A_i + \phi F_i A_i + \varepsilon_i \\ &= X_i'\delta + A_i[\rho_0 + \theta_1 S_{1i} + \theta_2 S_{2i} + \phi F_i] + \varepsilon_i \\ &= X_i'\delta + A_i \rho(X_i) + \varepsilon_i. \end{aligned} \tag{8}$$

This model implies

$$\begin{aligned} E[\rho(X_i)|S_i = 1] &= \rho_0 + \theta_1 + \phi E[F_i|S_i = 1] \\ E[\rho(X_i)|S_i = 2] &= \rho_0 + \theta_2 + \phi E[F_i|S_i = 2] \\ E[\rho(X_i)|S_i = 3] &= \rho_0 + \phi E[F_i|S_i = 3] \end{aligned} \tag{9}$$

and

$$\begin{aligned} E[\rho(X_i)|F_i = 1] &= \rho_0 + \theta_1 E[S_{1i}|F_i = 1] + \theta_2 E[S_{2i}|F_i = 1] + \phi \\ E[\rho(X_i)|F_i = 0] &= \rho_0 + \theta_1 E[S_{1i}|F_i = 0] + \theta_2 E[S_{2i}|F_i = 0] \end{aligned} \tag{10}$$

Note that reference groups for each categorical conditioning variable have different effects. Specifically,

$$E[\rho(X_i)|S_i = 3] \neq E[\rho(X_i)|F_i = 0] \tag{11}$$

Neither of these equal the award main effect, ρ_0.

In this example, 2SLS estimates are identified by exclusion of the four-instrument set $Z_i = \{A_i\ S_{1i}A_i\ S_{2i}A_i\ F_iA_i\}$ from equation (2). It remains to show that that average reduced form associated with this procedure is proportional to the corresponding average first stage. Substituting (3) in (2) to obtain the reduced form, it's easy to show the marginal sample mean reduced form and first stage satisfy:

$$\hat{E}[\rho(X_i)|S_i] = \hat{E}[\pi(X_i)|S_i]\mu_1, \tag{12}$$

A corresponding Figure VI for this example has five points, three for the values of S_i and two for the values of F_i.

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Table I
Descriptive statistics

			Non-Experimental Sample		Experimental Sample	
	Nebraska HS Seniors (1)	Eligible Applicants (2)	Guaranteed Award (3)	No Award (4)	All (5)	Treatment-Control (6)
Female	.49	.62	.68	.54	.62	.02 (.01)
White	.75	.63	.54	.57	.66	.00 (.01)
Black	.07	.06	.06	.11	.06	.00 (.01)
Hispanic	.12	.21	.27	.22	.20	.01 (.01)
Asian	.03	.05	.09	.04	.05	-.01 (.01)
Other race	.02	.04	.04	.05	.04	-.00 (.00)
Family income ($)	87,567	44,774 [45,178]	37,503 [73,675]	44,073 [28,233]	46,353 [38,911]	-1,131 (1226)
EFC ($)	---	2,692 [3,063]	2,026 [2,682]	2,634 [3,271]	2,836 [3,087]	-89 (75)
Eligible for Pell grant	---	.75	.80	.77	.74	.01 (.01)
At least one parent attended college	.70	.66	.57	.64	.68	.01 (.01)
At least one parent has a BA	.44	.31	.27	.28	.32	.00 (.01)
Lives in Omaha	---	.30	.35	.38	.28	-.01 (.01)
Took ACT	.85	.94	.94	.90	.94	.00 (.01)
Composite ACT score	21.61	21.87 [4.47]	22.67 [4.48]	20.18 [4.14]	21.94 (4.45)	-.13 (.10)
High school GPA	---	3.44 [.43]	3.61 [.36]	3.11 [.40]	3.451 (.416)	.007 (.010)
F-statistic					3.45	.01
p-value					.42	.01
# of applicants		11,009	1,667	1,152	8,190	

Notes: This table reports descriptive statistics for the experimental sample and, in column 1, a comparison group of Nebraska high school seniors. Data in column 1 comes from SEER (gender and race), ACS (family income and parent education status), and the ACT National Profile Report (ACT 2012). Treatment-control differences in column 7 come from regressions that control for strata dummies (cohort by target college). The sample includes the 2012-2016 applicant cohorts. Missing values for race (6 percent), family income (5 percent), and ACT (7 percent) are imputed from means within strata in the sample of eligible applicants. Standard deviations are reported in brackets. Robust standard errors for the differences in column 7 are reported in parentheses.

Table II
Initial enrollment effects

	Four-year strata				Two-year strata	
			NU 2013-2016			
	Control mean	Award effect	Regular Award	COS Award	Control Mean	Award effect
	(1)	(2)	(3)	(4)	(5)	(6)
Any college enrollment	.964	.023	.021	.024	.899	.058
		(.004)	(.005)	(.005)		(.014)
			A. Program Type			
Four-year	.833	.104	.115	.089	.057	.041
		(.008)	(.010)	(.012)		(.015)
Two-year	.095	-.067	-.078	-.065	.838	.004
		(.006)	(.007)	(.009)		(.020)
Dual enrollment	.036	-.014	-.016	-.001	.004	.013
		(.004)	(.005)	(.007)		(.005)
			B. Sector and Location			
Nebraska public	.876	.067	.067	.062	.862	.077
		(.007)	(.009)	(.011)		(.016)
University of Nebraska	.678	.115	.137	.119	.017	.046
		(.009)	(.012)	(.014)		(.011)
State college	.108	.014	.001	.004	.017	.012
		(.005)	(.004)	(.005)		(.008)
Community college	.121	-.073	-.084	-.057	.830	.024
		(.007)	(.008)	(.011)		(.020)
Out-of-state public	.024	-.016	-.019	-.014	.017	-.014
		(.003)	(.004)	(.005)		(.005)
Private	.064	-.027	-.028	-.025	.020	-.005
		(.005)	(.007)	(.008)		(.007)
# of applicants	3,786	6,845	5,212		705	1,345

Notes: This table reports scholarship award effects on post-secondary enrollment measured at the end of the scholarship application year. Columns 1 and 2 show estimates for four-year strata from all experimental cohorts. Estimates in columns 3 and 4 show estimates for NU applicants from the 2013-16 cohorts. These were computed by replacing A_i in equation (1) with dummies for each version of the NU treatment (regular or COS, where the latter drops the obligation to participate in LCs). Columns 5 and 6 show estimates for two-year strata from all experimental cohorts. Outcomes in each panel are mutually exclusive. Students simultaneously enrolled at both Nebraska public colleges and universities and non-Buffett eligible campuses are coded as being in Nebraska public schools only. The regressions used to estimate treatment effects control for strata dummies. Dependent variable construction is detailed in Appendix 1. Robust standard errors appear in parentheses.

Table III
Degree completion effects

	Four-year strata				Two-year strata	
			NU 2013-2014			
	Control Mean	Award effect	Regular Award	COS Award	Control mean	Award effect
	(1)	(2)	(3)	(4)	(5)	(6)
Bachelor's degree earned	.636	.081	.089	.080	.240	.055
		(.016)	(.022)	(.026)		(.034)
Associate degree earned	.076	-.032	-.030	-.038	.531	-.001
		(.008)	(.010)	(.011)		(.038)
Enrolled at four year	.015	-.006	-.009	-.009	.046	.009
		(.004)	(.005)	(.005)		(.017)
No degree earned	.307	-.052	-.058	-.055	.395	-.046
		(.015)	(.021)	(.025)		(.037)
Enrolled at four-year	.051	-.003	-.009	-.016	.014	.005
		(.007)	(.010)	(.012)		(.009)
Total years of schooling	3.93	.360	.366	.249	3.06	.393
		(.041)	(.056)	(.068)		(.121)
Time in four-year	3.17	.592	.622	.465	.751	.429
		(.051)	(.070)	(.083)		(.108)
Time in two-year	.487	-.219	-.239	-.212	2.20	-.077
		(.031)	(.042)	(.049)		(.098)
Dual enrollment	.278	-.012	-.018	-.004	.102	.042
		(.019)	(.025)	(.033)		(.029)
# of applicants	1,924	3,639	2,383		367	666

Notes: This table reports scholarship award effects on degree completion and years of schooling measured at the end of year six. Columns 1 and 2 show estimates for four-year strata in the 2012-14 cohorts. Estimates in columns 3 and 4 are for NU applicants from the 2013 and 2014 cohorts. These estimates were computed by replacing A_i in equation (1) with dummies for each version of the NU treatment (regular or COS, where the latter drops the obligation to participate in LCs). Columns 5 and 6 show estimates for two-year strata in the 2012-14 cohorts. Regressions used to estimate treatment effects control for strata dummies. Dependent variable construction is detailed in Appendix 1. Robust standard errors appear in parentheses.

Table IV
IV estimates of the effect of initial four-year credits completed on degrees

	2SLS				
	Strata and Subgroup Interactions	Supgroup Interactions	Strata Interactions	Just-identified	OLS
	(1)	(2)	(3)	(4)	(5)
			A. Bachelor's Degree		
Four-year credits earned	0.55	0.58	0.59	0.61	0.57
	(0.09)	(0.10)	(0.10)	(0.11)	(0.02)
First stage					
Any award				0.11	
				(0.01)	
F-stat	11.20	14.55	25.09		
Over-identification test	7.75	6.69	0.71	--	
Degrees of freedom	12	8	4		
p-value	0.80	0.57	0.95		
			B. Any Degree		
Four-year credits earned	0.32	0.34	0.36	0.37	0.43
	(0.09)	(0.10)	(0.10)	(0.11)	(0.02)
Over-identification test	8.25	5.64	2.23	--	
p-value	0.77	0.69	0.69		
			C. Associate Degree		
Four-year credits earned	-0.28	-0.27	-0.27	-0.26	-0.20
	(0.05)	(0.07)	(0.05)	(0.08)	(0.01)
Over-identification test	3.75	1.72	2.09	--	
p-value	0.99	0.99	0.72		
N	4,305	4,305	4,305	4,305	

Notes: This table reports 2SLS estimates and over-identification test statistics for models where the outcome is BA completion and the endogenous variable is initial four-year engagement as defined in Figure VI. The just-identified estimate in column 4 uses a single offer dummy as instrument. Estimates in columns 1 to 3 are from over-identified models with instrument sets constructed by interacting award offers with sets of dummies indicated in column headings. Instruments include an any-award dummy plus interactions with strata dummies: UNL, UNO, UNK, SC, and two-year colleges and subgroup dummies: Omaha residency, Nonwhite, male, Pell-eligible, below-median ACT, below-median GPA, first-generation, and listing a two-year college as an alternate. Strata and subgroups plotted are not mutually exclusive. We give an example of VIV using mutually exclusive subgroups in Online Appendix Figure A8. Estimates are for 2012-14 applicant cohorts in two- and four-year strata. All models control for strata and subgroup main effects. Robust standard errors appear in parentheses.

Table V
Dynamic exclusion parameter estimates and specification tests

	Strata Interactions			Subgroup Interactions			Strata and Subgroup Interactions		
	Year 2	Year 3	Year 4	Year 2	Year 3	Year 4	Year 2	Year 3	Year 4
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
μ_t	0.54	0.61	0.60	0.55	0.65	0.65	0.53	0.63	0.63
	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.07)	(0.07)	(0.08)	(0.07)
ψ_t	1.08	0.95	0.94	1.01	0.86	0.85	1.02	0.87	0.85
	(0.08)	(0.09)	(0.11)	(0.07)	(0.09)	(0.09)	(0.07)	(0.08)	(0.09)
$\psi_t \mu_t$	0.58	0.58	0.57	0.55	0.56	0.55	0.55	0.55	0.54
Over-id test	4.00	0.72	3.91	9.52	8.39	7.06	14.32	9.24	10.62
p-value	0.262	0.869	0.271	0.300	0.397	0.530	0.216	0.600	0.475

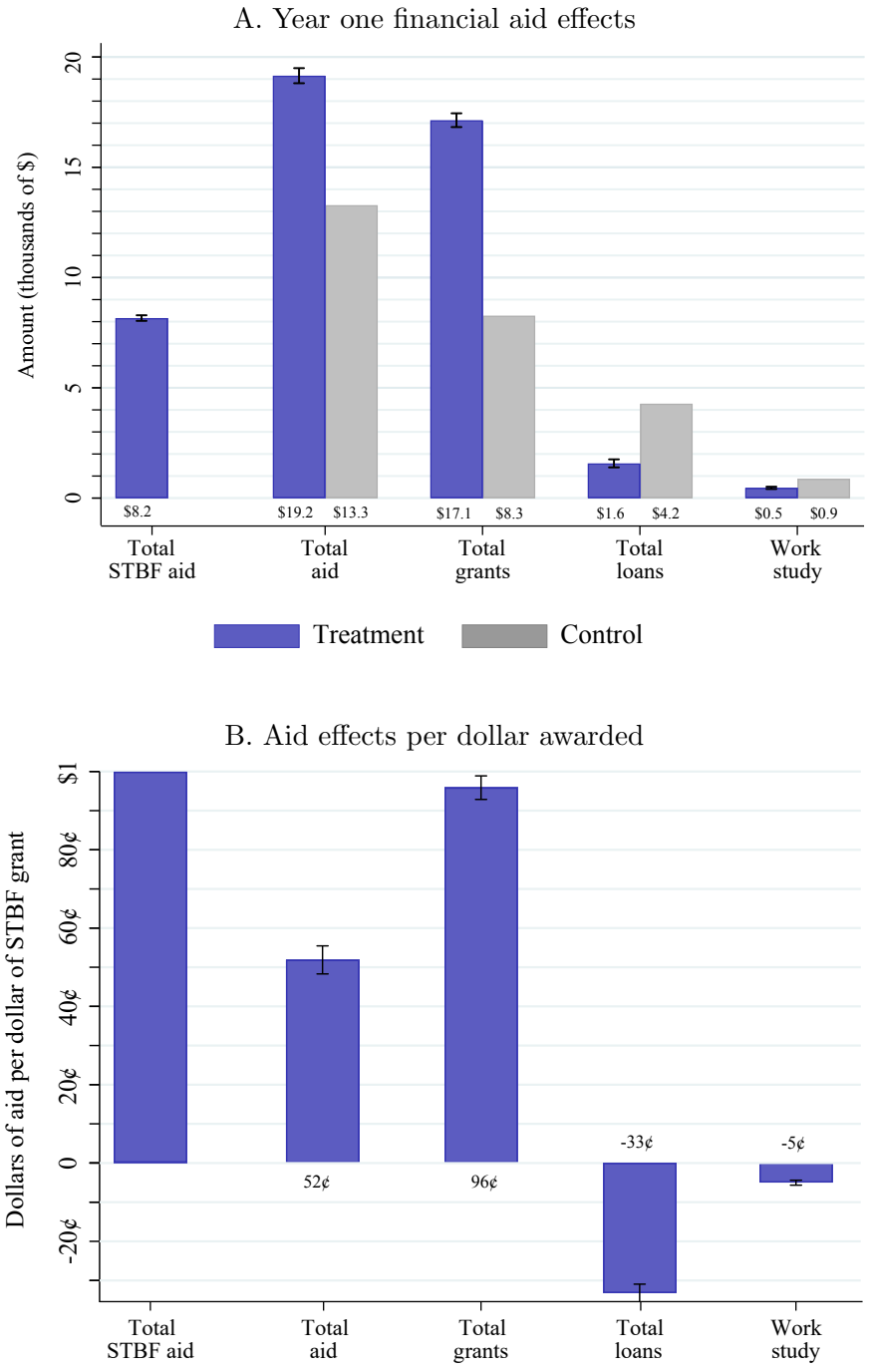
Notes: This table reports 2SLS estimates of μ_t in equation (6) and ψ_t in equation (5). The product of these two should equal μ_1 in equation (2). The over-identification test associated for 2SLS estimation of equation (7) tests this restriction. Instrument sets are indicated above column headings. Robust standard errors appear in parentheses.

Table VI
College costs and marginal spending by target campus

	Four-year strata	NU target campuses			State Colleges
		UNL	UNO	UNK	
	(1)	(2)	(3)	(4)	(5)
A. College Costs ($1000s)					
Treated					
Funder cost	32.25	33.09	33.05	32.97	26.77
COA	30.94	32.75	30.87	30.63	25.49
years of schooling	4.30	4.31	4.39	4.32	3.98
Control					
COA	28.55	31.07	26.03	26.55	25.78
years of schooling	3.93	4.01	3.91	3.88	3.78
# of applicants	3,639	1,632	1,009	500	498
B. Decomposition of marginal spending					
Award effects on:					
(1) Log cost of attendance	0.16	0.10	0.27	0.20	0.08
	(0.02)	(0.03)	(0.04)	(0.05)	(0.06)
(2) Log years of college	0.11	0.09	0.13	0.13	0.07
	(0.01)	(0.02)	(0.03)	(0.04)	(0.04)
(3) Log cost per year of college	0.05	0.01	0.14	0.07	0.01
	(0.01)	(0.02)	(0.03)	(0.03)	(0.04)
Share of marginal spending due to increased years of college (2)/(1)	0.66	0.91	0.49	0.65	0.88
# of applicants	3,593	1,616	990	495	492

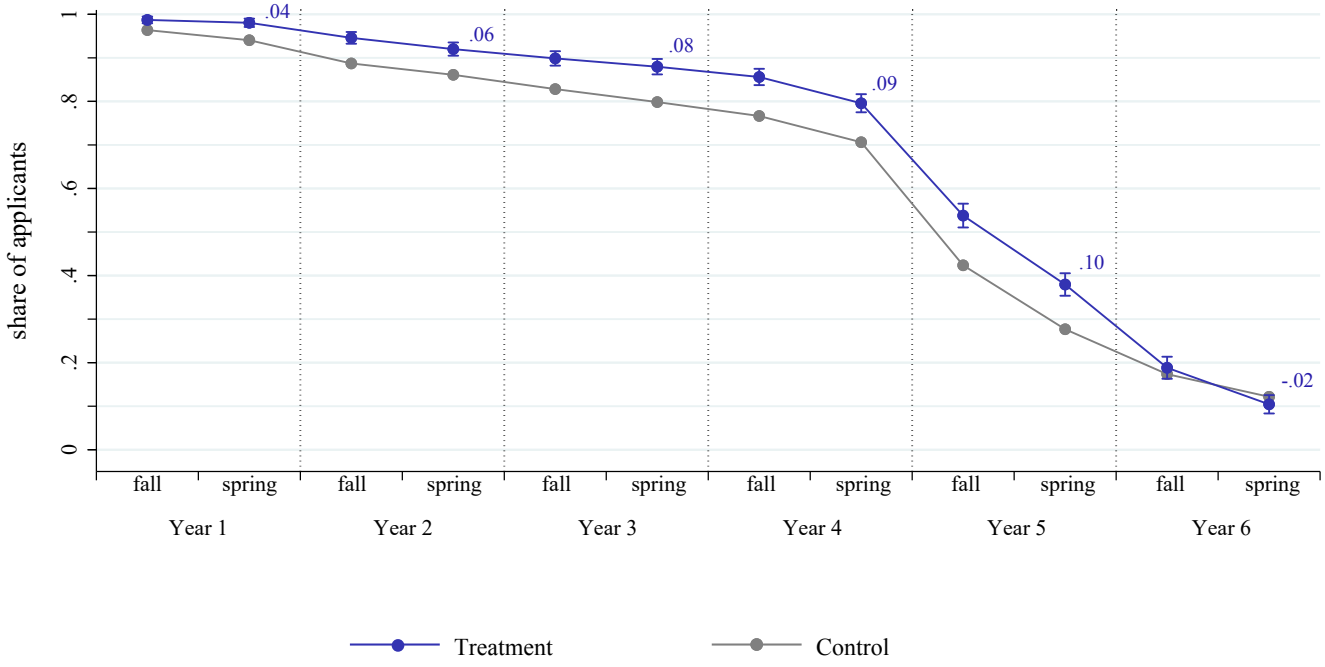
Notes: This table reports award effects on degree costs. Panel A shows statistics including students who have zero years of schooling and thus zero cost of attendance; Panel B excludes these students. Panel A reports mean cost and years of attendance for control students and treatment students. The first three rows in Panel B report results from regressions of log COA, log years, and log cost per year on a dummy for winning a scholarship in the given sample. These regressions include strata dummies. Estimates are for the 2012-2014 cohorts in four-year strata. Funder cost and COA are discounted back to Year 1 at 3%. Dollars values are reported in thousands.

Figure I
Award effects on post-secondary aid for applicants in four-year strata



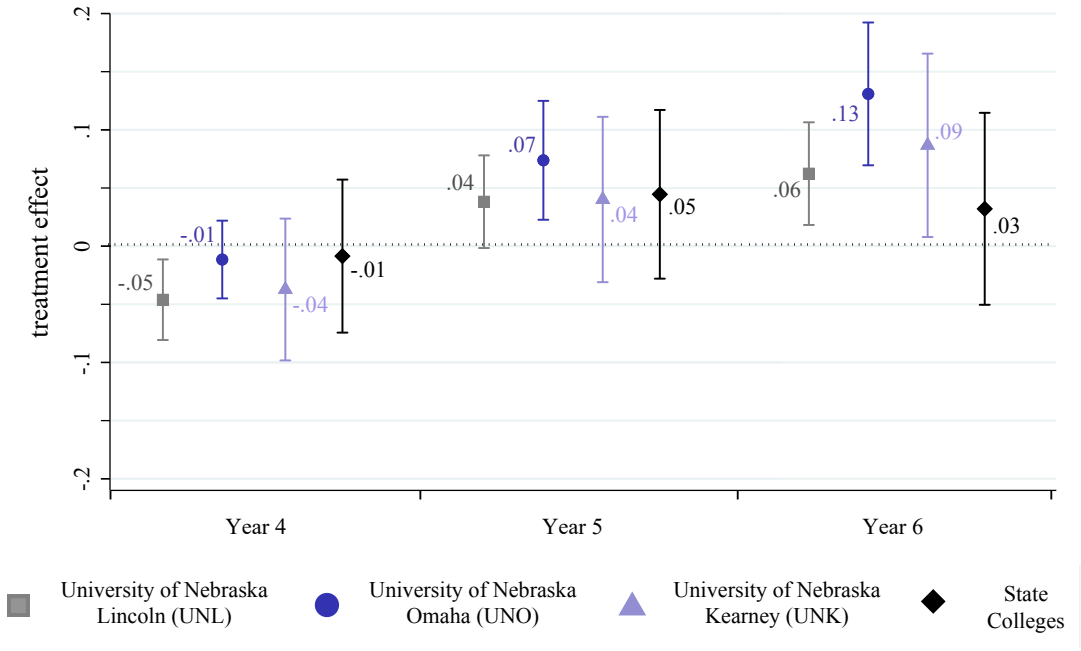
Notes: This figure shows the effect of STBF award offers on aid of various kinds received in the year after scholarship application. The sample is restricted to students who targeted four-year colleges and enrolled at a Nebraska public institution. Whiskers mark 95 percent confidence intervals for the treatment effect of an award offer. The regressions used to estimate treatment effects control for strata dummies.

Figure II
Enrollment effects in four-year strata



Notes: This figure plots enrollment rates by treatment status for the four-year strata. Grey lines plot completion rates for control applicants; blue lines plot the sum of control means and strata-adjusted treatment effects. Whiskers mark 95 percent confidence intervals. Samples differ by year. Regressions control for strata dummies. Whiskers mark 95 percent confidence intervals.

Figure III
BA effects by target campus

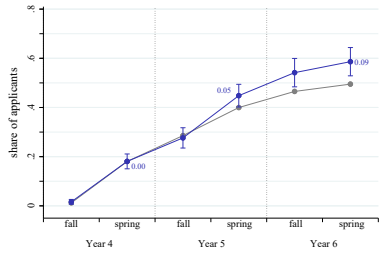


Notes: This figure plots STBF award effects on BA completion for applicants in four-year strata. Samples differ by year. The regressions used to compute these estimates control for strata dummies. Whiskers mark 95 percent confidence intervals.

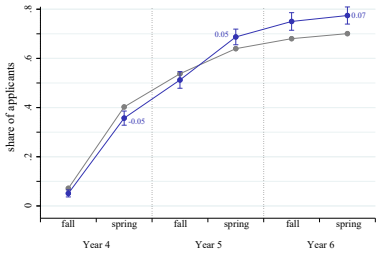
Figure IV
BA completion in demographic and college readiness subgroups

A. Demographic Subgroups

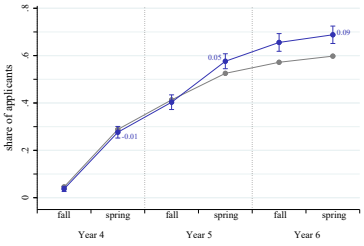
Nonwhite
(35%)



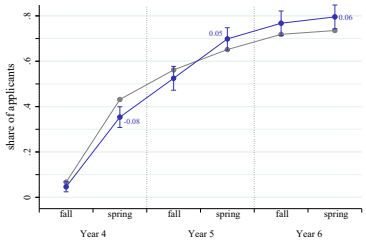
White
(65%)



Pell-Eligible
(74%)

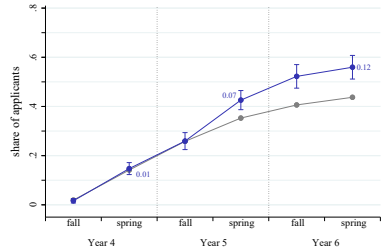


Not Pell-Eligible
(26%)

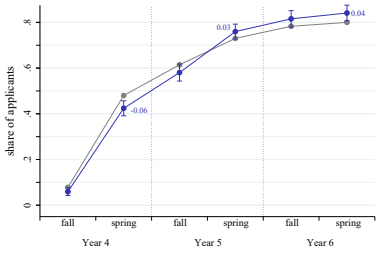


B. Four-Year College Readiness Subgroups

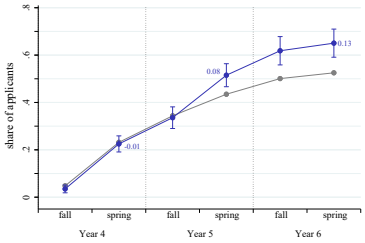
Below-median GPA
(47%)



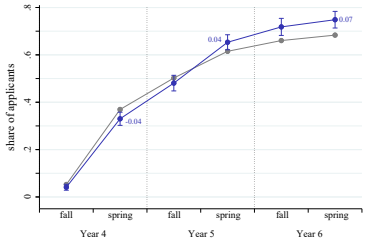
Above-median GPA
(53%)



Two-year college alternate
(33%)



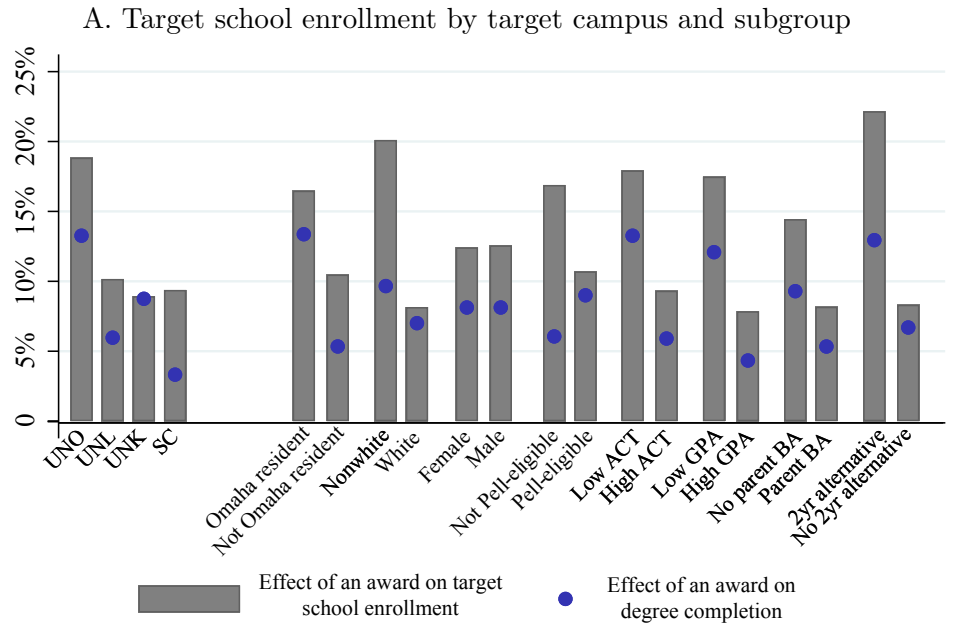
No two-year college alternate
(67%)

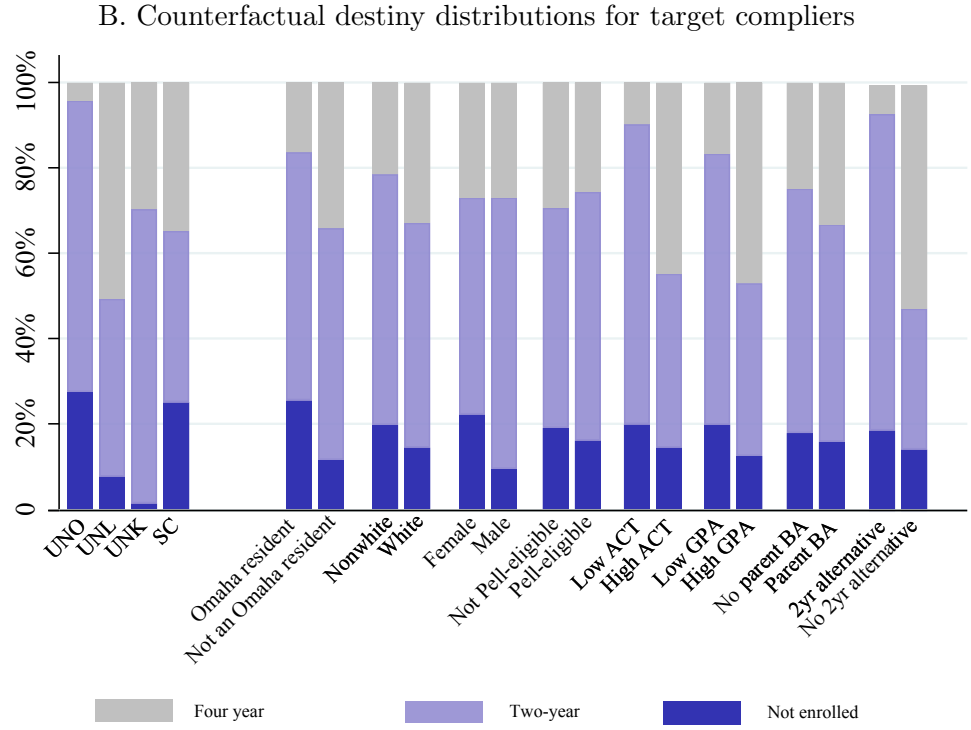


Notes: This figure plots mean degree completion rates by treatment status and subgroup for 2012-16 applicants in four-year strata. Grey lines plot completion rates for control applicants; blue lines plot the sum of control means and strata-adjusted treatment effects. Whiskers mark 95 percent confidence intervals. Samples differ by year. Percentages in each panel are for all experimental cohorts. The median high school GPA for Panel B is 3.49. STBF award applicants were asked to indicate their first choice ("target school") and to rank alternatives. "Two-year college alternate" indicates that a student ranked a two-year college among their alternative target schools on the STBF application. The differences in treatment effects in year six for each subgroup split are as follows (standard errors given in parentheses): Race: .018 (.005), Pell-eligibility: .027 (.006), GPA: .081 (.005), two-year alternate: .060 (.006).

Figure V

First-stage estimates and counterfactual destinies for target-school compliers in four-year strata

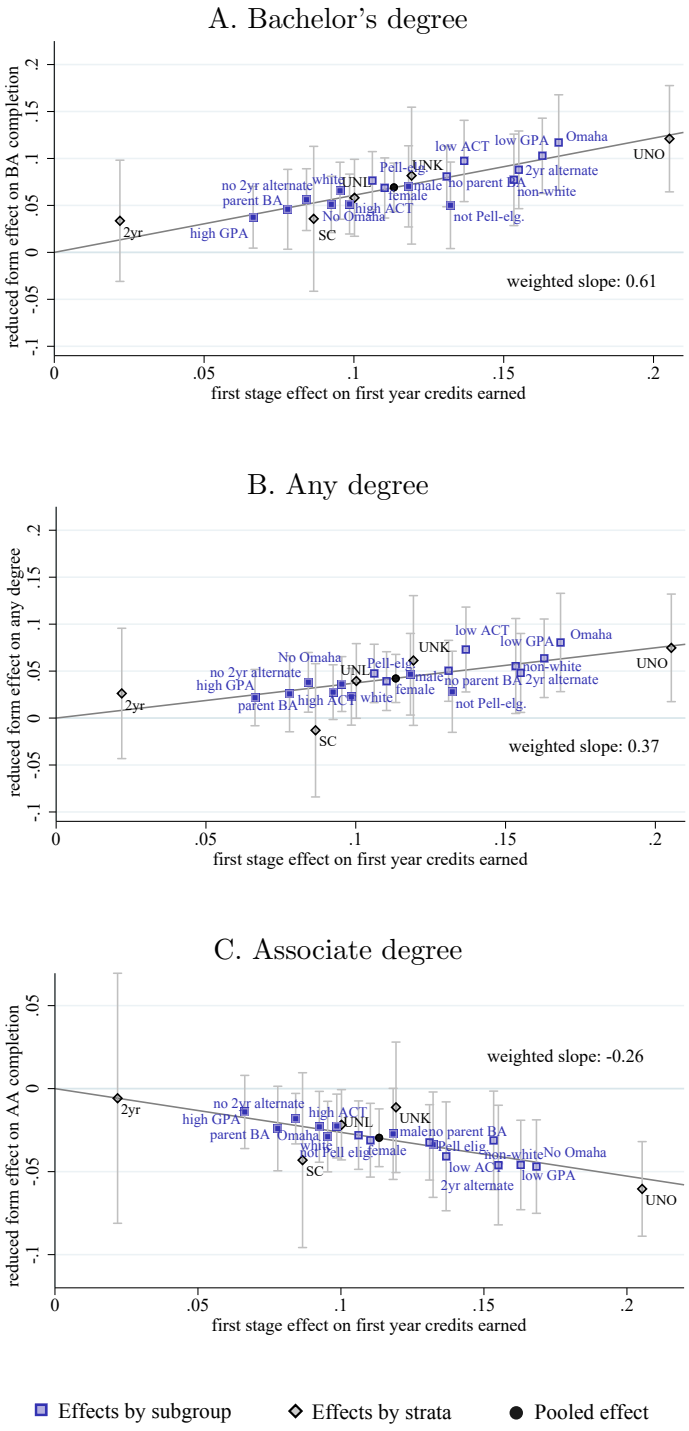




Notes: Bar height in Panel A measures the share of four-year applicant strata and subgroups who are target-school compliers; target school compliers are defined as the set of applicants who enroll in their target school when awarded scholarships but not otherwise. Dots in Panel A indicate BA completion effects in each group. Panel B shows the distribution of enrollment by school type for target-school compliers when compliers are untreated. Enrollment status is computed using first-year data only. Groups in the figure are the union of those used for Figure IV and Online Appendix Figure A4.

Figure VI

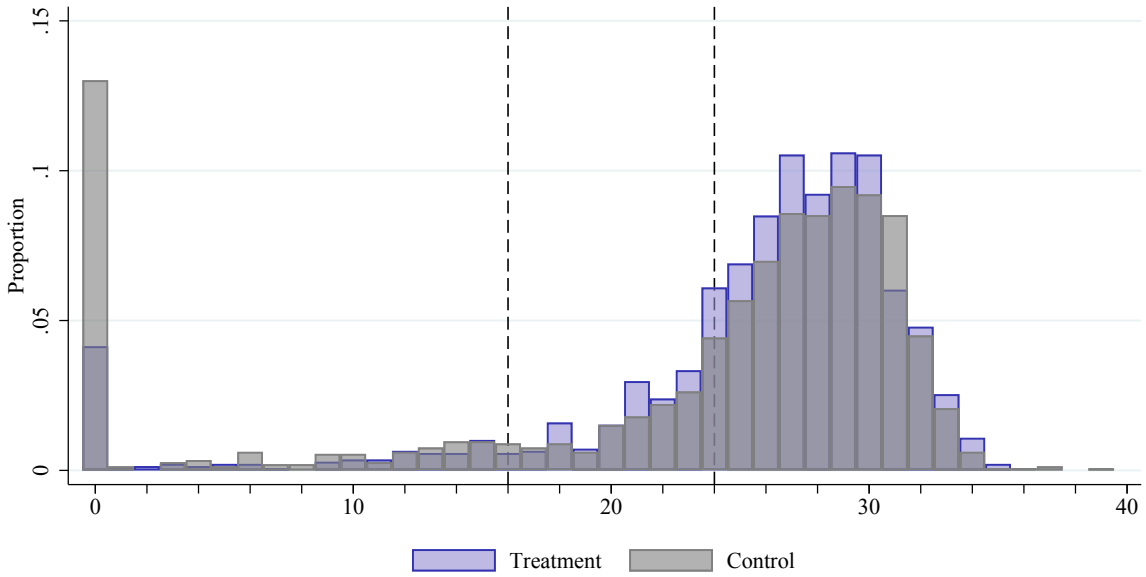
Visual IV estimates of the effect of award-induced four-year credit completion on degrees



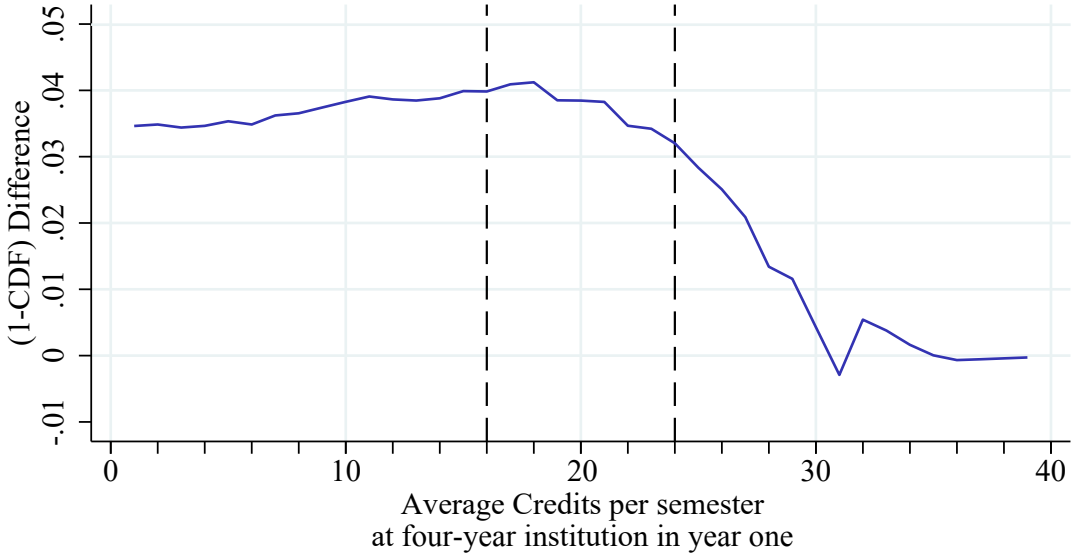
Notes: This figure plots reduced-form offer effects against first-stage offer effects, estimated as detailed in Section B. The x-axis shows effects on credit-hours earned at any four-year institution in the first post-application school year. Credit-hours are scaled by 24, the STBF standard for full-time enrollment. The y-axes show effects on degree completion. Regression lines in each panel are constrained to run through the origin and estimated using data weighted by strata and subgroup sample sizes. Estimates are for 2012-14 applicant cohorts in two- and four-year strata. All models control for strata and subgroup main effects. Whiskers mark 95 percent confidence intervals.

Figure VII
The distribution of four-year credits by treatment status

A. Four-year credit histograms by treatment status

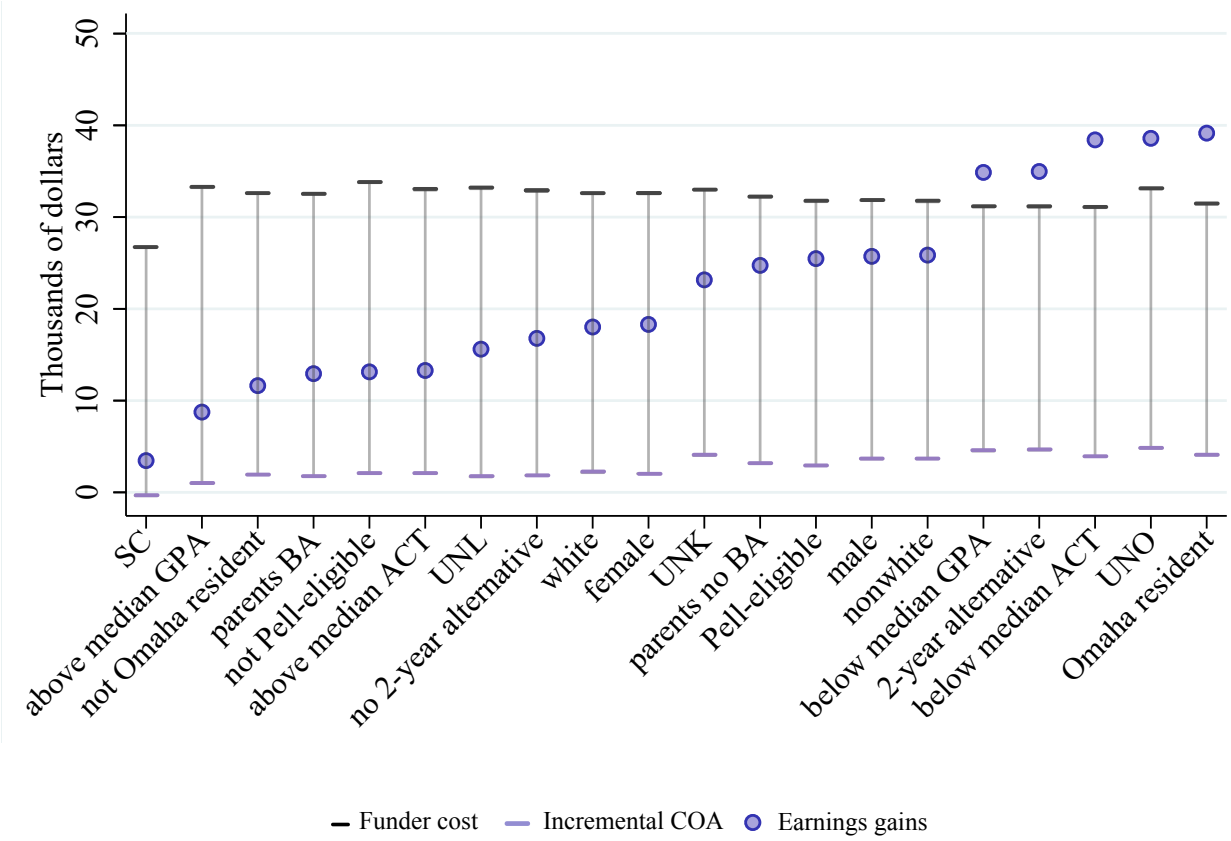


B. Normalized treatment-control difference in credit CDFs



Notes: Panel A plots the histogram of four-year credits earned in the first post-application school year, separately by treatment status. Panel B plots the difference in the (negative of the) CDF of four-year credits earned by treatment status, normalized to generate the weighting function described in the text. The x-axis in panel B measures the likelihood that an award shifts applicants from completing fewer than s credit(s) to completing at least s credit(s). Cutoffs for $\frac{3}{4}$- and full-time enrollment are marked on the x-axis. Students must be enrolled at least $\frac{3}{4}$ time to qualify for STBF support. Estimates are for 2012-14 applicant cohorts in four-year strata.

Figure VIII
Earnings gains compared with program costs



Notes: This figure compares program costs with estimates of the lifetime earnings generated by award receipt, when the latter are measured by the returns to levels of schooling. Details of this estimation can be found in Online Appendix C. Costs are measured two ways: the lower tick mark indicates the increase in educational spending (COA) generated by awards, while the upper tick mark shows average funder cost. Estimates are for the 2012-2014 cohorts in the four-year strata.

Online Appendix for "Marginal Effects of Merit Aid for Low-Income Students"

Joshua Angrist David Autor Amanda Pallais

December 2021

Contents

A Supplementary Material

A.1 STBF Application Details

The following are eligibility and application guidelines for students in the 2012-2016 cohorts. All students in the experimental sample, in other words, were subject to these requirements.

A.1.1 Award Eligibility

The STBF scholarship is awarded annually to students who meet the following eligibility requirements:

- Current residents of Nebraska
- Nebraska high school graduates or Nebraska GED recipients
  - Earned at least a 2.5 unweighted cumulative GPA
- First-time freshman when entering college
- Plan to attend a Nebraska public institution
- Need financial assistance in order to attend college
  - Students do not need to be Pell Grant eligible
  - Students must have an expected family contribution (EFC) of less than $10,000 ($15,000 in 2012)

A.1.2 Application Process

The STBF application goes live in the fall of each year. Students have a deadline of February 1 to submit a completed application, consisting of five parts: the application form, the student's high school transcript, two letters of recommendation, a student aid report generated by the FAFSA form, and a personal essay.

The application form asks for basic contact information, family background (such as parent names and education), student GPA and high school attended, and the student's "target school."

When soliciting an applicant's target school, the application asks the applicant to "please select the college you plan to attend if you receive this scholarship." [1]

Students are then prompted to upload a high school transcript and send requests for letters of recommendation to two adults in their community. The application instructs that recommendations "should come from teachers, school administrators, school counselors, employers, clergy, or other adult mentors." Requests will cue the recommenders to respond to the following prompts:

- Please speak to the student's work ethic and leadership skills
- Discuss the student's understanding of him or herself and how you have seen this play a role in his or her life.
- Discuss the student's motivation, goals, and any challenges they have overcome.
- How have you seen this student be active in the community or giving back to others?

After requesting recommendations, the applicant is prompted to upload a typed admissions essay of 1,000-1,500 words responding to the following prompt:

> "We'd like to learn more about the factors in your life that have led you to pursue a college education. Please compose an essay describing your reasons for wanting to attend college."

The final step in the application asks the applicant to complete the FAFSA and upload the resulting student aid report (SAR), which provides an estimated expected family contribution (EFC).

A.1.3 Award Details

Once a student applies for and is awarded a STBF scholarship, the Foundation coordinates primarily with the student's institution. STBF scholarship funds are determined based on a student's enrollment status. All STBF students are required to enroll at least three-quarters time (be enrolled in at least 9 credit hours) across all institutions. STBF determines maximum award amounts by school. These maximum amounts are calculated by taking the cost per credit and multiplying that by 15 credit hours.[2] The Foundation also awards each student a $500 stipend for books. Based

[1] The application also asks applicants to indicate other schools they might attend from a list of all Nebraska public institutions. We use this information to understand whether a student is considering a two-year college.

[2] Although maximum amounts are calculated using 15 credits, students only have to be taking 12+ credit hours for the Foundation to consider them "full-time."

on enrollment, these maximum award amounts are scaled by a student's enrollment status. For example, Mid Plains Community College (MPCC) has a $107 charge per credit hour for tuition and fees.

$$\$107 * 15 = \$1,605 + \$500 = \$2,105$$

so the maximum award amount is set at $2,105. If a student is enrolled three quarters time (9-11 credits), they would be awarded $1,578 ($\$2,105 * 0.75$).

Although maximum award amounts are based on tuition and enrolled credits, STBF scholarship funds can be applied to any part of an undergraduate student's cost of attendance including tuition, fees, books, room and board, personal expenses, and transportation. STBF is generous with this aid, explicitly stating in the award handbook that "STBF scholarships are intended to maximize the amount of aid a student can receive." In this spirit, STBF works to not "crowd-out" other forms of aid. STBF scholarships can be awarded in excess of a student's financial need (COA less EFC and other forms of aid), but the award from STBF may not exceed a student's baseline cost of attendance.

A.1.4 Renewing STBF Scholarships

STBF awards are renewable for up to five years at the University of Nebraska and Nebraska state colleges. Awards are renewable for up to three years at Nebraska Community Colleges (including NCTA). To maintain eligibility for the award, awardees must meet the following criteria:

- Maintain a 2.0 cumulative GPA at the end of all terms
- Earn at least 18 credit hours or 27 quarter hours in each year (3/4 time)

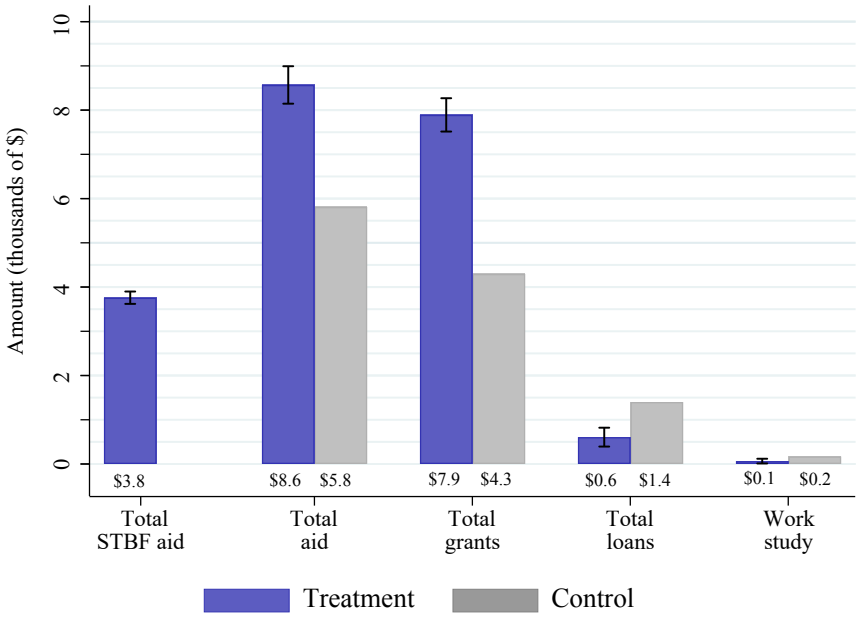
Failure to meet these requirements will result in a "probationary period." Two consecutive or three total terms of probation will result in the loss of scholarship eligibility.

Barring two consecutive or three total probationary periods, a student's STBF scholarship will automatically renew without action from the student. The Foundation communicates directly with each institution, so STBF students are not responsible for reporting grades directly to the Foundation. Students are encouraged, but not required, to complete and submit an updated FAFSA form each year.

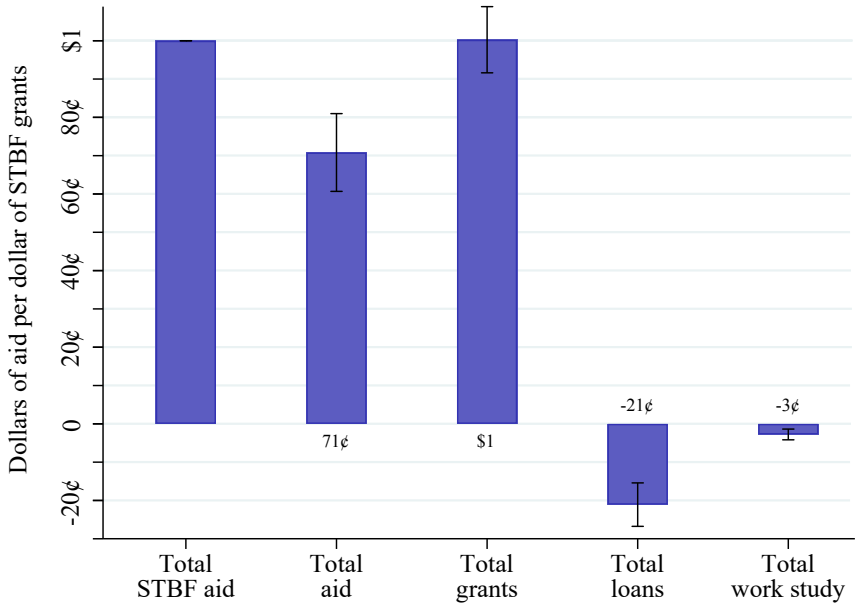
A.2 Additional Exhibits

Figure A1
Award effects on year one post-secondary aid for applicants in two-year strata

A. Financial aid effects in two-year strata

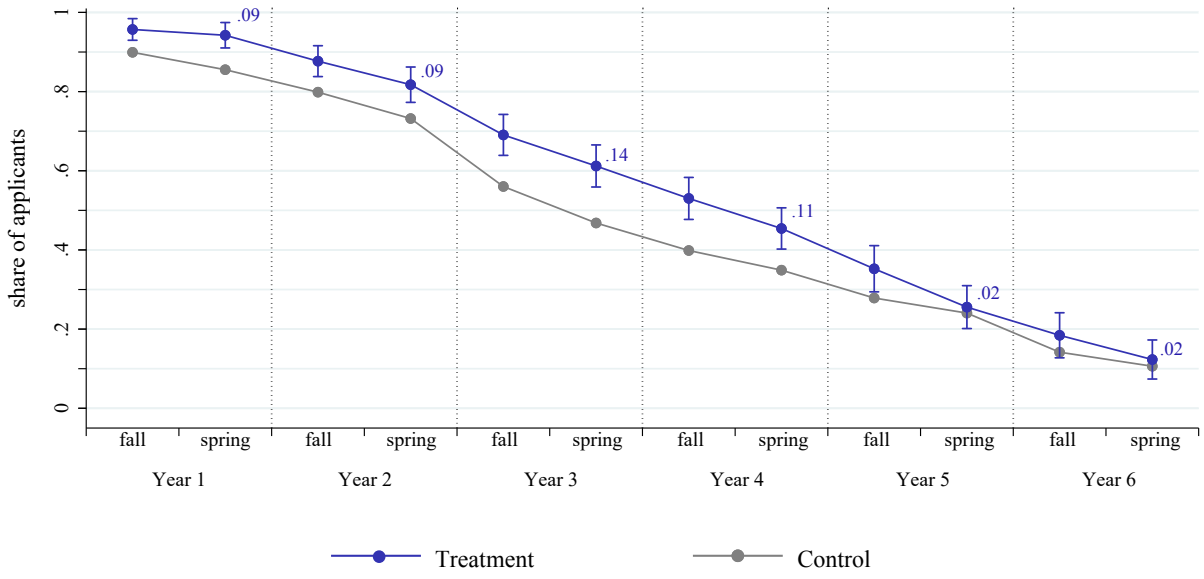


B. Aid effects per dollar awarded in two-year strata



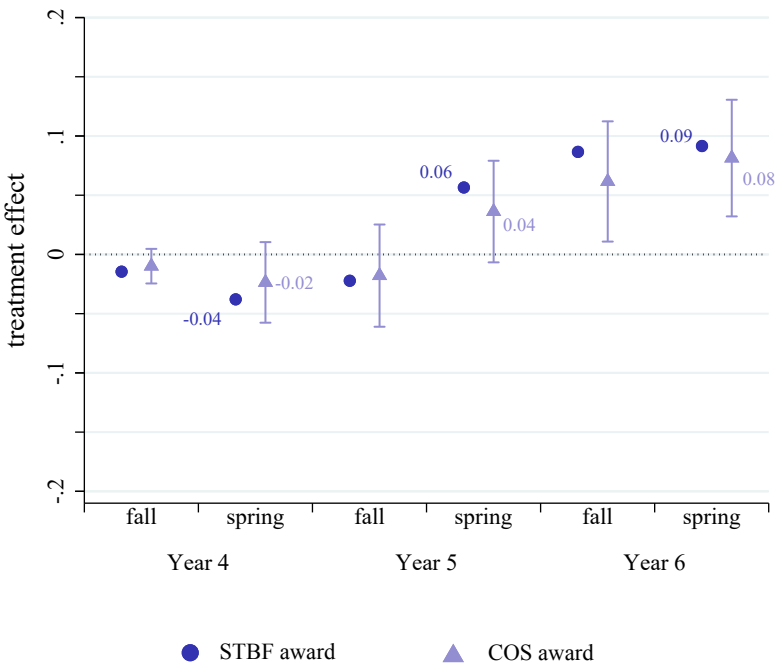
Notes: This figure shows the effect of an STBF award offer on aid of various kinds in the year following scholarship application. The sample is restricted to students who targeted two-year colleges and enrolled at a Nebraska public college or university. Whiskers mark 95 percent confidence intervals for the treatment effect of an award offer. The regressions used to estimate treatment effects control for strata dummies.

Figure A2
Enrollment effects in two-year strata



Notes: This figure plots the effect of an award on enrollment rates for students in the two-year strata without a BA. Samples differ by year. Regressions control for strata dummies. Whiskers mark 95 percent confidence intervals.

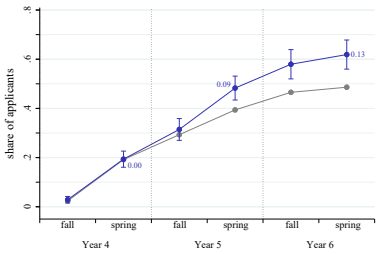
Figure A3
Bachelor's degree effects by award type



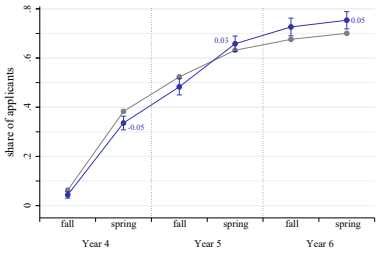
Notes: This figure plots the effect of awards with and without learning community participation on six-year degree completion for applicants targeting four-year campuses. Awards without an LC mandate are called College Opportunity Scholarships (COS). Whiskers mark 95 percent confidence intervals. The samples used to estimate treatment effects differ by year.

Figure A4
BA completion in demographic and college readiness subgroups

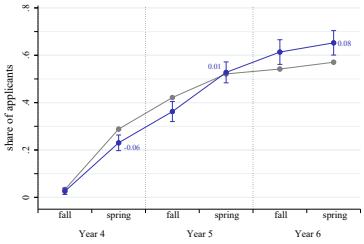
Omaha Resident
(30%)



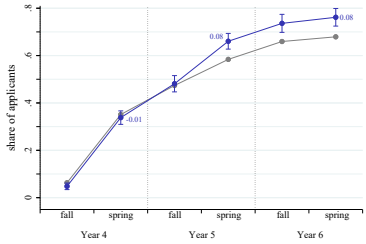
Not an Omaha Resident
(70%)



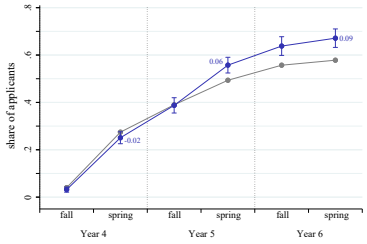
Male
(39%)



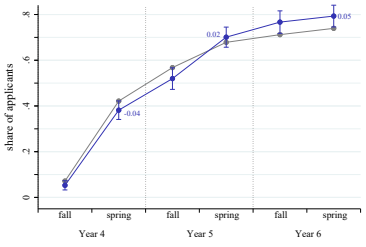
Female
(61%)



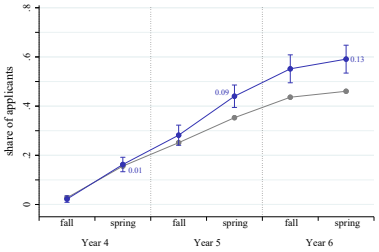
No parent with a BA
(66%)



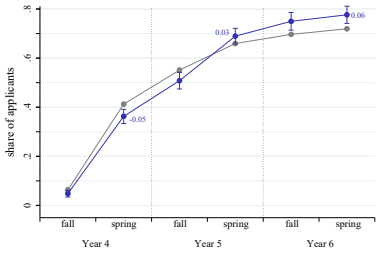
At least one parent with a BA
(34%)



Below-median ACT
(35%)



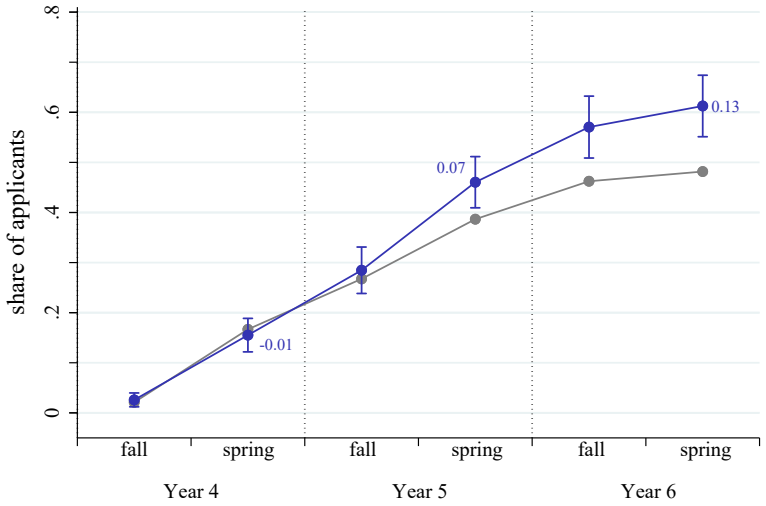
Above-median ACT
(65%)



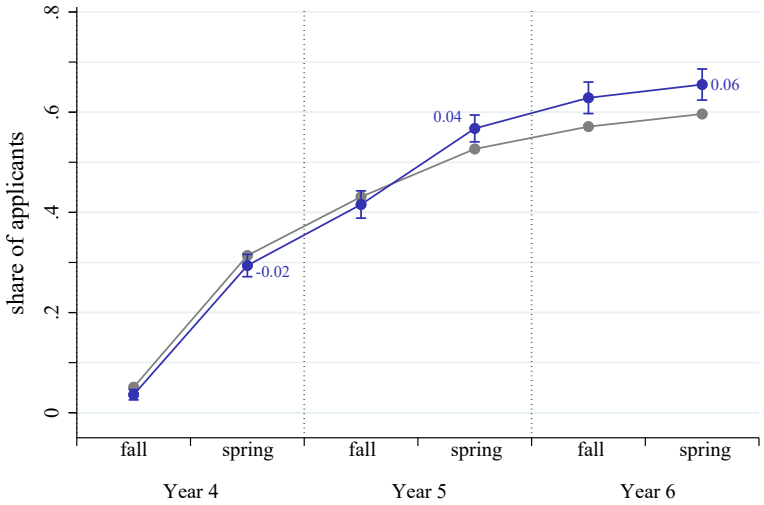
Notes: This figure plots mean degree completion rates by treatment status and subgroup for the four-year strata. Grey lines plot completion rates for control applicants; blue lines plot the sum of control means and strata-adjusted treatment effects. Whiskers mark 95 percent confidence intervals. Samples differ by year. Percentages given are for the full experimental sample (2012-2016 cohorts). The median ACT score for Nebraska test-takers is 21. The differences in treatment effects in year six for each subgroup split are as follows (standard errors given in parentheses): Omaha residency: .080 (.006), gender: .001 (.005), ACT: .074 (.006), parent BA: .039 (.005).

Figure A5
BA completion in UNO and non-UNO strata

A. BA completion in UNO strata
(27%)

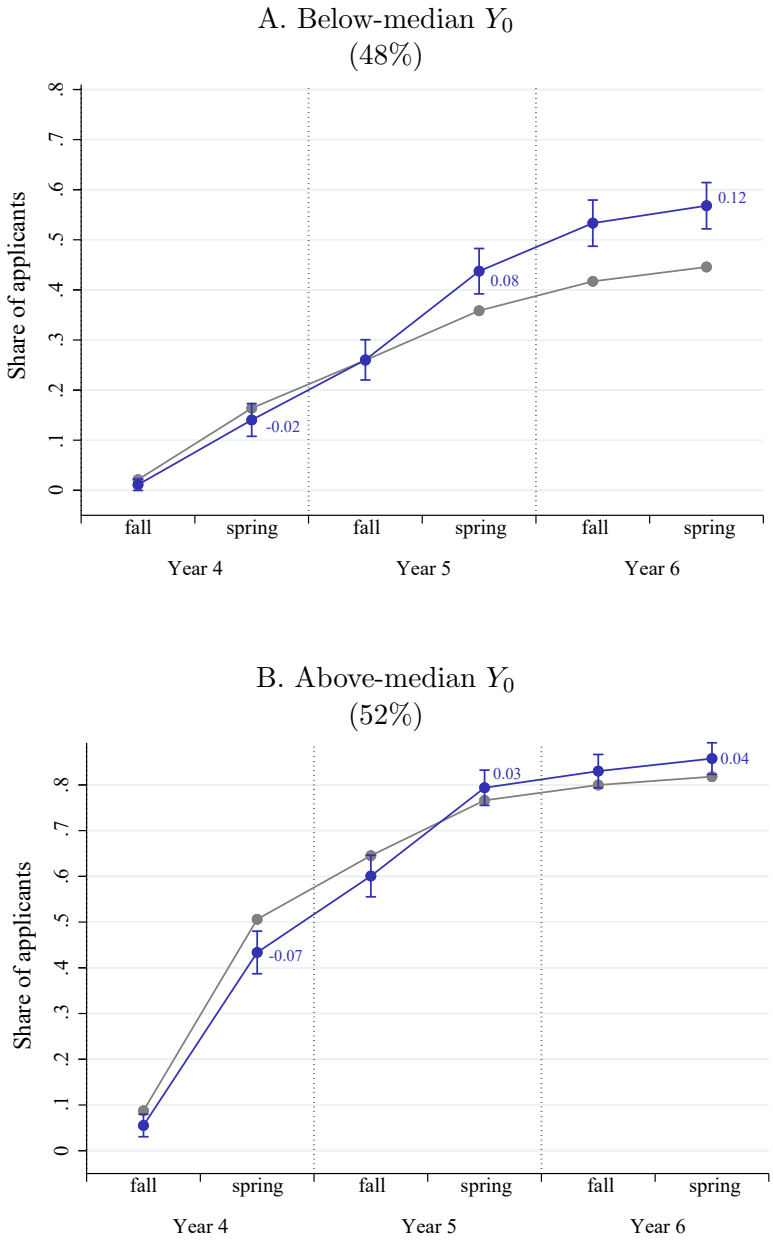


B. BA completion in non-UNO strata
(73%)



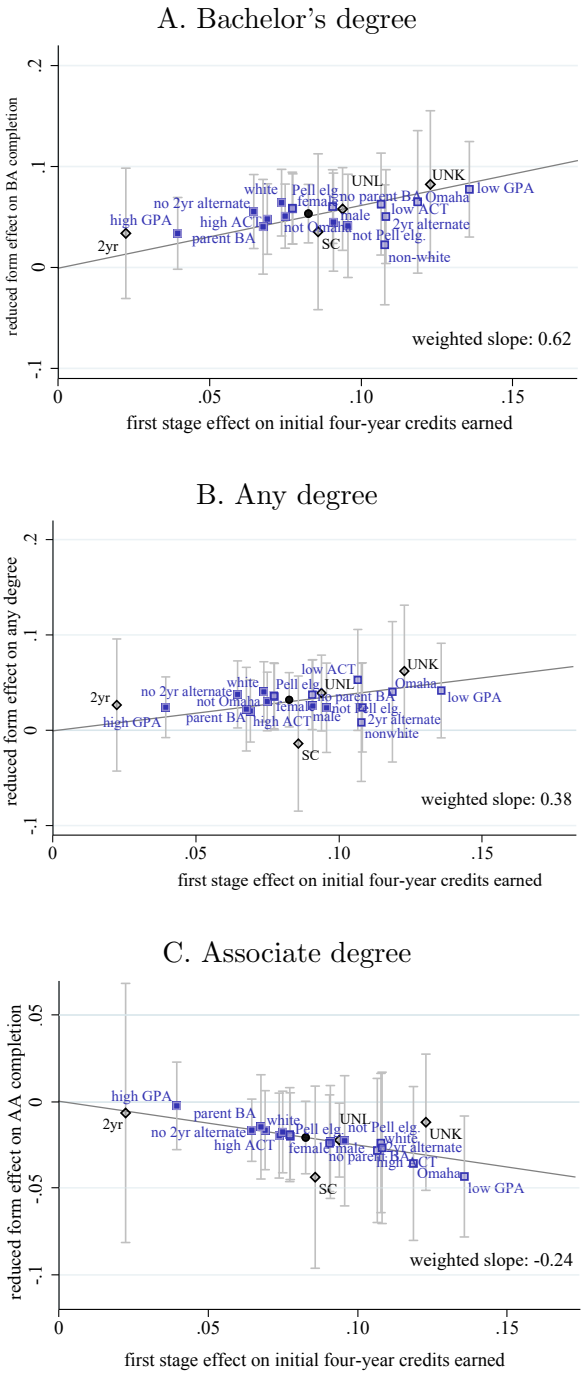
Notes: This figure plots mean degree completion rates by UNO strata status. The "non-UNO strata" group includes all non-UNO four-year strata (UNK, UNL, and SC strata). Grey lines plot completion rates for control applicants; blue lines plot the sum of control means and strata-adjusted treatment effects. Whiskers mark 95 percent confidence intervals. Samples differ by year.

Figure A6
BA completion by predicted bachelor's degree completion



Notes: This figure plots mean degree completion rates by treatment status and predicted bachelor's degree completion for the four-year strata. Y_0 represents a student's predicted propensity to complete a BA. Grey lines plot completion rates for control applicants; blue lines plot the sum of control means and strata-adjusted treatment effects. Whiskers mark 95 percent confidence intervals. Sample is restricted to the 2012-2014 cohorts. Predicted control group BA completion is estimated based on Abadie, Chingos and West (2018), using second-order strata and subgroup terms as in Figure VI in the main text.

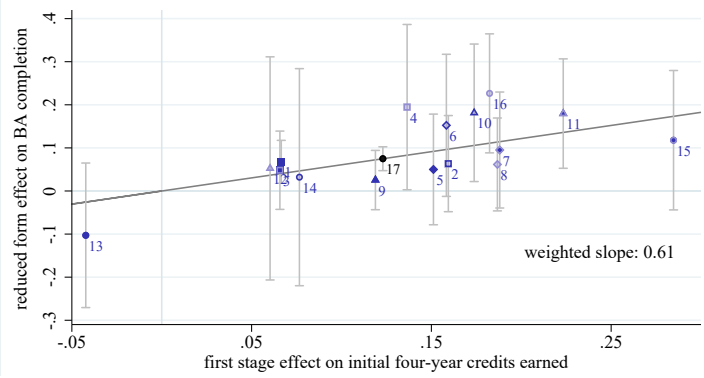
Figure A7
Visual IV estimates of the effect of award-induced
four-year credit completion on degrees in non-UNO strata



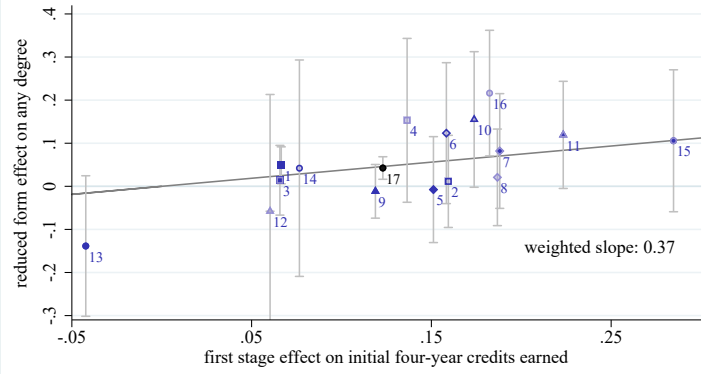
Notes: This figure plots reduced-form offer effects against first-stage offer effects, estimated in multivariable regressions as detailed in Section B. The x-axis shows effects on credit-hours earned at any four-year institution in the first post-application year. Credit-hours are scaled by 24, the STBF standard for full-time enrollment. The y-axes shows effects on degree completion. Regression lines in each panel are constrained to run through the origin and estimated using data weighted by strata and subgroup sample sizes. The sample is restricted to non-UNO targeters in the 2012-2014 cohorts. All models control for strata and subgroup main effects. Whiskers mark 95 percent confidence intervals.

Figure A8
Visual IV estimates of the effect of award-induced
four-year credit completion on degrees using mutually exclusive subgroups

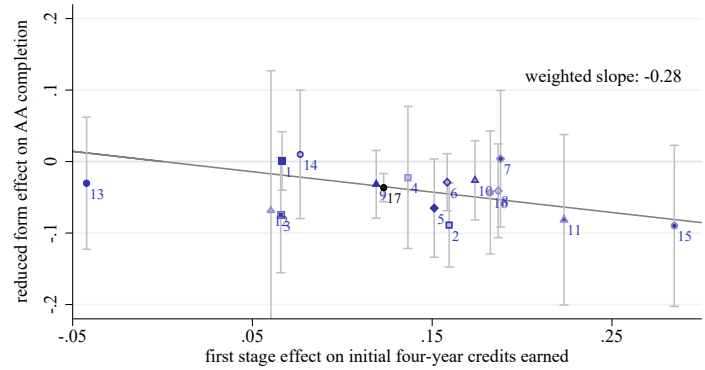
A. Bachelor's degree



B. Any degree



C. Associate degree



Notes: This figure plots reduced-form offer effects against first-stage offer effects for a set of mutually exclusive subgroup splits. The x-axis shows effects on credit-hours earned at any four-year institution in the first post-application year. Credit-hours are scaled by 24, the STBF standard for full-time enrollment. The y-axes shows effects on degree completion. Regression lines in each panel are constrained to run through the origin and estimated using data weighted by strata and subgroup sample sizes. The sample is restricted to the 2012-2014 cohorts. Whiskers mark 95 percent confidence intervals. Point labels are given in Online Appendix Table A4.

Table A1
Econometric research on grant aid

Financial Aid Program	Type of Aid	Source	Average Annual Grant Amount	Student Population	Type of School	Services Included?	Timing of Award	Length of Award	Study	Published In		Study Design
Panel A: RCT Studies												
Susan Thompson Buffett Foundation (STBF) Scholarship	Both	Private	7,807	NE resident, below 10K family EFC, 2.5 HS GPA, evaluated on other criteria	NE public (2 or 4yr)	One arm	HS	5 years (3 for 2yr)	Angrist, Autor, Hudson, and Pallais (2016) Angrist, Autor, and Pallais (2020)	WP WP	NBER NBER	RCT RCT
Opening Doors Louisiana Scholarship	Both	Private	1,488	Attend eligible New Orleans-area CC, attending school at least half-time, 18-34 years old, parent of at least one dependent, family income below 200% of the federal poverty line.	Three LA CCs	Yes	In college	Renewable	Barrow, et al. (2014)	Journal	Journal of Labor Economics	RCT
Wisconsin Scholars Grant	Need	Private	3,500	Pell-eligible, graduated from WI public high school in last 3 years, enrolled at WI public 2yr, full-time status (12 credit hours)	WI public (2 or 4yr)	No	In college	5 years	Anderson and Goldrick-Rab (2016) Goldrick-Rab, Kelchen, Harris, and Benson (2016)	Journal Journal	Economics of Education Review American Journal of Sociology	RCT RCT
Panel B: Quasi-Experimental State Aid Studies												
Arizona Instrument to Measure Standards	Merit	State	6,533	B or better in HS "core" classes, 3.5 GPA or top 5% of class, exceed standards on standardized AIMS test	AZ 4yr (public)	No	Yearly	Four years	Upton (2016)	Journal	Journal of Labor Research	DD
Cal Grant	Both	State		CA resident, income and GPA limits vary by year; 53,100 - 59,000 for a family of 3; 2.95 - 3.15 GPA	CA 4yr (public or private)	No	Yearly	Renewable	Kane (2003) Bettinger, Gurantz, Kawano, and Sacerdote (2019)	WP Journal	NBER AEJ: Economic Policy	RD RD
Carolina Covenant	Need	Institution	2,400	Incoming freshman/transfer students at UNC - Chapel Hill, first-time BA, full-time student, AGI <= 200% fed poverty line	UNC - Chapel Hill	Some years	HS	9 semesters	Clotfelter, Hemelt, and Ladd (2016)	Journal	Economic Inquiry	DD
D.C. Tuition Assistance Grant Program	Other	State	516 - 1288	D.C. metro-area residents attending college at least half-time	Any	No	Yearly	Renewable	Kane (2007)	Journal	The Journal of Human Resources	DD
Dell Scholars	Both	Private	3,240	Participated in an affiliated college readiness program, HS GPA of 2.4 or higher, Pell-eligible	Four-year	Yes	HS	4 years	Page, Kehoe, Castleman, and Sahadewo (2017)	Journal	The Journal of Human Resources	RD
Florida Bright Futures Scholarship	Merit	State	1,700-2,300	Completed 15 core HS credits, 3.0 HS GPA , 970 STA or 20 ACT (FMS award) / 3.5 GPA, 1270 STA or 28 ACT (FAS award)	FL publics (or $ equivalent at	No	HS	Renewable	Zhang, et al (2016) Castleman (2014) Castleman and Long (2016) Castleman, Long, and Mabel (2018)	Journal WP Journal Journal	The Journal of Higher Education Ed Policy Works Journal of Labor Economics Journal of Policy Analysis and Management	RD DD RD RD
Florida Student Assistance Grant	Need	State	864	EFC under $1,590, FL resident	FL publics (2 or 4yr)	No	Yearly	Renewable				
Gates Millenium Scholars	Both	Private	8,000	Pell eligible, 3.33 minimum HS GPA, evaluated on other criteria	Any	No	HS	5 years	DesJardins, et al. (2010)	Journal	Educational Evaluation and Policy Analysis	RD
Georgia HOPE	Merit	State	1,834	Graduate from GA HS after 1993 with a B average and be a GA resident	Most GA colleges and universities	No	Yearly	Renewable	Dynarski (2000) Cornwell, Mustard, and Sridhar (2006)	Journal Journal	National Tax Journal Journal of Labor Economics	DD DD
Indiana Twenty-First Century Scholars	Need	State	2,372	Residents of Indiana, eligible for free and reduced price lunch as of middle school, sign the TFCS pledge, maintain C avg in HS, apply to at least one postsecondary institution	IN publics (or $ equiv. at privates)	Yes	HS	Renewable	Toutkoushian, et al. (2015)	Journal	The Review of Higher Education	IV
Kalamazoo Promise	Other	Private	2,937	Graduate from Kalamazoo public school system, reside in the district, have been continuously enrolled since the beginning of high school	MI publics (or $ equiv. at privates)	No	HS	130 credits	Andrews, DesJardins, and Ranchhod (2010) Bartik, Hershbein, and Larchowska (2019)	Journal Journal	Economics of Education Review The Journal of Human Resources	DD DD
Longhorn Opportunity Scholarship and Century Scholars	Both	Institution	4,000	Attend eligible TX high school, gain admittance to UT Austin or Texas A&M universities	UT Austin or Texas A &M	Yes	HS	Renewable	Andrews, Imberman, and Lovenheim (2020)	WP	NBER	DD
Massachusetts Adams Scholarship	Merit	State	1,714	Advanced score on one section of MCAS and proficient/advanced on other portion, and top 25% score in district; enrolled in and graduate from Massachusetts public high school	MA public	No	HS	8 semesters	Cohodes and Goodman (2014)	Journal	AEJ: Applied	RD
New Mexico Legislative Lottery Scholarship	Merit	State	6,950	NM resident, 2.5 GPA after one full-time (12 credits) semester at 2yr or 4yr NM public college	NM public (2 or 4yr)	No	After 1st semester	8 semesters	Erwin and Binder (2019)	Journal	Education Finance and Policy	DD
Ohio College Opportunity Grant	Need	State	860	EFC below $2,190, OH resident	OH public (2 or 4yr)	No	HS	Renewable	Bettinger (2015)	Journal	Educational Evaluation and Policy Analysis	DD
Post-9/11 GI Bill	Other	Federal	5,000	Military service members ages 22 to 39 who had separated within 10 years of initial entry into the military	Any	No	Yearly	13 months	Barr (2019)	Journal	Journal of Labor Economics	DD
Tennessee HOPE	Merit	State	2,500	TN residents, enroll in eligible college within 16 months of HS graduation, 21+ ACT OR HS GPA above 3.0.	TN public 2yr or 4yr; TN private non-profit	No	HS	Five years	Welch (2014) Carruthers and Ozek (2016)	Journal Journal	Economics of Education Review Economics of Education Review	RD RD
Tennessee Student Assistant Awards	Need	State	1,800	TN residents, at least half time, first time college, less than 2K EFC	TN public (2 or 4yr)	No	Yearly	Four years	Doyle, Lee, and Nguyen (2017)	Journal	Review of Educational Research	RD
West Virginia Promise	Merit	State	2,500	WV resident, enrolled full-time, 3.0 HS GPA, 21+ on ACT or 1000+ on SAT, no financial eligibility reqs.	WV public (2 or 4yr)	No	HS	4 years	Scott-Clayton (2011) Scott-Clayton and Zafar (2016)	Journal Journal	Educational Evaluation and Policy Analysis Journal of Public Economics	RD RD
Panel C: Pell Grant Studies												
Pell Grant	Need	Federal	2,100	Beginning Postsecondary Students Longitudinal Study (BPS) cohort based on the National Postsecondary Student Aid Study (NPSAS) 1996; dependents enrolled at any 4yr in the fall of 1995	4-year	No	Yearly	12 semesters	Alon (2011)	Journal	Social Science Quarterly	IV
			709	Dependent college students enrolled in a public 4yr in TX in 2008 - 2011 academic years; family AGI within $12K of the automatic zero EFC income eligibility threshold.	TX 4yr				Denning, Marx, and Turner (2017)	Journal	AEJ: Applied	RD
			1,096	NPSAS undergraduate students who filed for financial aid and are within $2K of EFC threshold for Pell eligibility	4-year				Evans and Nguyen (2018)	Journal	Economics of Education Review	RD
			3,325	First time, degree seeking "non-traditional" students starting college at a two-year in 2003-2004	2-year				J. Chen and Hossler (2017)	Journal	Research in Higher Education	PSM
			560	First-time CC enrollees, entering in 2008-2010; US citizens who filed a FAFSA and have EFC within $2K of the Pell eligibility threshold	2-year (in an anoymous state)				Park and Scott-Clayton (2018)	Journal	Educational Evaluation and Policy Analysis	RD
			389	First-time, degree seeking first-year students entering CUNY system in fall 2004 - fall 2010; US citizens who completed the FAFSA and have EFC within $4K of the Pell eligibility threshold	CUNY (2yr)				Marx and Turner (2018)	Journal	AEJ: Applied	RD
Year-Round Pell Grant	Need	Federal	312	First-time, degree seeking , Pell-eligible students who entered the CC system in an anonymous state between fall 2006 and fall 2009	2-year (in an anonymous state)	No	Yearly	12 semesters	Liu (2018)	Journal	Education Finance and Policy	DD

Qualifications to be included:named scholarship program at the state, institution, or private level (for example, papers that utilize cutoffs in a specific school's merit or need-based aid calculation are not included: see Singell and Stone (2002) for an example); uses only the most recent study from a single organization or sub-set of authors if using same outcome measures (for eaxmple Cha and Patel (2014) vs Mayer, Patel, and Guttierez (2016)).

Notes: This table reviews other grant aid programs that have been the subject of academic studies. Qualifications to be included in this table include: named scholarship program at the state, institution, or private level (for example, papers that utilize cutoffs in a specific school's merit or need-based aid calculation are not included: see Singell and Stone (2016) for an example), focused on traditional students similar to the STBF sample (for example, papers focused on parents in college such as Barrow et al. (2014) are not included), and published in a peer-reviewed journal or working-paper series (technical reports, although valuable, are not included). Finally, the table uses only the most recent study from a single organization or sub-set of authors if using same outcome measures.

Table A2
Baseline sample selection

	Control (1)	STBF Award (2)	COS Award (3)	Total (4)		Control (5)	STBF Award (6)	COS Award (7)	Total (8)		Control (9)	STBF Award (10)	COS Award (11)	Total (12)
2012 Total	**495**	**504**		**999**	**2013 Total**	**936**	**484**	**209**	**1,629**	**2014 Total**	**860**	**606**	**211**	**1,677**
Four-Year Strata	424	431		855	Four-Year Strata	774	395	209	1,378	Four-Year Strata	726	469	211	1,406
UNK	63	64		127	UNK	71	66	51	188	UNK	73	64	48	185
UNL	173	175		348	UNL	369	153	89	611	UNL	413	167	93	673
UNO	141	142		283	UNO	181	123	69	373	UNO	143	140	70	353
State Colleges	47	50		97	State Colleges	153	53	0	206	State Colleges	97	98	0	195
Two-Year Strata	71	73		144	Two-Year Strata	162	89	0	251	Two-Year Strata	134	137	0	271
2015 Total	**1,033**	**624**	**220**	**1,877**	**2016 Total**	**1,167**	**619**	**222**	**2,008**	**Total**	**4,491**	**2,837**	**862**	**8,190**
Four-Year Strata	876	465	220	1,561	Four-Year Strata	986	437	222	1,645	Four-Year Strata	3,786	2,197	862	6,845
UNK	103	65	48	216	UNK	122	51	49	222	UNK	432	310	196	938
UNL	450	168	91	709	UNL	565	158	91	814	UNL	1,970	821	364	3,155
UNO	223	130	81	434	UNO	212	140	82	434	UNO	900	675	302	1,877
State Colleges	100	102	0	202	State Colleges	87	88	0	175	State Colleges	484	391	0	875
Two-Year Strata	157	159	0	316	Two-Year Strata	181	182	0	363	Two-Year Strata	705	640	0	1,345

Notes: This table reports sample counts by applicant cohort and target college. The sample contains applicants who were subject to random assignment. COS awards were offered only in the 2013-2016 University of Nebraska strata. Two-year college strata include Central Community College, Metropolitan Community College, Mid-Plains Community College, Northeast Community College, Southeast Community College, and Western Nebraska Community College strata. The State College strata include Chadron State, Peru Sate, and Wayne State strata.

Table A3
Descriptive statistics by target college

	Four-Year Strata									
	UNL		UNO		UNK		State Colleges		Two-Year Strata	
	All	Treatment - control	All	Treatment - control	All	Treatment - control	All	Treatment - control	All	Treatment - control
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Female	.55	.037	.64	.007	.71	-.014	.65	-.003	.61	.027
		(.021)		(.025)		(.035)		(.033)		(.026)
White	.67	-.005	.47	-.014	.77	-.004	.83	.024	.69	.013
		(.020)		(.025)		(.032)		(.025)		(.024)
Black	.07	.004	.09	.008	.02	-.021	.03	.002	.02	.002
		(.011)		(.015)		(.008)		(.011)		(.008)
Hispanic	.16	.005	.30	.032	.19	.033	.10	-.013	.20	-.008
		(.015)		(.023)		(.030)		(.020)		(.022)
Other race	.05	-.005	.09	-.010	.01	-.001	.01	-.005	.06	-.011
		(.009)		(.014)		(.007)		(.003)		(.012)
Family income ($)	49,374	-4,785	42,597	736	50,141	-626	48,335	2,179	42,444	570
	[29,058]	(3,091)	[27,886]	(1,359)	[39,452]	(3,125)	[33,960]	(2,185)	[33,379]	(1,736)
EFC ($)	3,051	2	2,389	-148	3,212	-157	3,167	-59	2,594	-159
	[3,115]	(135)	[2,914]	(150)	[3,126]	(238)	[3,195]	(216)	[3,096]	(162)
At least one parent attended college	.74	.011	.57	-.014	.73	-.028	.75	.029	.59	.046
		(.018)		(.025)		(.034)		(.030)		(.026)
At least one parent earned a bachelor's degree	.40	-.010	.25	.003	.33	-.012	.36	-.009	.18	.029
		(.021)		(.022)		(.035)		(.033)		(.021)
Took ACT	.98	-.004	.95	.001	.98	-.007	.98	-.000	.80	.011
		(.007)		(.011)		(.012)		(.009)		(.022)
Composite ACT score	23.8	-.23	21.1	-.28	22.2	-.55	21.7	-.09	18.9	.42
	[4.3]	(.18)	[4.6]	(.23)	[3.9]	(.28)	[3.8]	(.27)	[3.4]	(.19)
High school GPA	3.56	-.017	3.34	-.006	3.52	.041	3.48	-.006	3.26	.053
	[.38]	(.016)	[.41]	(.021)	[.41]	(.030)	[.41]	(.029)	[.41]	(.022)
F-statistic		1.10		.97		1.64		.61		1.19
p-value		.35		.48		.06		.85		.28
# of applicants	2,791	2,791	1,575	1,575	742	742	875	875	1,345	1,345

Notes: This table reports descriptive statistics by target college for the 2012-2016 cohorts. See Table I notes for variable definitions and descriptions.

Table A4
Point labels for visual IV estimates using mutually exclusive subgroups

Label	Gender	Race	ACT Score	Residency
1	Female	White	High	Non-Omaha
2	Female	White	High	Omaha
3	Female	White	Low	Non-Omaha
4	Female	White	Low	Omaha
5	Female	Nonwhite	High	Non-Omaha
6	Female	Nonwhite	High	Omaha
7	Female	Nonwhite	Low	Non-Omaha
8	Female	Nonwhite	Low	Omaha
9	Male	White	High	Non-Omaha
10	Male	White	High	Omaha
11	Male	White	Low	Non-Omaha
12	Male	White	Low	Omaha
13	Male	Nonwhite	High	Non-Omaha
14	Male	Nonwhite	High	Omaha
15	Male	Nonwhite	Low	Non-Omaha
16	Male	Nonwhite	Low	Omaha

Notes: This table labels the points plotted in Online Appendix Figure A8.

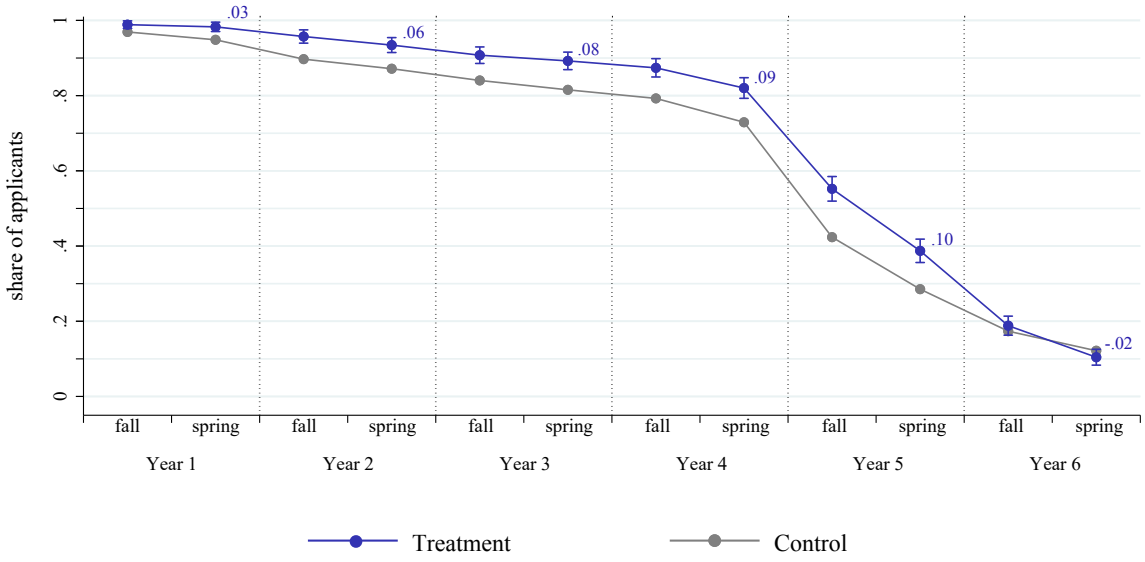
Table A5
IV estimates of the effect of initial credits on degrees for mutually exclusive subgroups

		2SLS	
	OLS	Just-identified	Disjoint VIV
	(1)	(2)	(3)
	A. Bachelor's Degree		
Four-year credits earned	0.50	0.61	0.61
	(0.01)	(0.10)	(0.09)
First stage			
Any award		0.12	
		(0.01)	
F-stat			6.49
Over-identification test		--	15.36
Degrees of freedom			15
p-value			0.43
	B. Any Degree		
Four-year credits earned	0.27	0.35	0.40
	(0.01)	(0.10)	(0.10)
Over-identification test		--	18.02
Degrees of freedom			15
p-value			0.26
	C. Associate Degree		
Four-year credits earned	-0.34	-0.30	-0.28
	(0.01)	(0.07)	(0.06)
Over-identification test		--	11.28
Degrees of freedom			15
p-value			0.73
N		4,305	4,305

Notes: This table reports 2SLS estimates and over-identification test statistics for models where the outcome is degree completion and the endogenous variable is initial four-year engagement as defined in Online Appendix Figure A8. The just-identified estimates in column 2 use a single offer dummy as instrument. Estimates in column 3 are from over-identified models with instrument sets constructed by interacting award offers with sets of dummies labeled in Online Appendix Table A4. The sample is restricted to the 2012-14 cohorts. All models control for strata and subgroup main effects.

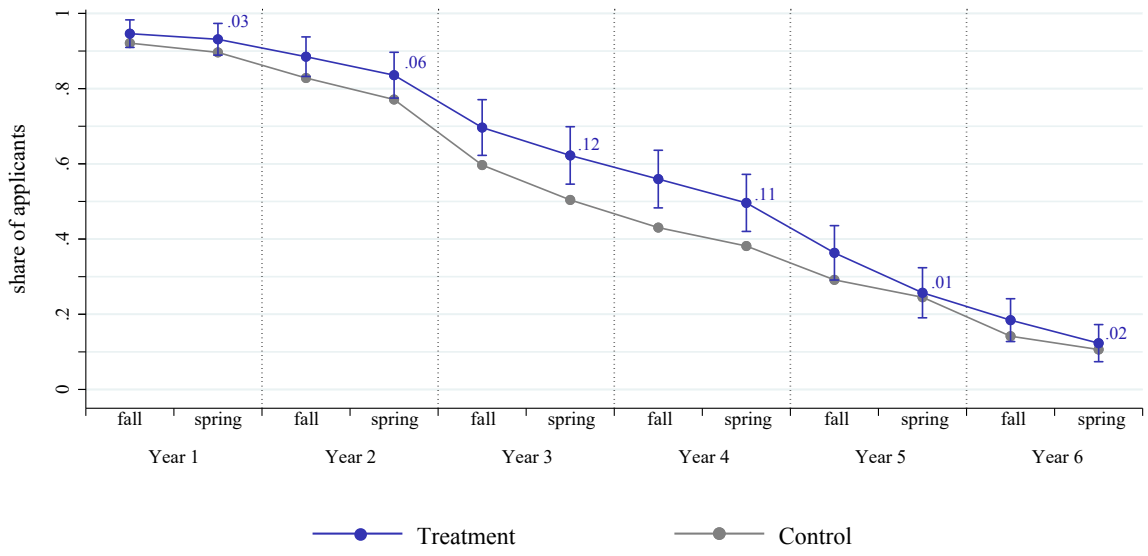
B Estimates in a Sample of Balanced Cohorts

Figure B1
Enrollment effects in the balanced sample four-year strata



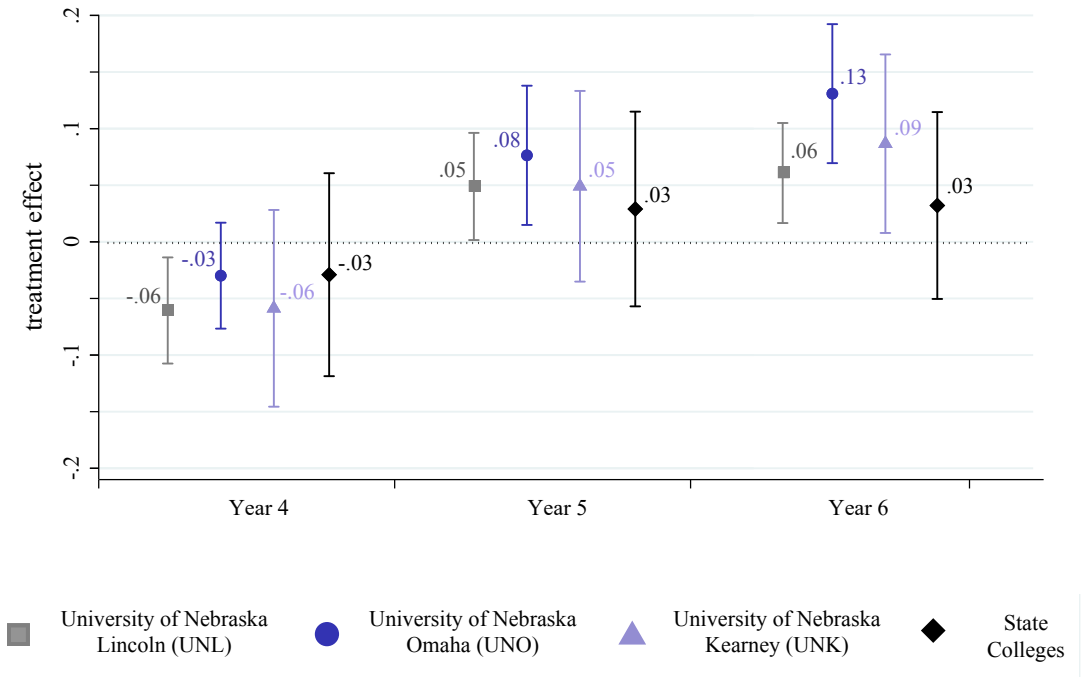
Notes: This figure plots the effect of an award on enrollment rates for students in the four year strata without a BA. Sample is restricted to the 2012-2014 cohorts. Regressions control for strata dummies. Whiskers mark 95 percent confidence intervals.

Figure B2
Enrollment effects in the balanced sample two-year strata



Notes: This figure plots the effect of an award on enrollment rates for students in two-year strata without a BA. The sample is restricted to the 2012-2014 cohorts. Regressions control for strata dummies. Whiskers mark 95 percent confidence intervals.

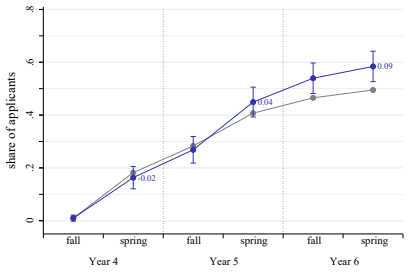
Figure B3
BA effects by target campus in a balanced sample



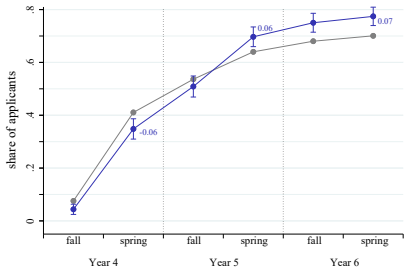
Notes: This figure plots the effect of an STBF award on degree completion for applicants targeting four-year campuses. Sample is restricted to the 2012-2014 cohorts. Whiskers mark 95 percent confidence intervals.

Figure B4
BA completion in balanced sample demographic subgroups

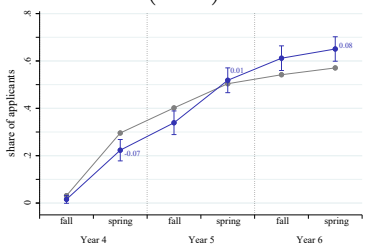
Nonwhite
(31%)



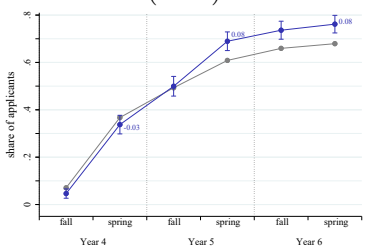
White
(69%)



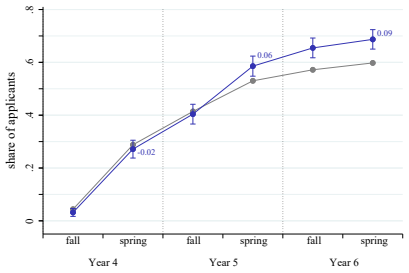
Male
(39%)



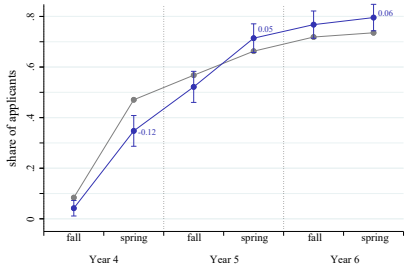
Female
(61%)



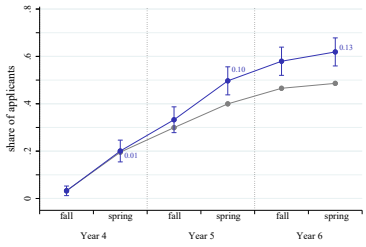
Pell-Eligible
(72%)



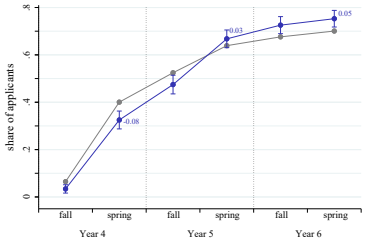
Not Pell-Eligible
(28%)



Omaha Resident
(30%)



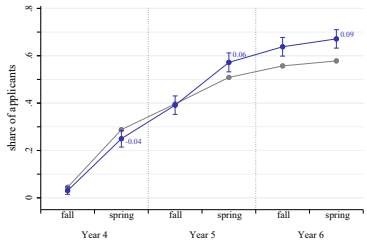
Not and Omaha Resident
(70%)



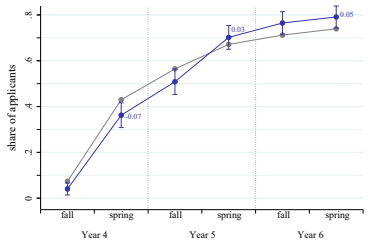
Notes: This figure plots mean degree completion rates by treatment status and subgroup for the four-year strata. Grey lines plot completion rates for control applicants; blue lines plot the sum of control means and strata-adjusted treatment effects. Whiskers mark 95 percent confidence intervals. Sample is restricted to the 2012-2014 cohorts. Percentages given are for 2012-2014 cohorts.

Figure B5
BA completion in balanced college readiness subgroups

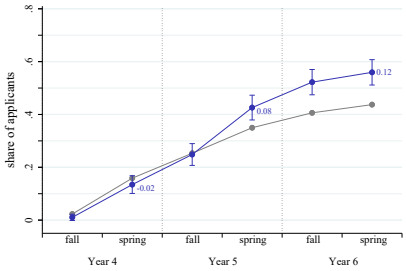
No parent with a BA
(64%)



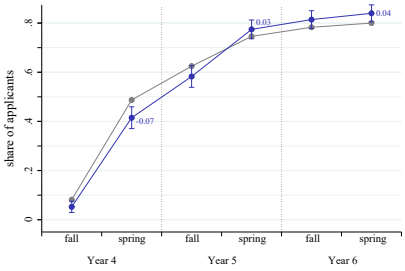
At least one parent with a BA
(35%)



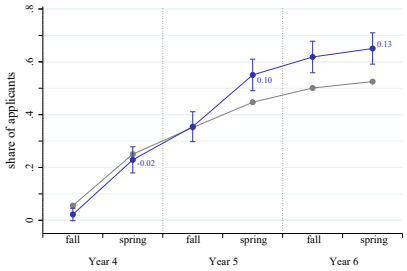
Below-median GPA
(45%)



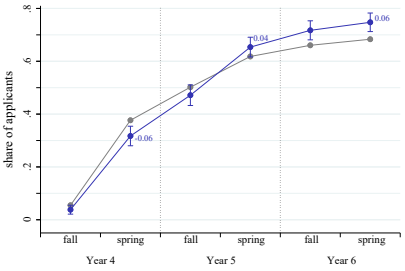
Above-median GPA
(55%)



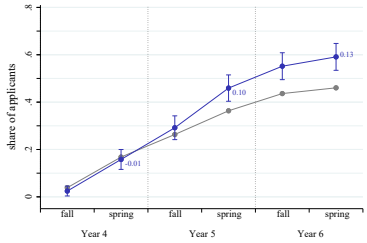
Two-year college alternate
(30%)



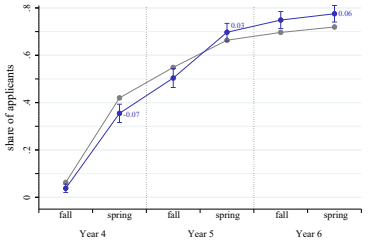
No two-year college alternate
(70%)



Below-median ACT
(34%)



Above-median ACT
(66%)



Notes: This figure plots mean degree completion rates by treatment status and subgroup for the four-year strata. Grey lines plot completion rates for control applicants; blue lines plot the sum of control means and strata-adjusted treatment effects. Whiskers mark 95 percent confidence intervals. Sample is restricted to the 2012-2014 cohorts. Percentages given are for 2012-2014 cohorts. The median high school GPA for the lottery sample is 3.49. STBF award applicants were asked to indicate their first choice ("target school") and to rank alternatives. "Two-year college alternate" indicates that a student ranked a two-year college among their alternative target schools on the STBF application. The median ACT score for Nebraska test-takers is 21.

C Earnings Imputation

C.1 Details

This section describes the lifetime earnings imputation sketched in Section B in more detail.

The lifetime earnings imputation proceeds in three steps. First, we estimate lifetime earnings profiles of Nebraska-born men and women aged 18 to 65 in ACS data from 2008-2019. The sample omits full-time students, those without a high school degree, those who hold a GED, and those with a degree higher than a BA. The sample also excludes self-employed respondents but includes those who are unemployed or not in the labor force. Earnings profiles are estimated separately in four subgroups: white men, white women, nonwhite men, and nonwhite women.

The earnings model is fit using Poisson regression. The Poisson specification stems from the role that zeroes play in the earnings regressions. Models used for imputation can be written as:

$$\log\left(E\left(w_i|s_i\right)\right) = \alpha + \beta_1 s_i + \beta_2 e_i + \beta_3 e_i^2 + \beta_4 e_i^3 + \beta_5 e_i^4 \tag{1}$$

where w_i is annual earnings from the ACS, s_i is a vector of dummies indicating the highest level of schooling completed (with high school graduates as the omitted group) and e_i is years of potential experience.

The dummies included in s_i are as follows:

- ND_i = college enrollment but no degree completed
- AA_i = associate degree completed
- BA_i = bachelor's degree completed

We impute potential experience from time in school estimates by Park (1994). Potential experience is defined as $e_i \equiv \max\{\text{age} - \hat{t}_i(s_i) - 18, 0\}$ where $\hat{t}_i(s_i)$ is the Park (1994) imputed time in school for highest level of schooling completed over the 12 years expected for high school graduation. We use subgroup-specific time in school estimates. Online Appendix Table C1 reports regression estimates of the wage equation by subgroup.

In a second step, we use the wage equation estimates to calculate the PDV of expected lifetime earnings for each educational level, j. For $s_j = s, e_j = e$, and demographic group $x_j = x$, equation

(1) generates a fitted value, $\hat{w}(s, e, x)$. The PDV of expected earnings for someone with s years of schooling in demographic group x is

$$\hat{w}_{sx}(S_j) = \sum_{18}^{65} \frac{\hat{w}(s, e, x)}{(1 + r)^{age-18}}, \tag{2}$$

where r is a discount rate, set to 3% in our reported figures and tables, and S_j is observed years of post-secondary enrollment.[3] Panel B of Online Appendix Table C2 applies equation (2) to calculate the PDV of the expected gain in lifetime earnings for each level of educational attainment relative to a high school degree.

In a final step, we calculate earnings profiles for the treatment and control groups in our experimental data to estimate the effect of scholarships on the PDV of expected lifetime earnings. For this exercise, we use a parametric approach to calculate an average expected earnings profile for the treatment and control groups. First, for the control group, we use means of potential experience and schooling dummies from our ACS sample as point estimates, which we plug into the earnings function estimated by equation (1) for the relevant subgroups. We do this separately for each race-by-gender subgroup. Next, we calculate treatment effects for time in school and educational attainment in the subgroup using the reduced form equation (1) in the main text. Panel A of Online Appendix Table C2 reports the treatment effects on degree attainment and time in school. These treatment effects are added to the control group estimates to obtain treatment group estimates for time in school and educational attainment which are plugged into the earnings function estimated by equation (1) to obtain expected earnings for the treated group. We difference the PDV of lifetime earnings for the treatment and control groups to obtain the estimated award effect on the PDV of lifetime earnings in each subgroup. Panel C of Online Appendix Table C2 reports these estimates.[4]

We apply an analogous procedure to obtain earnings gains for cost-benefit analysis (CBA) subgroups plotted in Figure VIII in the main text. We again use the ACS sample to calculate means of potential experience and schooling dummies for the control group, using as weights the race/sex distribution in the relevant CBA subgroup. We calculate treatment effects in the CBA subgroup for time in school and educational attainment using the reduced form equation (1) in the

[3]For imputations where potential experience is negative (i.e., the earnings of college graduates at age 18), we assign the intercept of the wage equation.

[4]To obtain the award effect on earnings for the full sample, we form a weighted average of the earnings gains in each of the four subgroups, using the groups' prevalence in the control group as weights.

main text. We finally take the difference in the PDV of lifetime earnings between the treatment and control groups calculated with equation (2) to obtain the estimated award effect for the CBA subgroup.

C.2 Earnings-Related Exhibits

Table C1
Estimated Earnings Functions

		White		Nonwhite	
	All	Male	Female	Male	Female
	(1)	(2)	(3)	(4)	(5)
Some college (no degree)	0.122	0.150	0.165	0.162	0.097
	(0.012)	(0.015)	(0.017)	(0.075)	(0.074)
Associate degree (AA)	0.294	0.298	0.379	0.285	0.244
	(0.012)	(0.016)	(0.018)	(0.093)	(0.093)
Bachelor's degree (BA)	0.680	0.713	0.708	0.849	0.827
	(0.012)	(0.015)	(0.016)	(0.073)	(0.090)
Potential experience	0.219	0.230	0.188	0.265	0.198
	(0.006)	(0.008)	(0.007)	(0.038)	(0.030)
(Potential experience^2)/100	-1.336	-1.331	-1.188	-1.806	-1.315
	(0.051)	(0.073)	(0.067)	(0.365)	(0.314)
(Potential experience^3)/1000	0.371	0.359	0.336	0.530	0.378
	(0.017)	(0.024)	(0.023)	(0.126)	(0.116)
(Potential experience^4)/10000	-0.039	-0.037	-0.035	-0.056	-0.038
	(0.002)	(0.003)	(0.003)	(0.014)	(0.014)
Constant	8.884	8.984	8.782	8.683	8.666
	(0.020)	(0.032)	(0.024)	(0.109)	(0.100)
N	109,896	49,348	54,843	2,784	2,921

Notes: This table reports estimates of the earnings model used to predict lifetime earnings, that is, equation (2), described in Section B. The model is fit using Poisson regression with robust standard errors. The sample is restricted to Nebraska-born residents aged 18-65 in the American Community Survey. The column labels indicate the sample restriction.

Table C2
Award effects on lifetime earnings

	Discount Rate	All (1)	Men: Nonwhite (2)	Men: White (3)	Women: Nonwhite (4)	Women: White (5)
Panel A. Treatment effects for earnings imputation						
High school only		-0.007	0.007	-0.001	-0.020	-0.007
		(0.003)	(0.007)	(0.004)	(0.009)	(0.005)
Some college		-0.045	-0.110	-0.031	-0.016	-0.047
		(0.015)	(0.050)	(0.030)	(0.037)	(0.019)
Associate degree		-0.030	-0.024	-0.029	-0.035	-0.030
		(0.007)	(0.021)	(0.014)	(0.014)	(0.010)
Bachelor's degree		0.081	0.127	0.061	0.071	0.084
		(0.016)	(0.049)	(0.031)	(0.037)	(0.021)
Time in school		0.360	0.524	0.405	0.403	0.267
		(0.041)	(0.150)	(0.082)	(0.105)	(0.052)
Panel B. Returns to degree completion relative to high school ($1,000s)						
Some college	3%	57	71	92	27	65
	5%	32	42	53	15	41
Associate degree	3%	164	137	208	85	173
	5%	101	83	126	52	112
Bachelor's degree	3%	470	586	629	433	376
	5%	296	374	391	281	242
Panel C. Award effect on the PDV of lifetime earnings ($1,000s)						
Award effect	3%	21.15	43.60	16.16	16.79	19.58
Award effect	5%	12.06	26.06	7.05	9.61	12.20

Notes: This table shows the lifetime PDV earnings gains (in thousands of dollars). Panel A shows the treatment effects for degree attainment and time in school that are used to calculate earnings gains in Panel C. Panel B shows these earnings gains relative to high school graduates for Nebraska-born men and women who completed the indicated level of post-secondary education. Panel C reports the effect of an award on predicted lifetime earnings, computed as described in section B. Estimates are for the 2012-2014 cohorts in four-year strata.

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