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THE ECONOMIC IMPACT OF ACCESS TO PUBLIC FOUR-YEAR COLLEGES

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ABSTRACT

We provide the first estimated economic impacts of students' access to an entire sector of public higher education in the U.S. Approximately half of Georgia high school graduates who enroll in college do so in the state's public four-year sector, which requires minimum SAT scores for admission. Regression discontinuity estimates show enrollment in public four-year institutions boosts students' household income around age 30 by 20 percent, and has even larger impacts for those from low income high schools. Access to this sector has little clear impact on student loan balances or other measures of financial health. For the marginal student, enrollment in such institutions has large private returns even in the short run and positive returns to state budgets in the long run.

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1. Introduction

To what extent do public colleges and universities improve economic mobility? Two-thirds of U.S. college students seeking bachelor's degrees enroll in public four-year colleges and universities, which are partially subsidized by state appropriations.[1] Descriptive evidence from Chetty et al. (2017) identify such colleges as catalysts for economic mobility but we have relatively little causal evidence on whether access to this sector improves students' economic trajectories. Those who choose to attend public four-year colleges and universities differ from those who choose otherwise, making the question empirically challenging to answer. Rigorous evidence on the economic benefits of a college education would inform the discourse around public funding of these institutions.

We provide the first estimated economic impacts of students' access to an entire public sector of higher education in the U.S. We study the University System of Georgia (USG), where approximately half of Georgia's high school graduates who attend college enroll. USG includes the state's 17 public four-year universities that we refer to as the University System of Georgia's universities (USGU), all of which require minimum SAT scores for admissions.[2] This threshold provides a source of exogenous variation in college access, allowing us to compare otherwise identical students who differed only in their college options. In Goodman, Hurwitz, and Smith (2017), we showed that students just above this SAT threshold for admission were substantially more likely to attend USGU instead of two-year colleges or no college at all. Enrollment in these public four-year universities in turn substantially increased bachelor's and overall degree completion rates.

We show here that access to Georgia's public four-year universities leads to substantial economic benefits for the marginal student. We do so by linking the universe of Georgia SAT takers from the high school classes of 2004 through 2008 to credit bureau data on these individuals measured in November 2017, when such individuals were in their late 20's and early 30's. The credit bureau data contain various measures of economic and financial well-being, including estimated household income, credit scores, outstanding debt, student loans, mortgages, and residential location. Many of these outcomes have not previously been measured in the literature

[1] See Table 3 of https://nscresearchcenter.org/wp-content/uploads/CurrentTermEnrollmentReport-Spring-2019.pdf.
[2] USG also includes nine "state colleges". During our time period, the state colleges only awarded associate's degrees but they now also offer bachelor's degrees. In one year of sample, one state college had an SAT minimum threshold.

on the economic returns to college. As such, we can paint a fairly comprehensive picture of the economic returns from attending public four-year colleges. We do so in four stages.

First, we replicate our earlier finding that access to and enrollment in the public four-year sector substantially boosts B.A. completion rates. To do so, we focus on the over 120,000 Georgia students who first took the SAT in senior year of high school, too late to retake the test in a potentially endogenous reaction to missing the publicly known admissions thresholds. Among such students, those just above the USGU admissions threshold are five percentage points (17 percent) more likely to enroll in the USGU than those just below, who instead largely attend two-year colleges or no college at all. Instrumental variable estimates suggest access-driven enrollment in a public four-year university relative to those alternatives increases B.A. completion rates by a substantial 38 percentage points, nearly quintupling the 10 percent B.A. completion rate among those denied access to a USGU.

Second, we show that enrollment in such public four-year universities substantially boosts household income as measured around age 30, driven almost entirely by students from low income high schools. In particular, enrollment in USGU increases annual household income by 20 percent, or over $11,000. The increase in income is almost 40 percent for students from low income high schools. These results are robust to a variety of specification choices, suggesting clear evidence that access to four-year universities yields large labor market returns for the marginal student.

Third, we use the credit bureau data to show that enrollment in this sector has little clear impact on student loan balances. Those who barely met the USGU admissions criteria have similar student loan balances at age 30, compared to students who barely missed these thresholds. There is some evidence that those from middle and high income high schools have higher student loan balances. We see, however, no corresponding evidence that USGU access changes students' financial health, as measured by credit scores, payment delinquency, and bankruptcy status. Overall, the costs of four-year public college attendance (relative to available alternatives) do not increase financial strain as measured 10 to 15 years after college entry. Access to public four-year universities neither changes home ownership rates, as proxied by mortgage status, nor changes the probability of living in state around age 30.

Fourth and finally, we show that enrollment in the public four-year sector has positive private and public returns. For private returns to the marginal student, we show that short-run increases in tuition costs, relative to the two-year sector or non-enrollment, are rapidly offset by increased income. The private return to public four-year university enrollment becomes positive and large early in a student's career. Under reasonable assumptions, the marginal student's enrollment in public four-year university is a break-even proposition 10 years after initial enrollment and has a net present value of nearly $100,000 after 20 years and over $150,000 after 30 years.

We compute public returns by comparing Georgia's increased expenditures on college subsidies for an additional student against the increased state income tax revenue from increased earnings. After 10 years the state roughly breaks even on its initial investment and after 30 years the net present value of that investment is close to $10,000. The large increase in income tax revenue generated by additional B.A. completion more than offsets the cost of subsidizing one additional student at a four-year campus. Accounting for additional effects of college education on co-worker productivity, sales tax revenue, and health would likely make this calculation even more favorable for the state. Accounting for increased federal income taxes would likely increase the computed social returns even further.

Our work makes two major contributions to the research literature. First, we extend prior work on college returns to generate the first estimated economic impacts of American students' access to an entire public system of higher education. Recent well-identified work on the returns to college access in the U.S. have largely exploited thresholds generated by a single institution's admissions process (Hoekstra, 2009; Zimmerman, 2014). Well-identified research showing substantial returns to access to broader sets of institutions or degree programs has largely been conducted outside of the U.S., in countries with more centralized admissions systems, such as France (Canaan and Mouganie, 2018) or Chile (Hastings, Neilson and Zimmerman, 2014). Closer in spirit to this work is Mountjoy (2019), which uses distance instruments to estimate earnings impacts of community college access relative to no college or four-year colleges. Our work complements recent work on earnings by Bleemer (2018), studying access to a few campuses in the University of California system, and Kozakowski (2019), studying impacts of access to Massachusetts' four-year state colleges.

Our estimated 20 percent increase in estimated household income from public four-year university enrollment is remarkably similar to those from these other papers. Hoekstra (2009) finds that enrollment in a state's most selective public university access increases earnings by 20 percent (for white men) and Zimmerman (2014) finds that access to a state's least selective public four-year college increases earnings by 22 percent. Our results are consistent with, though more precisely estimated, than the negative returns to community college enrollment that Mountjoy (2019) observes for students who otherwise would have attended four-year colleges (the "diversion" effect). Kozakowski (2019) estimates a 26 percent return from access to the public four-year sector, or a nearly 45 percent return from enrollment in such colleges. Her sample of low income students is more comparable to our sub-sample from low income high schools, for whom we also observe returns on the order of 40 percent.

Our second main contribution is to expand the set of economic outcomes considered by most literature on the returns to college. The U.S. papers discussed above measure outcomes using state-level administrative data on earnings as reported to unemployment insurance agencies. Linking to the credit bureau data allows us to see estimated household income, which includes the student's own wage earnings, spousal earnings and non-wage earnings, an arguably more complete measure of economic well-being than individual earnings might capture. We also observe a much wider range of financial outcomes than the typical state administrative data set. The only other papers in the higher education space to consider such outcomes are Scott-Clayton and Zafar (2019), on the impact of one state's merit scholarship program, and Boatman, Hurwitz, Lee and Smith (2019), on the impact of test-based college credit. These outcomes give a more complete picture of students' economic well-being than considering only income and allow us to study policy questions not focused solely on earnings.

2. Data and Summary Statistics

We combine data from three main sources: College Board's SAT data, the National Student Clearinghouse (NSC), and TransUnion credit bureau data. We begin with the College Board's data on the nearly 300,000 SAT takers residing in Georgia and in the high school graduating cohorts of 2004-2008. We observe each student's full history of SAT scores. The SAT contains a math and verbal/critical reading section, each scored between 200 and 800 in increments of 10.[3] The exam was offered approximately six times per year, typically at high schools, and is most frequently taken in 11th and 12th grades. Students may retake the SAT as often as they like. The SAT data

[3] The SAT later introduced the writing section but this was not relevant for most of the students in the sample and often not used in admissions. The exam was also redesigned in 2016.

include basic demographic information students report upon registration, including: sex, race/ethnicity, parental education and income, home zip code, and high school enrolled in.

We merge the data on Georgia SAT takers to the National Student Clearinghouse, which tracks college enrollment and completion across the U.S. As of 2015, over 3,600 colleges and universities participate in the NSC, comprising over 98% of all students enrolled in American postsecondary institutions.[4] We use the NSC data to track college enrollment spells of SAT takers up to six years after high school graduation. We observe which college a student is enrolled in at any given point in time, as well as the timing and type of any degree completed. We supplement this with data from the Integrated Postsecondary Education Data System (IPEDS) on college type (two-year or four-year, public or private, for-profit or non-profit).

Financial outcome data come from TransUnion, one of three main credit bureaus that collects and generates financial metrics for most people in the U.S. We merge a single cross-section of these data as of November 2017 to our SAT and NSC data, giving us a single snapshot in time of students' financial well-being. The merging process yields a 97 percent match rate in the state of Georgia.[5] The outcome of greatest interest is household income. The credit bureau uses a wide range of financial characteristics to estimate a consumer's joint gross adjusted income, with an algorithm based on many income sources and debt service parameters.[6] We observe debt variables directly related to college enrollment, such as outstanding student loans, as well as other forms of debt such as non-student loans and mortgages. We use principal components analysis to generate a standardized financial health index, the four components of which are: credit scores;[7] whether any payments are delinquent; the amount of delinquent payments; and whether the individual has ever declared bankruptcy. Finally, we know students' state of residence in 2017, allowing us to measure out-of-state mobility.

Our full analytical sample consists of all Georgia SAT takers in the high school graduating cohorts of 2004-2008 who took the SAT for the first time their senior year of high school and who are matched to the credit bureau data (97 percent match rate). As previously noted, we focus on students who first took the SAT during their senior year to circumvent issues arising from

[4] See Dynarski, Hemelt and Hyman (2015) for deficiencies in NSC data.
[5] See Appendix B1 for details.
[6] See Appendix B2 for details about the construction and validation of this household income measure.
[7] The credit score is known by TransUnion as the VantageScore 3.0. The score was developed jointly by TransUnion, Equifax, and Experian, and is used by many major lenders across the U.S.

endogenous retaking. These students have fewer opportunities to retake the exam and therefore the first SAT scores of these students most closely resembles the scores that appear on the college applications. The public nature of the USGU SAT thresholds means that students who take the exam earlier in their high school careers and miss the eligibility cutoffs have clear incentives to retake the exam and meet the thresholds.[8] Relative to all SAT takers, senior year SAT takers have lower SAT scores, have lower parental income, and are more likely to be Black, a pattern that holds true both in Georgia and nationally (Goodman, Gurantz and Smith, forthcoming).

Table 1 shows mean characteristics for all students and for students within 60 SAT points of the threshold. Both samples look similar, suggesting that those near the threshold are typical of senior year SAT takers. Nearly half are White and another 38 percent are Black. Another five percent are Hispanic or Native American, so underrepresented minorities comprise 43 percent of the sample. Nearly half of the sample attend a low-income high school, which we define as those in the lowest tercile statewide, based on students' self-reported income (less than about $59,000).[9]

Average first SAT scores in this sample are about 900, which represents roughly the 30th percentile of the national score distribution during this time period. Slightly more than half of students achieve the minimum section scores needed for admission to USGU. Despite the modest academic preparation of these students, the NSC data shows that about 40 percent enrolled in a four-year college within one year of high school graduation, and over 60 percent of those enrolled in one of the USG universities. Another 28 percent enrolled in a two-year college. Only 26 percent of the sample finished a B.A. within six years and fewer than eight percent completed an associate degree. in that time.

Students are nearly 29 years old on average when we observe them in the credit bureau data in November 2017. Their average estimated household income at that point is about $62,000. They have total student loan balances of $21,000, of which nearly all are government loans. Nearly 11 percent of the sample missed student loan payments and nearly 20 percent have been delinquent on some loan payment within the past year. About three percent have ever declared bankruptcy. As a result, senior year SAT takers have a financial health index about 0.28 standard deviations

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[8] See Goodman, Hurwitz, and Smith (2017) for details.

[9] We prefer high school average income to individual self-reported income because students do not always report their family income and because high school environment is an important determinant of college enrollment.

below the mean of all of Georgia's SAT test-takers during this period. Finally, over 80 percent of the sample students still live in Georgia in 2017.

3. Methodology

To estimate the causal impact of access to and enrollment in public four-year universities, we exploit the USGU admissions thresholds. In Georgia, a student must score at least 430 in verbal/critical reading and at least 400 in math to be eligible for admission to USGU.[10] A regression discontinuity design that compares outcomes of the nearly identical students just above and below these thresholds helps eliminate bias driven by students' non-random college choices. Because Georgia's admissions thresholds are publicly known, we define each student's distance from the threshold using that student's first SAT scores. First scores do not suffer from potential endogeneity driven by any retaking of SAT upon failure to meet the thresholds.[11]

We collapse the two-dimensional threshold into a single dimension by defining distance from USGU access (our running variable) as:

$$Distance = \min(SAT_R - 430,\, SAT_M - 400) \qquad (1)$$

This variable takes on negative values when a student has missed at least one threshold and takes zero or positive values when a student has met or exceeded both thresholds. This method of collapsing a multi-dimensional boundary into a single dimension is discussed in Reardon and Robinson (2012) and has previously been used in papers such as Cohodes and Goodman (2014) and Papay, Murnane, and Willet (2014).[12] The resulting estimates are local average treatment effects average across students near either component of the admissions threshold.

We first show that the admissions thresholds generate exogenous variation in college choice, generating first stage estimates with local linear regressions of the form:

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[10] Each university can and do set thresholds above the minimums.

[11] Appendix Table A1 shows that our regression discontinuity design, using first SAT scores to construct the running variable, has covariates balanced across the threshold. Appendix Figure A1 shows no jump in density at the threshold. A small jump in density two bins above the threshold appears in other states and results from lumpiness in the underlying SAT scores, as explained in further detail in Goodman, Hurwitz and Smith (2017).

[12] Our estimates are quite similar if we define the running variable as distance from one subject's threshold and limit the sample to students whose score in the other subject exceeds the relevant threshold.

$$USGU_{ic} = \alpha_0 + \alpha_1 Access_i + \alpha_2 Distance_i + \alpha_3 Access_i * Distance_i + X_i\Delta + \gamma_c + \mu_{ic} \quad (2)$$

Here, USGU indicates the initial enrollment (within one year of high school graduation) of student i in high school cohort c in a Georgia public four-year university. *Distance*, as described above, measures the number of SAT points from the stated thresholds. *Access* is an indicator variable representing whether the student met or exceeded the relevant test score thresholds (i.e. *Distance* ≥ 0). In many specifications, we also control for a vector of student demographics (X) to confirm that the regression discontinuity estimates are robust to covariate inclusion. High school cohort fixed effects (γ_c) control for state-wide, cohort-specific shocks. Because the two sets of students on either side of the threshold are nearly identical in terms of academic skill and other characteristics, the coefficient of interest, α_1, estimates the causal effect of achieving the minimal SAT scores on enrollment in Georgia's public four-year sector.

We then generate instrumental variable estimates of the impact of enrollment in the public four-year sector by fitting the model below:

$$Y_{ic} = \beta_0 + \beta_1 \widehat{USGU}_i + \beta_2 Distance_i + \beta_3 Access_i * Distance_i + X_i\Delta + \delta_c + \varepsilon_{ic} \quad (3)$$

where $\widehat{USGU}$ is instrumented by *Access* according to equation 2. Fitting the two-stage model specified by equations 2 and 3 implies that we are estimating the impact of enrollment in the public four-year sector relative to the full set of forgone alternatives, including enrollment in two-year colleges, in non-USGU four-year colleges, and no college at all. The outcomes of primary interest, Y, includes all college completion outcomes and economic outcomes available from the credit bureau data.

We test the robustness of our estimates by varying bandwidths and using the optimal bandwidths suggested by Imbens and Kalyanaraman (2012). We also try different weights in the local linear regression, adding polynomials, and including or excluding control variables. We also cluster standard errors by discrete distance to the threshold, as suggested by Lee and Card (2008).

4. Results

Access to public four-year universities substantially changes where students enroll. Panel A of Figure 1 shows a clear discontinuity at the USGU admission threshold in students' probability of enrolling at an in-state public four-year university. Students who do not meet the USGU thresholds on their first SAT attempt can enroll in USGU by meeting criteria through other means, including retaking the SAT or taking the ACT, explaining the USGU enrollment below the threshold. The discontinuity is fuzzy above the threshold because such students do not all apply to USGU, are not necessarily admitted upon applying, and do not necessarily enroll upon admission. The first column of Table 2 estimates the magnitude of this first stage discontinuity, showing that SAT-based admissibility increases the probability of enrolling in USGU by 4.7 percentage points. That result is highly statistically significant and precise enough to easily pass weak instrument tests with an F-statistic of 38. The magnitude of that first stage effect does not vary by high school income and is somewhat larger for URM students, though still large and statistically significant for non-URM students.[13]

Most students who enrolled in a public four-year university due to the admissions threshold would not otherwise have enrolled in a four-year institution at all. Students at this SAT margin are not typically enrolling in Georgia Tech of the University of Georgia, the two most selective universities in the university system. Had they not been admissible, half would have otherwise enrolled in a two-year college. Columns 2 and 3 of Table 2 show instrumental variables estimates of the impact of USGU enrollment on the type of college chosen. For the marginal student, enrolling in the USGU increases the probability of any four-year college and university enrollment by 67 percentage points and decreases the probability of two-year college enrollment by 52 percentage points. Though some would have enrolled in a private or out-of-state four-year college otherwise, for most such students the in-state public four-year sector is their only four-year college option. The treatment here can thus be thought of as inducing students to choose a public four-year university instead of counterfactual options, the most common of which is a two-year college.

Enrollment in public four-year universities, instead of these counterfactual options, substantially increases the probability of completing a B.A. Panel B of Figure 1 shows a clear discontinuity at the USGU admission threshold in students' probability of earning a B.A. within six years. Column 4 of Table 2 shows that enrollment in USGU increases by 38 percentage points the probability of completing a B.A, an intuitive result since access to USGU increases the

[13] Along with the full sample of late SAT takers, we focus on URM/non-URM and low income/high income high school subgroups throughout the paper. Our pre-analysis plan mentions numerous other subgroups but in results not shown, splitting the sample too much reduces the statistical power of the first stage.

likelihood that a student first enrolls in any four-year college. Little of this increased B.A. completion represents substitution away from A.A. degrees, the completion rates for which drops a statistically insignificant 12 percentage points, as seen in column 5. Access to public four-year universities thus substantially increases educational attainment, consistent with our earlier findings in Goodman, Hurwitz and Smith (2017).

Access to public four-year universities substantially increases household income. Figure 2 shows clear discontinuities at the USGU admission threshold in both mean household income and the logarithm of income. The instrumental variable estimates in Table 3 suggest that, for the marginal student, enrollment in the USGU increases household income by more than \$11,000, a slightly more than 20 percent increase relative to the control complier mean income of \$50,000. The logarithmic specification yields a similar estimate, with the coefficient implying that public four-year university enrollment boosts income by 20 percent ($e^{0.183}$-1). These results are robust to alternative specifications and placebo tests using senior year SAT takers outside of Georgia appropriately show no statistically significant impact of the USGU admissions threshold on income.[14] Using Opportunity Insights' measure of college-level average individual income as of 2014 shows that the level effects are smaller in magnitude but still precisely estimated, while the percentage increases are nearly identical to our estimates.[15] Table 3 also shows that the household income effects are most visible in the middle of the household income distribution.

Strikingly, the observed income effects are entirely concentrated among students from low income high schools. For such students, enrollment in public four-year colleges boosts household income by over \$25,000, relative to a control complier mean income of \$37,000. The logarithmic specification suggests that, for the marginal student from a low income high school, public four-year university enrollment boosts household income by 40 percent ($e^{0.338}$-1). Returns for students from middle and high income high schools are statistically insignificant and have point estimates quite close to zero. Though the standard errors do not allow us to rule out meaningfully large impacts on their income, it is intriguing that the large degree completion effects observed for such students do not appear to translate into income gains. One hypothesis is that the counterfactual

[14] Panel A of Tables A2 and A3 show that these estimated impacts on income are robust to different bandwidths and exclusion of demographic controls.

[15] See Table A4. Opportunity Insights provides aggregate data at the college-cohort level. While they have the same high school cohorts as our data, the income is reported as of 2014, which is 3-4 years prior to our income measures. We also use their measure of aggregate percent married as of 2014 as an outcome and find relatively small treatment effects, providing evidence against differential marriage rates across treatment/control driving our results.

education and labor market options available to students from higher income high schools are sufficiently good as to make public four-year university access less crucial. Control compliers from higher income high schools have much higher household incomes ($60,000) than do their counterparts from low income high schools. Mean income effects are much more similar in magnitude between URMs and non-URMs, suggesting that in this context socioeconomic status is more important than race as a predictor of returns to college.[16]

We see at most only suggestive evidence that access to public four-year universities increases student loan balances around age 30. No clear discontinuity is visible in the graph of the relationship between student loan balances and distance to the admissions threshold.[17] Point estimates from regression models imply that enrollment in the USGU increase student loan balances by about $11,000, nearly all of which is driven by an increase in government-sponsored student loans.[18] That overall effect is, however, fairly imprecise and only marginally statistically significant in the case of government loans, and not visually obvious. URM students and those from lower income high schools see little increase in loan balances, perhaps because they are more frequently eligible for grant aid that reduces the cost of tuition. We see clearer evidence that student loan balances rise more for students from higher income high schools and particularly for non-URM students, whose balances increase by close to $30,000, perhaps in part due to graduate school loans, which we cannot distinguish. This motivates study of the impact of such enrollment on financial stress.

We see no evidence that access to and enrollment in public four-year universities either increases or decreases the financial health of students, which we measure as an index based on credit score, payment delinquency and bankruptcy status. Neither visual evidence nor regression models show a discontinuity, with point estimates almost exactly zero and confidence intervals that rule out impacts beyond 0.2 standard deviations of the index, either positive or negative.[19] We therefore see no clear evidence that increased household income has improved the financial health of students from low income high schools, nor any evidence that the increased student loan balances for non-URM students have harmed their financial health. Though we see suggestive

[16] Panels B and C of Tables A2 and A3 show that estimated impacts on income by high school income and race are also robust to different bandwidths and exclusion of demographic controls.
[17] See Figure A2.
[18] See Table A4.
[19] See Figure A3 for visual evidence and column 1 of Table A5 for regression estimates. See Table A6 for regression estimates of the variables included in the financial health index.

visual evidence of an increase in home ownership rates, as proxied by mortgage status, regression estimates are too imprecise to reject the null of no impact.[20] Finally, we see little clear evidence of changes in the probability of living in Georgia around age 30.[21] The marginal student here is largely choosing between in-state two-year colleges and public four-year universities, not leaving the state for education or work. This lack of out-migration by the marginal student is an important factor when computing the state's returns on investment to its subsidies of the public four-year sector.

5. Returns on Investment

We compute both the private and public returns to the marginal student enrolling in an in-state public four-year university, relative to the counterfactual mixture that consists largely of in-state public two-year colleges and to a lesser extent private or out-of-state four-year colleges and universities, as well as no college. To compute private returns, we compare students' increased future income streams to the increased costs they pay in tuition and other fees as a result of USGU enrollment. To compute public returns, we compare Georgia's increased income tax revenue from higher-earning residents to the state's increased expenditures on the subsidies required for each student enrolling in the public four-year sector. All calculations are in 2017 dollars and assume a discount rate of three percent.

Computing both the private and public returns requires that we estimate the increase in income at every age for the marginal student, even though we only directly observe their income in 2017. To impute students' incomes in other years, we use the 2017 American Community Survey (ACS) to estimate quadratic income-age profiles in Georgia separately for people with bachelor's degrees, associate's degrees, some college, and no college. Using these estimated income-age profiles and each student's observed 2017 income, we assign a predicted income to every year prior to 2017 that students are not in college and every year after 2017. To compute after-tax income, we assume a federal tax rate based on the average tax rate by income quintiles plus Georgia's state income tax rate of 6 percent.[22] We discount each year's after-tax income

[20] See Figure A4 for visual evidence and column 2 of Table A5 for regression estimates.
[21] See Figure A5 for visual evidence and column 3 of Table A5 for regression estimates.

[22] We use the most recent quintiles and average tax rates available from the Congressional Budget Office, which is 2016. Available here: https://www.cbo.gov/publication/55413.

relative to students' high school cohorts, then aggregate the discounted predicted net incomes over various time horizons to get the present discounted value (PDV) of net income for each student.

To complete the private return calculation, we compute the PDV of the tuition costs each student likely faced given their college enrollment choices. To do so, we use sticker price and average grant aid for each institution in each year as reported to IPEDS. We assume students pay private colleges the sticker price less average grant aid, out-of-state public colleges the sticker price minus average federal aid, and in-state public colleges our best approximation of the average tuition for in-state students.[23] The NSC data allow us to construct each student's complete history of college enrollment, which we combine with these estimated costs to compute for each student a PDV of their college tuition costs. The difference between the PDVs of each student's after-tax income stream and tuition cost stream yields the net present value (NPV) of that student's college choice.

The private return to public four-year university enrollment becomes positive and large fairly early in students' careers. To show this, we generate fuzzy RD estimates using each student's NPV at 10, 20 and 30 years as our model's outcome. For the marginal student, enrollment in public four-year college is a break-even proposition after 10 years but has an NPV of nearly $100,000 after 20 years and over $150,000 after 30 years. The substantial increase in income due in part to increased B.A. completion rates thus rapidly outweighs increased tuition costs (relative to cheaper counterfactual college options) and delayed earnings due to increased time spent enrolled on the way to degree completion. For the marginal student, enrollment in the public four-year sector thus pays off fairly rapidly.

We use a similar approach to computing the public return to Georgia of the marginal student's enrollment in the USGU. We use the imputed income-age profiles and the state's six percent income tax rate to compute for each student their PDV of state income tax payments. We estimate the state's expenditures on each student's college education by assigning the average per capita state expenditure at each in-state public college in years when the student is enrolled at such a college, and zero state expenditures when they are enrolled at private, out-of-state or no college.[24] These expenditures are discounted to each student's high school graduation year and then added

[23] IPEDS only provides average net tuition for all students. We assume out-of-state tuition pay sticker tuition less average federal grants. Using these averages and the relative proportion of in-state and out-of-state students, we back out the average in-state tuition for in-state students.
[24] The college-specific state expenditure data come from the Delta Cost Project, which is derived from IPEDS.

to a PDV of state expenditures. The state's NPV is the difference between the PDV of income tax payments and expenditures on college subsidies.

The state appears to break even in the relatively short run and may even make money in the longer run on additional enrollment in its four-year universities. We show this by generating fuzzy RD estimates using the state's NPV at 10, 20 and 30 years as our model's outcome. We observe little impact on the state's NPV after 10 years but the marginal student's enrollment in a public four-year university increases the state's NPV by nearly $6,000 after 20 years and over $9,000 after 30 years. The large increase in income tax revenue generated by additional B.A. completion thus completely offsets the cost to the state of subsidizing one additional student at a four-year campus. This likely represents a lower bound on the budget impacts of expanding college access given that our calculations ignore spillovers to the productivity of co-workers (Moretti, 2004) and potentially reduced state expenditures on health care given the impact of college education on the health of students and their children (Buckles et al., 2016; Currie and Moretti, 2003).

Finally, we show that federal tax revenues substantially increase when these marginal students begin at the USGU. The marginal increase in PDV of federal tax revenue is approximately $15,000, $34,000 and $53,000, after 10, 20, and 30 years after initial enrollment, respectively. These magnitudes suggest that federal policies, programs, and/or subsidies that encourage enrollment in colleges similar to those in USGU over the typical alternative may pay for themselves.

6. Conclusion

This paper presents some of the first clear evidence that access to entire public systems of four-year colleges substantially improves students' income, particularly for those from low income high schools. For many students, state subsidies of in-state public four-year institutions mean that such institutions are the only relatively low-cost options that also have reasonable degree completion rates. We show that enrollment in such universities dramatically increases students' B.A. completion rates and raises their incomes around age 30 by 20 percent on average. Students from low income high schools see 40 percent increases in income from such enrollment. We see little clear positive or negative impact on other measures of economic well-being, including student loan balances, financial health, mortgage status and residential location. We estimate that the marginal student sees a positive return on investment to enrollment in a public four-year university in the relatively short run.

Our estimates also suggest that expanding access to the public four-year sector might be revenue-neutral or even revenue-enhancing to states in the long run. Many states explicitly ration access to the public four-year sector through required academic qualifications such as minimum SAT scores and GPAs. Others implicitly ration such access through processes that rely on the judgment of individual colleges' admissions officers. Our estimates suggest that, though such rationing is understandable given short-run budget constraints, allocating state tax dollars to increase the number of college enrollees might improve states' budget outlooks in the long run. Increasing access to public four-year institutions of higher education likely has positive social returns.

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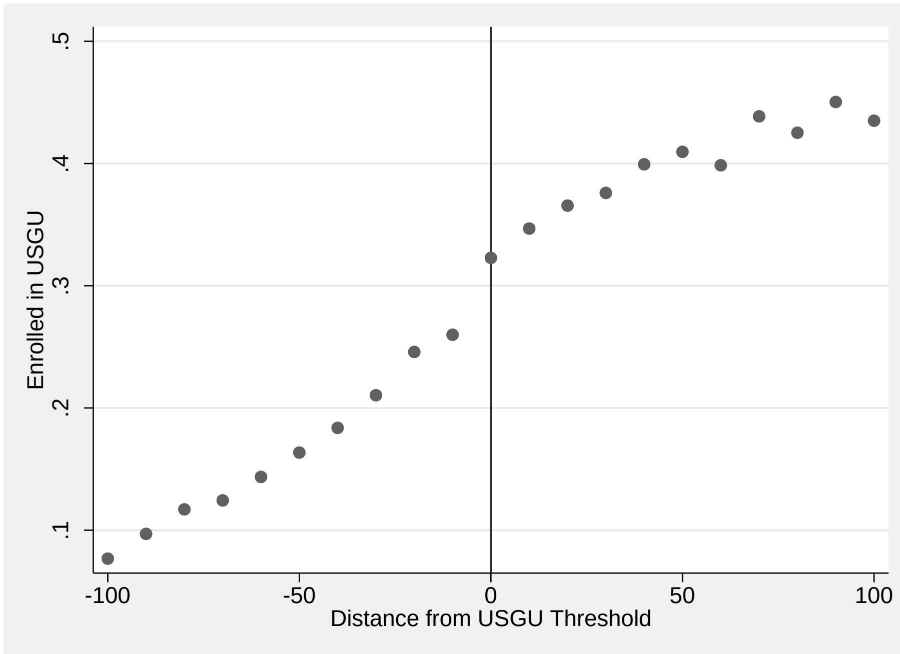
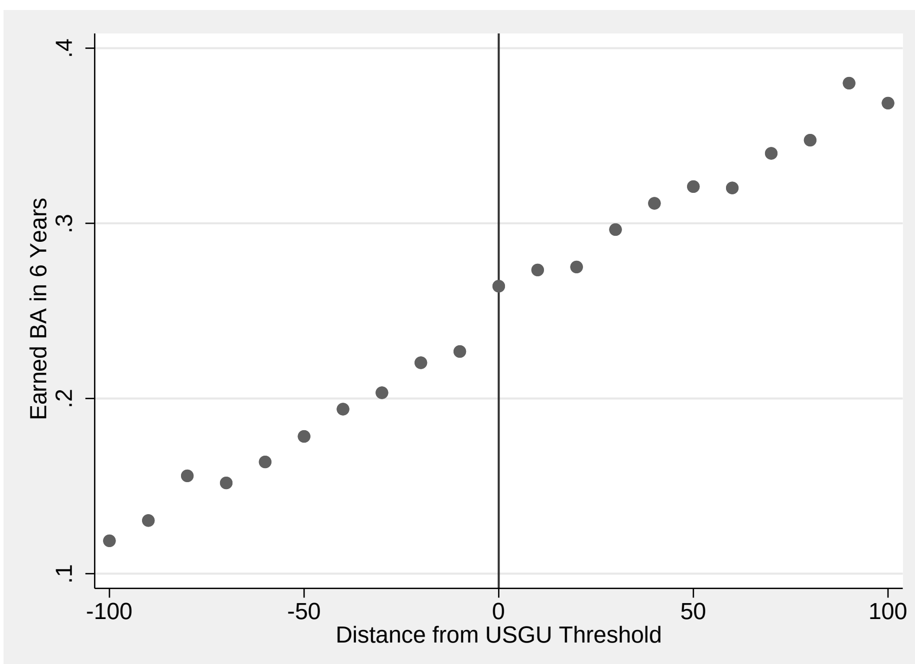
Figure 1 – Public Four-Year University Enrollment and Degree Completion

Panel A



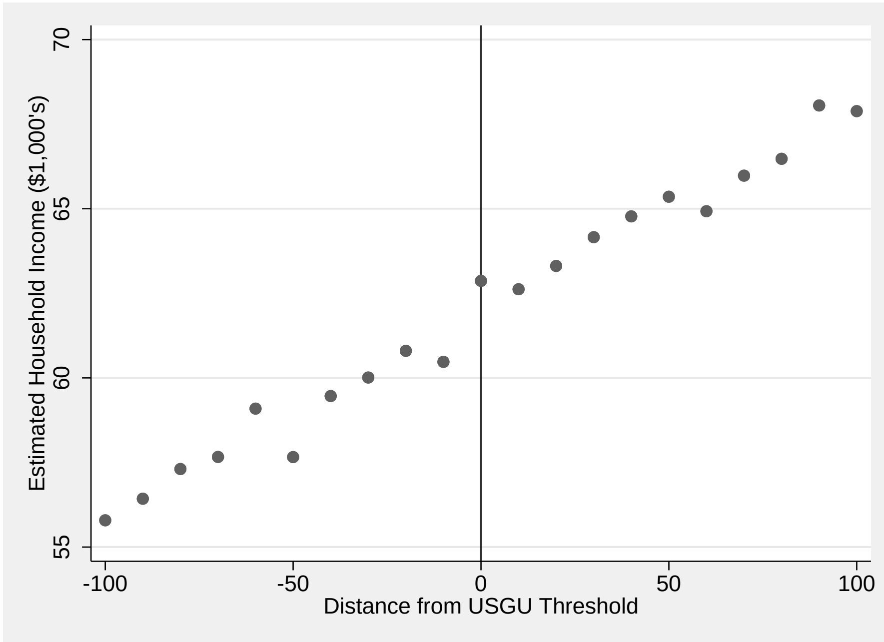
Panel B



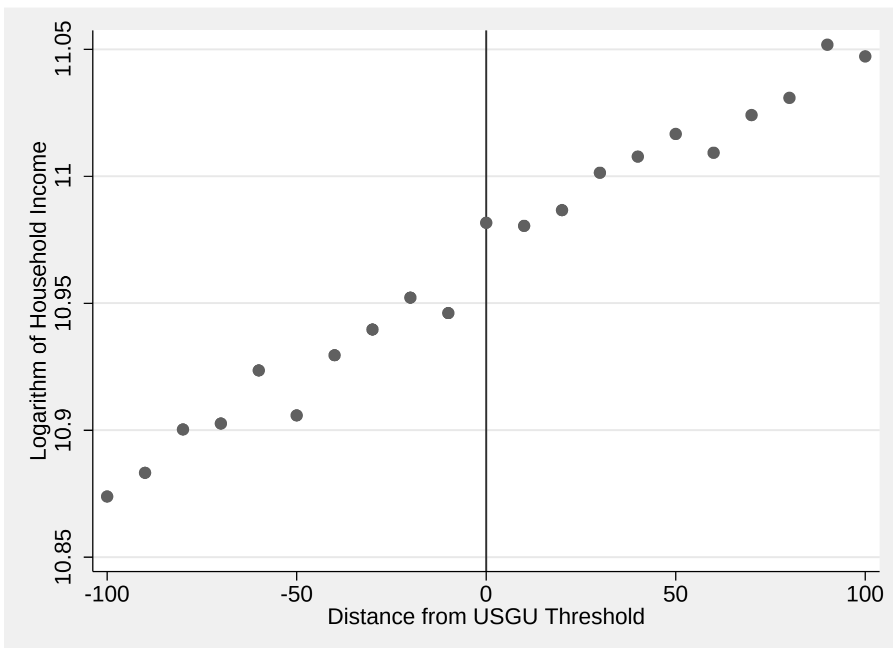
Notes: Sample includes all Georgia high school graduates between 2004 and 2008 who took the SAT for the first time in their senior year and matched to financial data. University System of Georgia's (USG) university admission threshold is 400 math and 430 verbal and the distance is the minimum between a student's scores and the thresholds for each section.

Figure 2 – Household Income around Age 30

Panel A



Panel B



Notes: Sample includes all Georgia high school graduates between 2004 and 2008 who took the SAT for the first time in their senior year and matched to financial data. University System of Georgia's (USG) university admission threshold is 400 math and 430 verbal and the distance is the minimum between a student's scores and the thresholds for each section.

Table 1 - Summary Statistics

	Full sample (N = 123,888)	RD sample (N = 68,101)
(A) Demographics		
Female	0.54	0.56
White	0.49	0.49
Black	0.38	0.38
URM (Black/Hispanic/Native American)	0.43	0.43
Low income high school	0.46	0.47
(B) College enrollment and completion		
First SAT score	900	890
Met or exceeded USGU minimum	0.54	0.55
Enrolled in USGU	0.29	0.30
Enrolled in 4-year college	0.47	0.48
Enrolled in 2-year college	0.28	0.29
Earned B.A. within 6 years	0.26	0.25
Earned A.A. within 6 years	0.08	0.08
(C) Income		
Age (as of November 2017)	28.9	28.9
Estimated household income ($000's)	62.2	62.0
(D) Student loans		
Outstanding student loans ($000's)	21.3	21.4
Government student Loans ($000's)	19.3	19.4
Any student loans past due last year	0.11	0.11
(E) Other financial outcomes		
Financial health index	-0.28	-0.28
Credit score above 700	0.31	0.30
Delinquent on any payments last year	0.20	0.20
Total past due in last year ($000's)	0.16	0.16
Ever bankrupt	0.03	0.03
Any mortgage	0.18	0.18
Lives in Georgia	0.81	0.81

Notes: The full sample includes all Georgia students from the graduating high school cohorts of 2004-2008 who first took the SAT in senior year and who were matched to credit bureau data. The regression discontinuity sample includes only those whose first SAT scores are within 60 points of the USGU admissions threshold.

Table 2 - Four-Year Public University Access, College Enrollment and Degree Completion

	First stage	Instrumental Variables			
	Enrolled in USGU	Enrolled in 4-year college	Enrolled in 2-year college	Completed B.A.	Completed A.A.
	(1)	(2)	(3)	(4)	(5)
(A) All students					
USGU access / enrollment	0.047***	0.673***	-0.515***	0.382***	-0.117
	(0.007)	(0.065)	(0.083)	(0.111)	(0.083)
Control mean / CCM	0.270	0.327	0.515	0.099	0.163
N	66,356	66,356	66,356	66,356	66,356
(B) By high school income					
Low income	0.047***	0.524***	-0.456***	0.319***	-0.184
	(0.009)	(0.182)	(0.114)	(0.115)	(0.194)
Control mean / CCM	0.285	0.476	0.456	0.222	0.185
N	30,892	30,892	30,892	30,892	30,892
Middle/high income	0.050***	0.800***	-0.550***	0.409***	-0.072*
	(0.007)	(0.057)	(0.102)	(0.132)	(0.043)
Control mean / CCM	0.256	0.200	0.550	0.012	0.145
N	35,464	35,464	35,464	35,464	35,464
(C) By student race/ethnicity					
URM	0.063***	0.558***	-0.411***	0.318***	0.010
	(0.008)	(0.080)	(0.057)	(0.105)	(0.069)
Control mean / CCM	0.341	0.442	0.411	0.152	0.017
N	28,569	28,569	28,569	28,569	28,569
Non-URM	0.042***	0.816***	-0.664***	0.480**	-0.304***
	(0.008)	(0.098)	(0.148)	(0.193)	(0.103)
Control mean / CCM	0.209	0.184	0.664	0.023	0.356
N	37,787	37,787	37,787	37,787	37,787

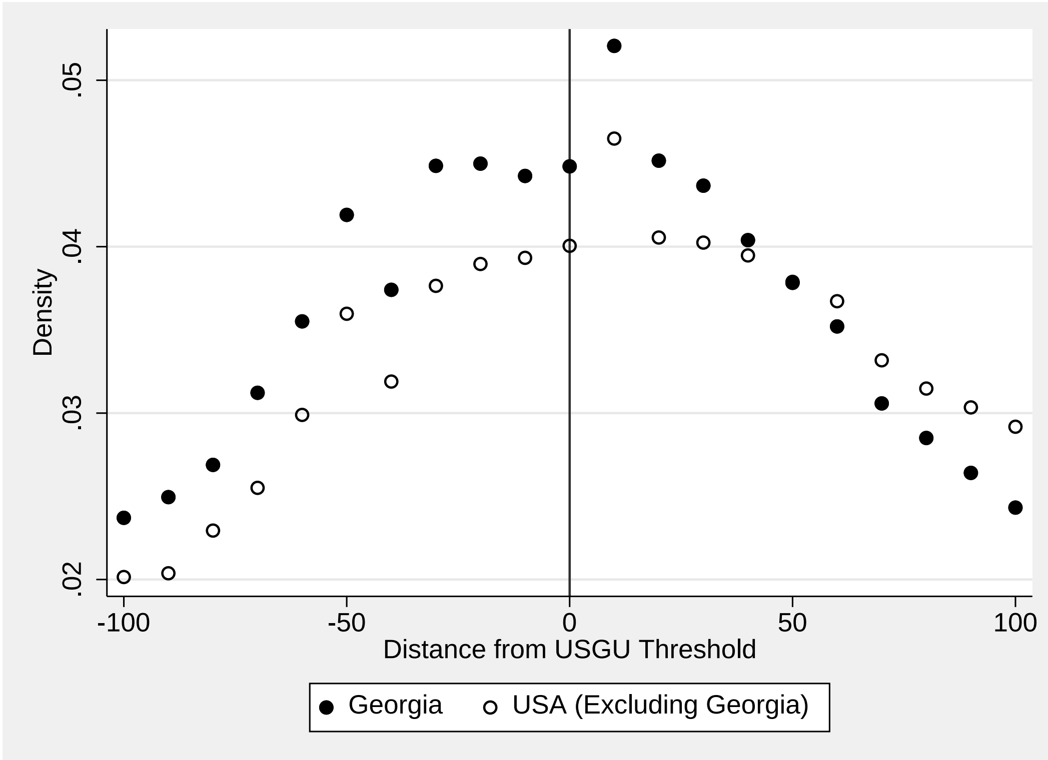
Notes: Standard errors clustered by distance from the threshold are shown in parentheses (*** p<0.01, ** p<0.05, * p<0.1). Column 1 shows first stage estimates of being above the threshold on enrollment in a USG university (with mean USGU enrollment just below the threshold listed at bottom). Columns 2-5 show instrumental variables estimates of the impact of USGU enrollment on the listed outcome (with control complier outcome means listed at bottom). All local linear regression discontinuity models use a bandwidth of 60 SAT points, high school cohort fixed effects, and indicators for sex, URM status, and low income high school status. Panel A includes all late SAT takers, panel B splits students by their enrollment in a high school in the lowest tercile of statewide income, and panel C splits students by underpresented minority status. College enrollment and completion are defined respectively as within one year and six years of high school graduation.

Table 3 - Four-Year Public University Enrollment and Household Income

	Income ($000s)	Log(income)	$25,000+	$50,000+	$75,000+
	(1)	(2)	(3)	(4)	(5)
(A) All students					
USGU enrollment	11.56***	0.183***	-0.008	0.245**	0.071
	(3.29)	(0.064)	(0.011)	(0.098)	(0.101)
CCM	49.95	10.79	1.00	0.47	0.15
N	66,356	66,356	66,356	66,356	66,356
(B) By high school income					
Low income	25.51***	0.338***	0.000	0.254***	0.103
	(7.86)	(0.103)	(0.021)	(0.082)	(0.152)
CCM	37.00	10.63	1.00	0.33	0.15
N	30,892	30,892	30,892	30,892	30,892
Middle/high income	0.26	0.061	-0.012	0.240	0.059
	(6.87)	(0.098)	(0.011)	(0.177)	(0.184)
CCM	59.87	10.91	1.00	0.56	0.12
N	35,464	35,464	35,464	35,464	35,464
(C) By student race/ethnicity					
URM	10.70**	0.210**	0.005	0.366***	0.049
	(4.44)	(0.082)	(0.008)	(0.127)	(0.067)
CCM	44.507	10.67	0.99	0.27	0.07
N	28,569	28,569	28,569	28,569	28,569
Non-URM	10.98*	0.134	-0.017	0.069	0.047
	(5.80)	(0.106)	(0.012)	(0.113)	(0.155)
CCM	55.47	10.92	1.00	0.72	0.22
N	37,787	37,787	37,787	37,787	37,787

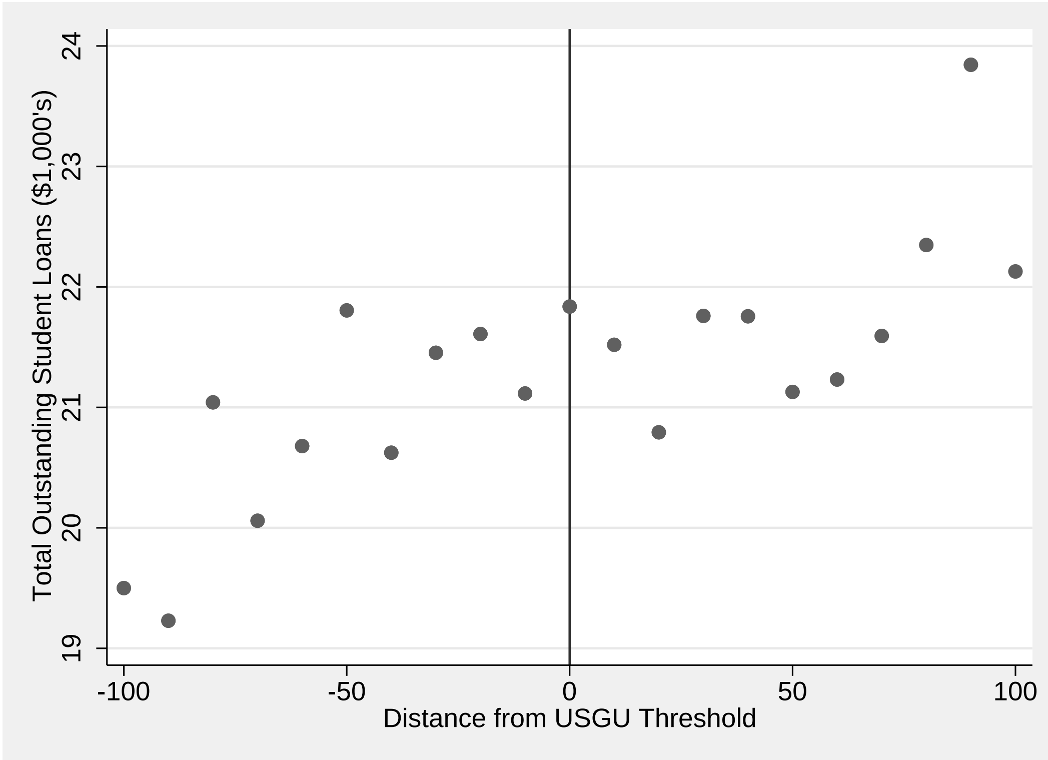
Notes: Standard errors clustered by distance from the threshold are shown in parentheses (*** p<0.01, ** p<0.05, * p<0.1). Each coefficient is an instrumental variables estimate of the impact of USG university enrollment on the listed outcome (with control complier outcome means listed at bottom). All local linear regression discontinuity models use a bandwidth of 60 SAT points, high school cohort fixed effects, and indicators for sex, URM status, and low income high school status. Panel A includes all late SAT takers, panel B splits students by their enrollment in a high school in the lowest tercile of statewide income, and panel C splits students by underpresented minority status. Household income is measured in November 2017, when respondents are about 30 years old.

Figure A1 – Density of Running Variable



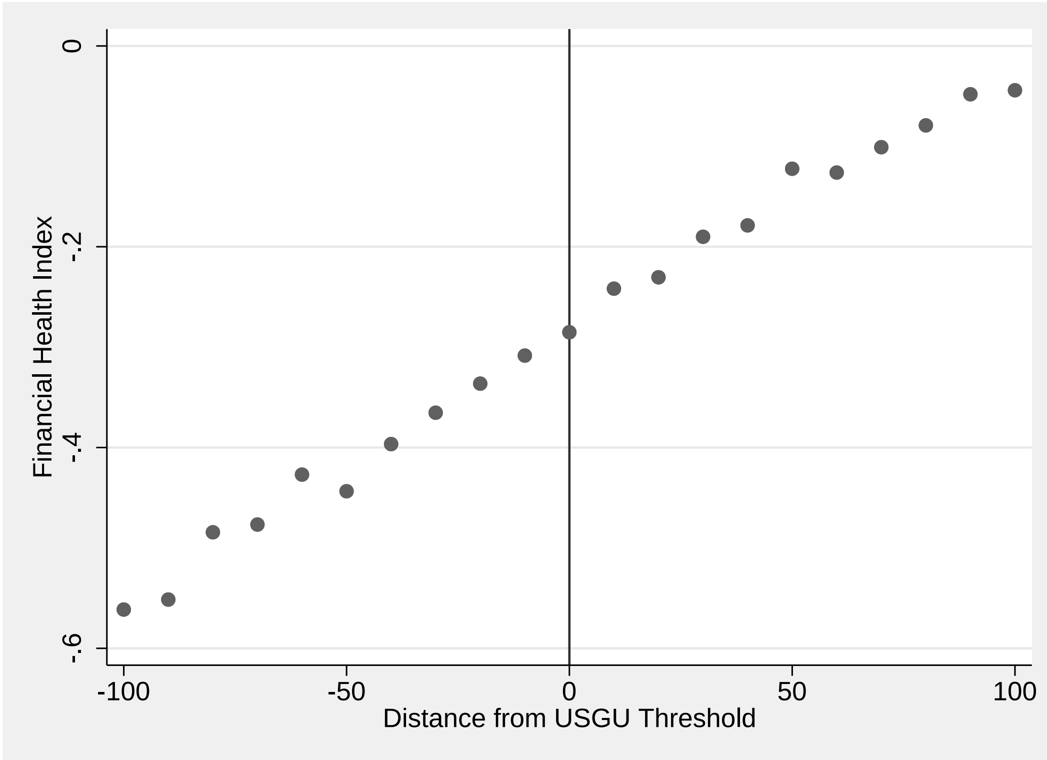
Notes: Sample includes all Georgia high school graduates between 2004 and 2008 who took the SAT for the first time in their senior year and matched to financial data. University System of Georgia's (USG) university admission threshold is 400 math and 430 verbal and the distance is the minimum between a student's scores and the thresholds for each section.

Figure A2 – Total Student Loan Balances



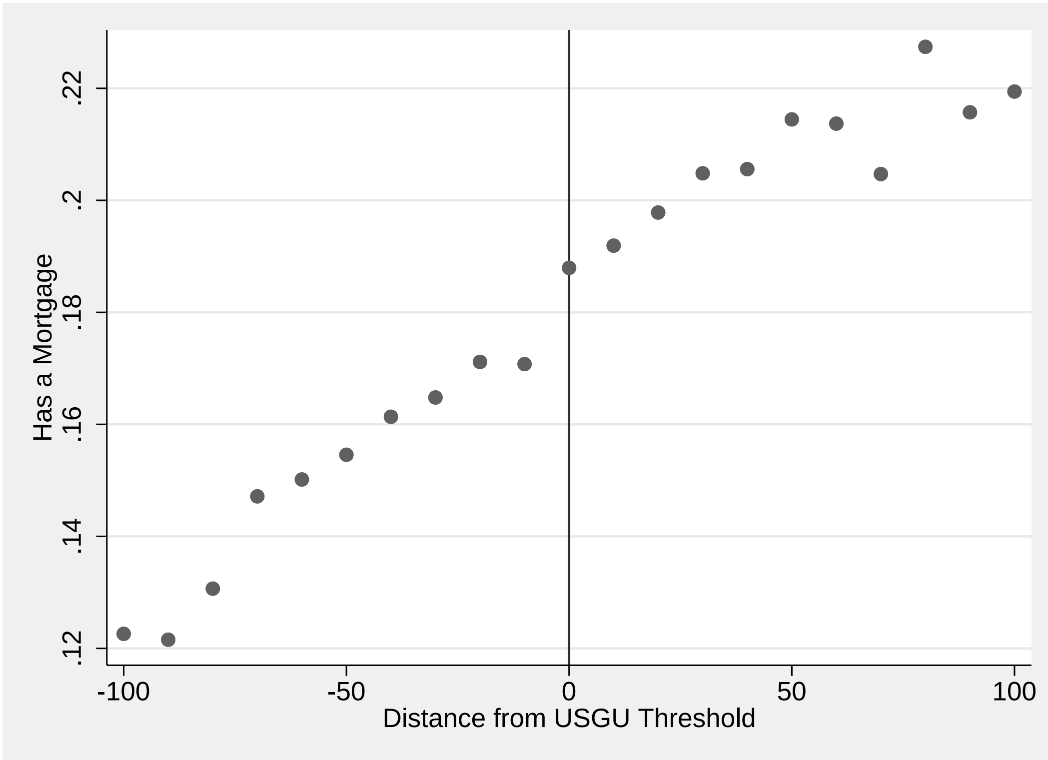
Notes: Sample includes all Georgia high school graduates between 2004 and 2008 who took the SAT for the first time in their senior year and matched to financial data. University System of Georgia's (USG) university admission threshold is 400 math and 430 verbal and the distance is the minimum between a student's scores and the thresholds for each section.

Figure A3 – Financial Health Index



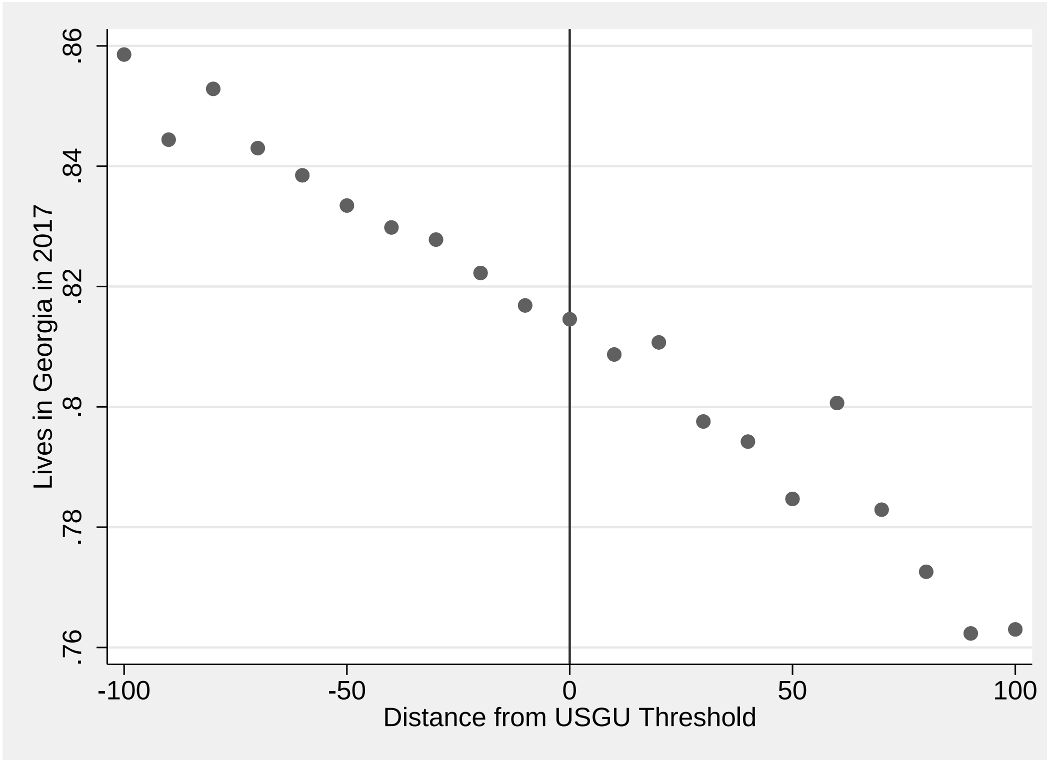
Notes: Sample includes all Georgia high school graduates between 2004 and 2008 who took the SAT for the first time in their senior year and matched to financial data. University System of Georgia's (USG) university admission threshold is 400 math and 430 verbal and the distance is the minimum between a student's scores and the thresholds for each section.

Figure A4 – Probability of Having a Mortgage



Notes: Sample includes all Georgia high school graduates between 2004 and 2008 who took the SAT for the first time in their senior year and matched to financial data. University System of Georgia's (USG) university admission threshold is 400 math and 430 verbal and the distance is the minimum between a student's scores and the thresholds for each section.

Figure A5 – Probability of Living in Georgia in 2017



Notes: Sample includes all Georgia high school graduates between 2004 and 2008 who took the SAT for the first time in their senior year and matched to financial data. University System of Georgia's (USG) university admission threshold is 400 math and 430 verbal and the distance is the minimum between a student's scores and the thresholds for each section.

Table A1 - Covariate Balance

	First SAT score	Low income high school	Black	Hispanic	Asian	Other race	Female
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
USGU access	-1.091	-0.005	-0.007	0.000	0.001	0.002	0.008
	(0.644)	(0.004)	(0.004)	(0.001)	(0.002)	(0.002)	(0.004)
N	66,356	66,356	66,356	66,356	66,356	66,356	66,356

Notes: Standard errors clustered by distance from the threshold are shown in parentheses (*** p<0.01, ** p<0.05, * p<0.1). Each coefficient is a reduced form estimate of being above the threshold on the lsited covariate. All local linear regression discontinuity models use a bandwidth of 60 SAT points and high school cohort fixed effect. The sample includes all Georgia students from the graduating high school cohorts of 2004-2008 who first took the SAT in senior year and who were matched to credit bureau data.

Table A2 - Robustness Checks, Household Income

Bandwidth	30	40	50	60	70	80	90	60
Demographic controls	Y	Y	Y	Y	Y	Y	Y	N
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(A) All students								
USGU enrollment	10.135***	9.069**	6.746	11.563***	10.286***	9.977***	8.002***	16.458***
	(3.595)	(3.527)	(4.132)	(3.292)	(2.765)	(2.178)	(2.290)	(3.800)
N	38,737	48,145	57,781	66,356	73,791	80,480	86,664	66,356
(B) By high school income								
Low income	13.128***	23.165*	23.512**	25.513***	18.494***	15.242***	15.187***	32.521***
	(5.071)	(12.033)	(9.574)	(7.863)	(6.507)	(5.054)	(4.560)	(9.356)
N	17,976	22,311	26,865	30,892	34,365	37,524	40,349	30,892
Middle/high income	9.827**	-1.902	-9.204	0.259	3.410	5.532	2.338	0.950
	(4.972)	(8.771)	(11.611)	(6.868)	(5.428)	(4.343)	(4.160)	(5.953)
N	20,761	25,834	30,916	35,464	39,426	42,956	46,315	35,464
(C) By student race/ethnicity								
URM	6.126	14.270*	9.515*	10.702**	8.415**	6.940**	5.896**	11.472***
	(5.208)	(8.185)	(5.347)	(4.443)	(3.932)	(3.142)	(2.996)	(4.143)
N	16,590	20,621	24,886	28,569	31,857	34,738	37,374	28,569
Non-URM	14.803***	3.229	1.150	10.984*	10.711**	12.292***	9.004**	11.104*
	(4.379)	(9.329)	(11.094)	(5.797)	(4.923)	(4.088)	(4.155)	(5.710)
N	22,147	27,524	32,895	37,787	41,934	45,742	49,290	37,787

Notes: Standard errors clustered by distance from the threshold are shown in parentheses (*** p<0.01, ** p<0.05, * p<0.1). Each coefficient is an instrumental variables estimate of the impact of USG university enrollment on household income. All local linear regression discontinuity models include high school cohort fixed effects. Each uses the listed bandwidth. Columns 1-7 include indicators for sex, URM status, and low income high school status, while column 8 excludes such controls.

Table A3 - Robustness Checks, Log(Household Income)

Bandwidth	30	40	50	60	70	80	90	60
Demographic controls	Y	Y	Y	Y	Y	Y	Y	N
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(A) All students								
USGU enrollment	0.179**	0.142*	0.128	0.183***	0.161***	0.167***	0.132***	0.252***
	(0.077)	(0.077)	(0.082)	(0.064)	(0.059)	(0.047)	(0.046)	(0.066)
N	38,737	48,145	57,781	66,356	73,791	80,480	86,664	66,356
(B) By high school income								
Low income	0.154**	0.279**	0.287**	0.338***	0.233**	0.226***	0.227***	0.437***
	(0.068)	(0.130)	(0.114)	(0.103)	(0.092)	(0.071)	(0.064)	(0.127)
N	17,976	22,311	26,865	30,892	34,365	37,524	40,349	30,892
Middle/high income	0.242***	0.044	-0.016	0.061	0.103	0.118*	0.059	0.069
	(0.085)	(0.133)	(0.155)	(0.098)	(0.087)	(0.069)	(0.068)	(0.085)
N	20,761	25,834	30,916	35,464	39,426	42,956	46,315	35,464
(C) By student race/ethnicity								
URM	0.166	0.246*	0.182*	0.210**	0.170**	0.155***	0.134***	0.222***
	(0.110)	(0.134)	(0.096)	(0.082)	(0.072)	(0.056)	(0.052)	(0.077)
N	16,590	20,621	24,886	28,569	31,857	34,738	37,374	28,569
Non-URM	0.201**	0.034	0.046	0.134	0.131	0.167**	0.118	0.135
	(0.098)	(0.172)	(0.177)	(0.106)	(0.096)	(0.081)	(0.078)	(0.105)
N	22,147	27,524	32,895	37,787	41,934	45,742	49,290	37,787

Notes: Standard errors clustered by distance from the threshold are shown in parentheses (*** p<0.01, ** p<0.05, * p<0.1). Each coefficient is an instrumental variables estimate of the impact of USG college enrollment on the logarithm of household income. All local linear regression discontinuity models include high school cohort fixed effects. Each uses the listed bandwidth. Columns 1-7 include indicators for sex, URM status, and low income high school status, while column 8 excludes such controls.

Table A4 - Four-Year Public University Enrollment and Opportunity Insights Outcomes

	Credit Bureau Income		Opportunity Insights Measures		
	Income ($000s)	Log(income)	Mean Income ($000s)	Log(mean income)	Percent Married
	(1)	(2)	(3)	(4)	(5)
(A) All students					
USGU enrollment	12.130***	0.216***	4.424***	0.201***	0.038*
	(2.691)	(0.041)	(1.146)	(0.049)	(0.022)
CCM	47.348	10.730	23.233	3.103	0.199
N	53,442	53,442	53,442	53,442	53,442
(B) By high school income					
Low income	25.491***	0.370***	4.582***	0.215***	0.083**
	(8.013)	(0.098)	(1.342)	(0.067)	(0.033)
CCM	35.307	10.580	22.119	3.060	0.157
N	25,454	25,454	25,454	25,454	25,454
Middle/high income	0.131	0.079	4.376*	0.198*	-0.012
	(7.485)	(0.100)	(2.550)	(0.109)	(0.021)
CCM	57.683	10.857	23.868	3.122	0.237
N	27,988	27,988	27,988	27,988	27,988
(C) By student race/ethnicity					
URM	12.239**	0.222**	3.531**	0.184**	0.071***
	(4.951)	(0.087)	(1.704)	(0.072)	(0.027)
CCM	44.356	10.673	23.347	3.092	0.158
N	24,831	24,831	24,831	24,831	24,831
Non-URM	12.021*	0.214**	5.429*	0.216*	-0.038
	(7.129)	(0.106)	(2.797)	(0.113)	(0.034)
CCM	49.123	10.778	22.548	3.096	0.260
N	28,611	28,611	28,611	28,611	28,611

Notes: Standard errors clustered by distance from the threshold are shown in parentheses (*** p<0.01, ** p<0.05, * p<0.1). Each coefficient is an instrumental variables estimate of the impact of USG university enrollment on the listed outcome (with control complier outcome means listed at bottom). All local linear regression discontinuity models use a bandwidth of 60 SAT points, high school cohort fixed effects, and indicators for sex, URM status, and low income high school status. Panel A includes all late SAT takers, panel B splits students by their enrollment in a high school in the lowest tercile of statewide income, and panel C splits students by underpresented minority status. Opportunity Insights measures mean and median income and marriage rates at the college level-initial enrollment year level as of 2014. We convert opportunity Insight's income into 2017 dollars. Opportunity Insights reports incomes for non-enrollees aggregated across the U.S. for each cohort and we deflate that by the ratio of Georgia to U.S. mean and median incomes in the 2014 ACS for each cohort.

Table A5 - Four-Year Public University Enrollment and Student Loan Balances

	Total student loans ($000s)	Government student loans ($000s)	Private student loans ($000s)	Student loans past due in past year	Student loan debt to income ratio
	(1)	(2)	(3)	(4)	(5)
(A) All students					
USGU enrollment	11.304	10.881*	0.423	-0.019	0.114
	(7.617)	(6.270)	(2.837)	(0.075)	(0.109)
CCM	13.97	10.63	3.34	0.10	0.30
N	66,356	66,356	66,356	66,356	66,356
(B) By high school income					
Low income	9.171	6.076	3.096	0.083	0.042
	(9.452)	(11.956)	(3.779)	(0.143)	(0.143)
CCM	24.23	22.82	1.41	0.00	0.49
N	30,892	30,892	30,892	30,892	30,892
Middle/high income	13.110	14.844**	-1.734	-0.097	0.171
	(9.887)	(7.523)	(3.905)	(0.088)	(0.145)
CCM	7.26	2.14	5.11	0.19	0.19
N	35,464	35,464	35,464	35,464	35,464
(C) By student race/ethnicity					
URM	-0.007	1.085	-1.093	0.001	-0.057
	(4.743)	(5.478)	(3.559)	(0.083)	(0.100)
CCM	37.785	32.670	5.115	0.189	0.771
N	28,569	28,569	28,569	28,569	28,569
Non-URM	28.989***	27.451***	1.538	-0.035	0.380**
	(11.133)	(8.354)	(4.414)	(0.059)	(0.150)
CCM	-10.96	-13.06	2.10	0.02	-0.17
N	37,787	37,787	37,787	37,787	37,787

Notes: Standard errors clustered by distance from the threshold are shown in parentheses (*** $p<0.01$, ** $p<0.05$, * $p<0.1$). Each coefficient is an instrumental variables estimate of the impact of USG university enrollment on the listed outcome (with control complier outcome means listed at bottom). All local linear regression discontinuity models use a bandwidth of 60 SAT points, high school cohort fixed effects, and indicators for sex, URM status, and low income high school status. Panel A includes all late SAT takers, panel B splits students by their enrollment in a high school in the lowest tercile of statewide income, and panel C splits students by underpresented minority status. Student loan balances are measured in November 2017, when respondents are about 30 years old.

Table A6 - Robustness Checks, Total Student Loan Balances

Bandwidth	30	40	50	60	70	80	90	60
Demographic controls	Y	Y	Y	Y	Y	Y	Y	N
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(A) All students								
USGU enrollment	17.994**	11.229	14.589	11.304	7.194	5.375	-3.382	5.095
	(8.794)	(10.522)	(9.278)	(7.617)	(7.856)	(6.863)	(8.138)	(7.796)
N	38,737	48,145	57,781	66,356	73,791	80,480	86,664	66,356
(B) By high school income								
Low income	3.275	5.550	6.656	9.171	8.427	8.892	1.066	-1.207
	(14.533)	(13.715)	(12.146)	(9.452)	(8.815)	(7.235)	(8.063)	(10.956)
N	17,976	22,311	26,865	30,892	34,365	37,524	40,349	30,892
Middle/high income	31.303***	14.774	21.597**	13.110	6.763	4.387	-4.359	13.516
	(7.762)	(12.557)	(11.006)	(9.887)	(10.493)	(10.116)	(10.203)	(9.587)
N	20,761	25,834	30,916	35,464	39,426	42,956	46,315	35,464
(C) By student race/ethnicity								
URM	5.514	3.382	4.279	-0.007	-2.189	0.006	-10.284	0.890
	(5.050)	(6.265)	(5.240)	(4.743)	(4.499)	(4.500)	(7.419)	(5.881)
N	16,590	20,621	24,886	28,569	31,857	34,738	37,374	28,569
Non-URM	33.978**	18.326	31.461*	28.989***	25.087**	18.875*	13.788	29.462***
	(14.928)	(20.249)	(16.656)	(11.133)	(10.778)	(10.147)	(9.450)	(10.819)
N	22,147	27,524	32,895	37,787	41,934	45,742	49,290	37,787

Notes: Standard errors clustered by distance from the threshold are shown in parentheses (*** p<0.01, ** p<0.05, * p<0.1). Each coefficient is an instrumental variables estimate of the impact of USG university enrollment on total student loan balances. All local linear regression discontinuity models include high school cohort fixed effects. Each uses the listed bandwidth. Columns 1-7 include indicators for sex, URM status, and low income high school status, while column 8 excludes such controls.

Table A7 - Four-Year Public University Enrollment and Other Outcomes

	Financial health index (1)	Any mortgage (2)	Still lives in Georgia (3)
(A) All students			
USGU enrollment	-0.000	0.059	0.021
	(0.095)	(0.092)	(0.065)
CCM	-0.133	0.150	0.835
N	66,003	66,356	66,356
(B) By high school income			
Low income	-0.186	0.049	0.101
	(0.228)	(0.131)	(0.113)
CCM	-0.109	0.127	0.763
N	30,731	30,892	30,892
Middle/high income	-0.244	0.071	-0.024
	(0.122)	(0.095)	(0.086)
CCM	-0.354	0.152	0.883
N	35,272	35,464	35,464
(C) By student race/ethnicity			
URM	-0.122	0.078	0.129
	(0.198)	(0.091)	(0.116)
CCM	-0.451	0.048	0.801
N	28,448	28,569	28,569
Non-URM	0.222	0.035	-0.064
	(0.196)	(0.117)	(0.098)
CCM	0.035	0.237	0.850
N	37,555	37,787	37,787

Notes: Standard errors clustered by distance from the threshold are shown in parentheses (*** p<0.01, ** p<0.05, * p<0.1). Each coefficient is an instrumental variables estimate of the impact of USG university enrollment on the listed outcome (with control complier outcome means listed at bottom). All local linear regression discontinuity models use a bandwidth of 60 SAT points, high school cohort fixed effects, and indicators for sex, URM status, and low income high school status. Panel A includes all late SAT takers, panel B splits students by their enrollment in a high school in the lowest tercile of statewide income, and panel C splits students by underpresented minority status. Outcomes are measured in November 2017, when respondents are about 30 years old. The financial health index is the first principal component of standardized versions of an individual's credit score, past year payment delinquency status, past year amount past due, and an indicator for ever having declared bankruptcy.

Appendix B – Financial Outcomes Data

B.1. – Matching Process

The College Board acquired TransUnion data after a match on available student information. The procedure resulted in an approximately 90 percent match rate, which is similar to Scott-Clayton and Zafir (2016) who perform the analysis with Equifax credit bureau for all West Virginia public school students. In our analytic sample, the match rate is 97 percent. All observations are observed, regardless of match status.

B.2. - Estimated Income

With its proprietary algorithm, TransUnion uses a wide range of financial characteristics to estimate a consumer's joint gross adjusted income (line 37 of the 1040 federal tax form). This algorithm is based on multiple income sources including: investment income, alimony, business income, IRA distributions, pensions and annuities, real estate income, unemployment compensation, and Social Security benefits. In addition, debt service parameters are also factored in such as: monthly spend data, and up to 30 months of extended account history. This history includes credit lines, length of credit history, historical credit card balances, and recent credit card transactions.[25] The estimate does not account for whether someone is employed, but rather predicts a value that is restricted to between $0 and $1 million.

In Figure B1, we compare the median earnings from the College Scorecard to the TransUnion income estimator. To do so, we used the College Board sample of approximately 17 million observations matched to TransUnion data (and National Student Clearinghouse). This allows us to construct college-specific incomes for different cohorts, similar to the reporting level in the College Scorecard.[26]

The left panel plots college level median earnings from the College Scorecard versus median estimated income from TransUnion for students eight years after initial enrollment. The

[25] Further details on potential uses for the TransUnion CreditVision Income Estimator can be found at https://www.transunion.com/resources/transunion/doc/products/resources/product-creditvision-income-estimator-as.pdf.

[26] The College Scorecard includes all students who received federal financial aid. The College Board data contains observations for people who did and did not receive financial aid, but misses students who did not take the PSAT, SAT, or Advanced Placement exams.

45-degree line represents a one-to-one correspondence. Most dots are below the 45-degree line, suggesting that the TransUnion income estimator is substantially higher than the Scorecard earnings. However, this is largely a level shift, as the slope of the regression line is parallel to the 45-degree line. This makes sense since the income estimator is joint income and not just earnings, as in the Scorecard. Also, the correlation is about 0.7. The right panel shows colleges where at least 80 percent of students enrolled appear in the College Board data. We see the correlation jump to almost 0.8 but the slope of the line changes. We observe similar patterns in Figure B2, which performs the same exercise for students 10 years since initial enrollment.

In Figures not shown, we show similar figures to below for restricted subsamples and consistently find the same pattern of a level difference in income measures and not a slope shift. These include only using students who attended high school in Georgia from the TransUnion data (our main sample), only using low-income students in the TransUnion data, as measured by College Board parental income, who are likely to be represented in the College Scorecard, and both together. We also look at only Georgia colleges, separately for Georgia two-year colleges and four-year colleges, and separately for USGU universities and non-USGU public colleges in Georgia. We always see a level shift in income with the same slopes and it does not differ by type of students or types of colleges.

Overall, we view this as compelling evidence that TransUnion's income estimate contains accurate and valuable information about an individual's income.

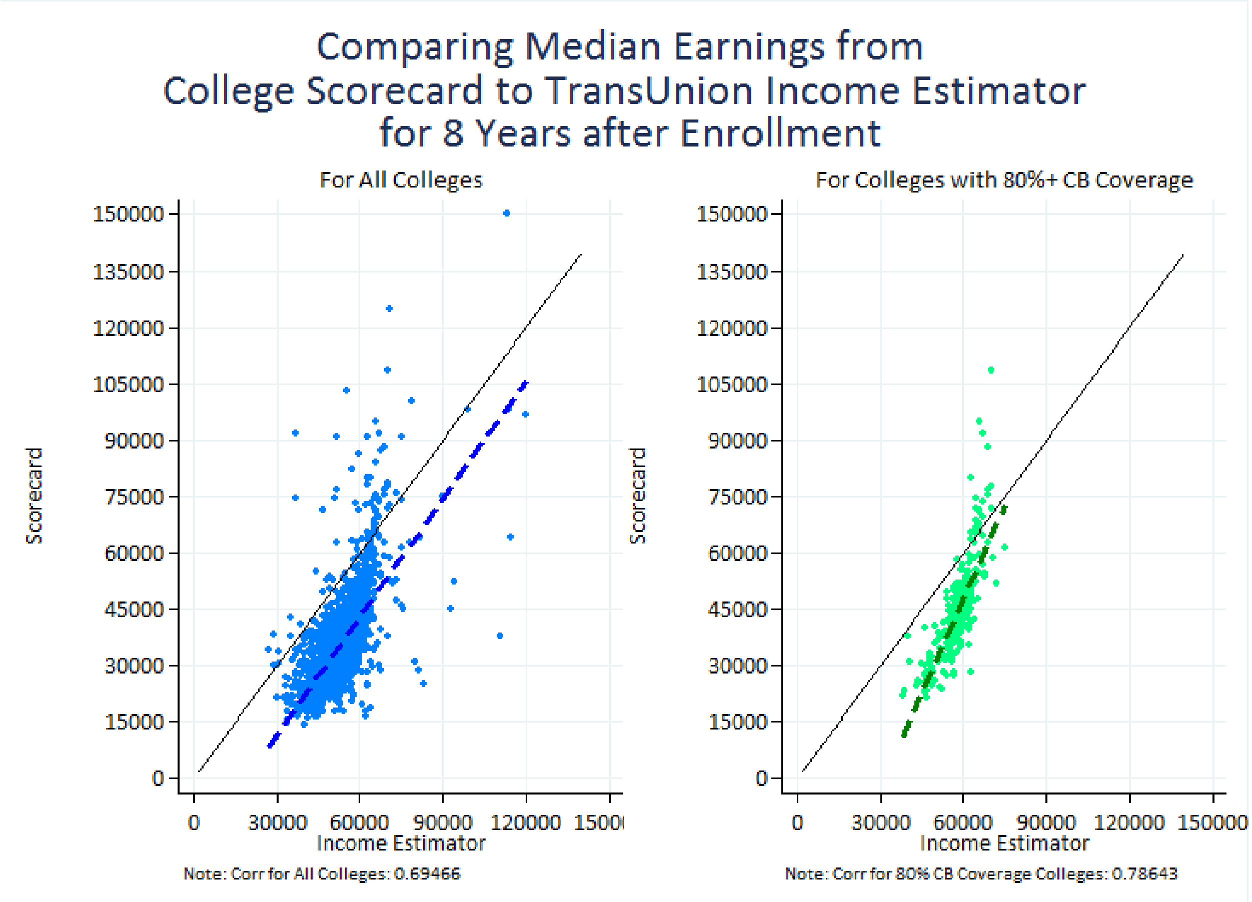
B.3. – Matching, Missingness, and Identification

Our primary specification in equation (1) relies on no strategic manipulation around the USGU admission threshold. One concern is that our matching with TransUnion data is somehow related to earning those admission relevant SAT scores. For example, perhaps earning a 430 on math and 400 on verbal improves college completion rates, which in turn increases the odds of opening credit cards, which creates a credit history. This could bias our results in unknown ways, depending on what type of person receives the credit history.

We formally test for such endogenous match rates in Appendix Table B1. To do so, we test whether there was a successful match with TU data for the full Georgia sample and all the subgroups we consider.

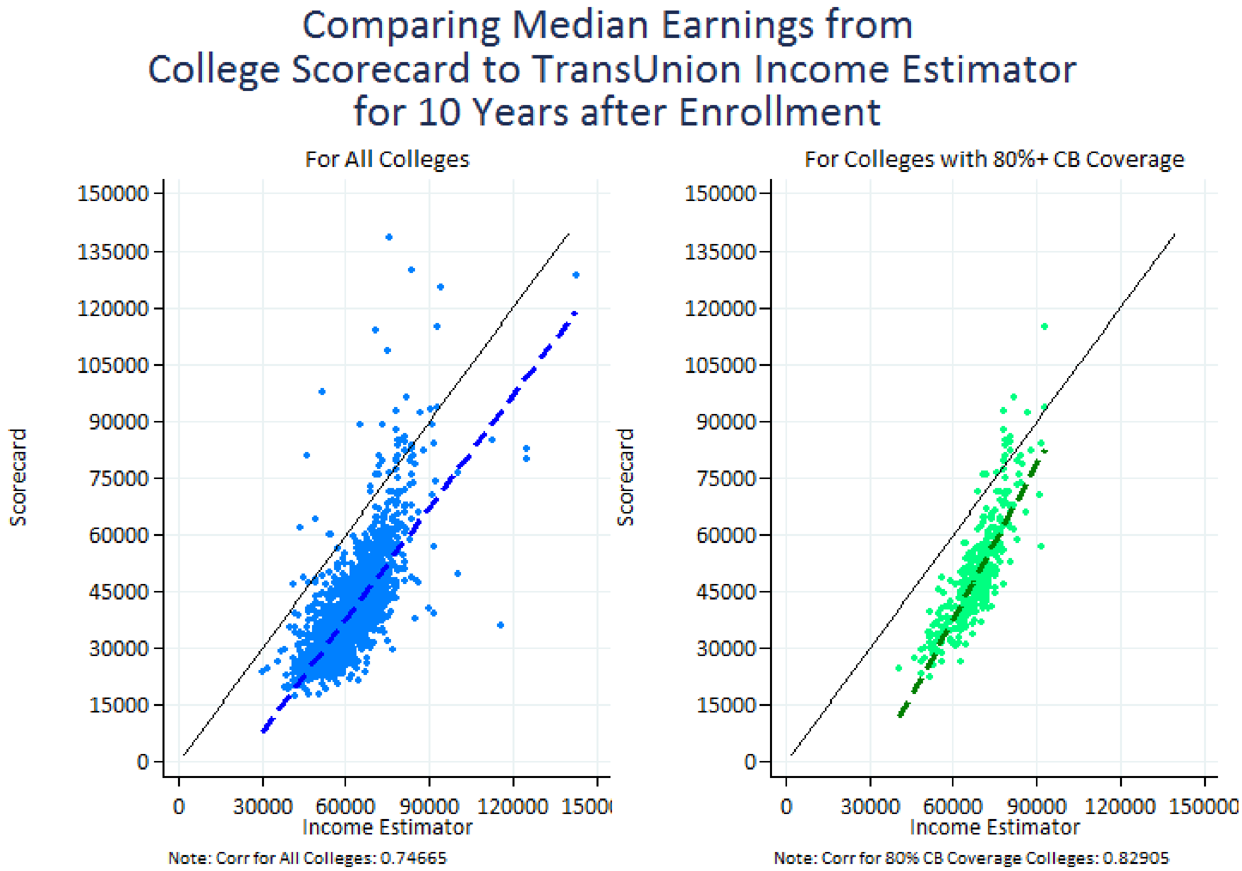
The table shows that we do not see a discontinuous match rate for students just above the USGU admission threshold, regardless of subgroup. We take this as evidence that our identification strategy is not threatened by the matching process.

Figure B1



Notes: Scorecard data are from the College Scorecard aggregated data at the college-year level, which is freely available online. CreditVision Income Estimator comes from TransUnion credit bureau. It is merged to individual-level data and aggregated to the college-year level.

Figure B2



Notes: Scorecard data are from the College Scorecard aggregated data at the college-year level, which is freely available online. CreditVision Income Estimator comes from TransUnion credit bureau. It is merged to individual-level data and aggregated to the college-year level.

Appendix Table B1 - Matching College Board to Financial Outcome Dataset

	All SAT Takers	*All Late SAT Takers*	*Low-Income High School*	*Non-Low-Income High School*	*Underrepresented Minority*	*Non-Underrepresented Minority*
	Matched to Financial Outcome Data					
Access	-0.001	0.001	-0.000	0.001	0.002	-0.001
	(0.001)	(0.003)	(0.004)	(0.003)	(0.004)	(0.003)
Observations	139,921	70,404	32,689	37,715	30,253	40,151
	Matched to Financial Outcome Data, with Controls					
Access	-0.001	0.001	-0.000	0.001	0.002	-0.001
	(0.001)	(0.003)	(0.004)	(0.003)	(0.004)	(0.003)
Observations	139,921	70,404	32,689	37,715	30,253	40,151
	Matched to Financial Outcome Data and Valid Income Measure					
Access	-0.000	0.002	0.006	-0.003	0.002	0.001
	(0.001)	(0.002)	(0.004)	(0.003)	(0.004)	(0.002)
Observations	139,921	70,404	32,689	37,715	30,253	40,151
	Matched to Financial Outcome Data and Valid Income Measure, with Controls					
Access	-0.000	0.002	0.006	-0.003	0.002	0.001
	(0.001)	(0.002)	(0.004)	(0.003)	(0.004)	(0.002)
Observations	139,921	70,404	32,689	37,715	30,253	40,151

Notes: Standard errors are clustered by distance from USGU minimum and shown in parentheses. *** p<0.01, ** p<0.05, * p<0.1. A bandwidth of 60 SAT points is used. All analyses control for distance to USGU minimum (and interaction with whether above threshold), sex, URM status, whether in low-income high school, and year fixed effects. Access equals one if student verbal SAT score is at least 430 and math SAT score is at least 400, otherwise it equals zero. Low-income high schools have an average self-reported parental income in the bottom tercile.