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Policies and Payoffs to Addressing America's College Graduation Deficit

Christopher Avery, Harvard Kennedy School
Jessica Howell, College Board
Matea Pender, College Board
Bruce Sacerdote, Dartmouth College

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POLICIES AND PAYOFFS TO ADDRESSING AMERICA'S COLLEGE GRADUATION DEFICIT

Christopher Avery
Harvard University and NBER
Christopher_Avery@hks.harvard.edu

Jessica Howell
The College Board
jhowell@collegeboard.org

Matea Pender
The College Board
mpender@collegeboard.org

Bruce Sacerdote*
Dartmouth College and NBER
bruce.sacerdote@dartmouth.edu

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Abstract

We consider four distinct policy levers available to states for raising bachelor's degree completion rates in the U.S. through their public colleges and universities. We simulate these policies using elasticities from the existing literature and a matched College Board-National Student Clearinghouse dataset on enrollment and degree completion. Increasing spending at public college and targeted elimination of tuition and fees at four-year public colleges with an income cutoff are projected to be the most effective of these policies in terms of cost per additional BA degree. Reducing tuition and fees at public colleges and a distinct policy of moving students to the best available in-state public college (BISPO) are next best on a cost-benefit basis. Free community college policies are significantly less cost effective. While reducing community college tuition and fees to zero does lead to more Associates degrees, some students are drawn away from the four-year sector in the process. Low-income students see the smallest gains from free community college policies since these students already face very low net prices of attendance.

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*Corresponding author: Department of Economics, Dartmouth College, 6106 Rockefeller, Hanover NH 03755. bruce.sacerdote@dartmouth.edu. Jaclyn Eagle and Carolyn Zhou provided outstanding research assistance. We are grateful to the National Science Foundation for generous support.

I. Introduction

Despite the substantial economic returns to completing a college degree, the United States is situated in the middle of the pack within OECD countries for the fraction of high school students who complete a four-year college degree.[1] Most of the gap between the U.S. and the leading countries stems not from a failure of U.S. students to enter postsecondary education, but rather from the high number of U.S. students who enter college or university who do not complete a four-year degree. We focus on the role of public colleges in promoting or inhibiting college completion in the United States because of their substantial market share: 44% of students enrolled in college attend four-year public colleges, while approximately three-quarters of students attend either public two-year or four-year colleges.[2] Nearly 15 million students are enrolled in public colleges in the U.S., yet there are three distinct constraints that limit the impact of public colleges in helping these students achieve their degree completion goals.

First, funding plans for public colleges have shifted over time to emphasize tuition revenues rather than state support in the form of public subsidies. For two decades or more the average levels of tuition and fees at public colleges have increased at rates that outpace inflation and that also outpace increases at private colleges.[3] Although government funding has generally increased over time as well, the net cost of public colleges has also increased over time, and this increase in net cost has likely contributed to the contemporaneous increase in student loans.[4] Students from low-income backgrounds have been typically been underrepresented at selective public colleges, even after accounting for correlation between income and academic qualifications.[5] Although the vast majority of low-income students pay less than $5,000 per year in tuition and fees at public institutions[6], recent evidence suggests it is an economic hardship for Pell Grant eligible students to attend most public flagship universities.[7]

A second potential limitation of public colleges is that students at public institutions take longer, on average, to complete degrees and also complete bachelor's degrees at lower rates than students at comparable private

[1] See https://data.oecd.org/eduatt/graduation-rate.htm#indicator-chart.
[2] Digest of Education Statistics, Table 303.25. For-profit institutions have been the focus of many media stories and policy debates, yet less than 1% of the students in the data set we use for this study enroll at for-profit colleges.
[3] Trends in College Pricing, Figure 4B.
[4] Trends in College Pricing, Figures 8 and 9.
[5] See, for example, Pallais and Turner (2006).
[6] Trends in College Pricing, Figure 11.
[7] See http://www.collegeaccess.org/affordability.

colleges. The average time to degree for those completing a bachelor's degree is 4.6 years at public colleges compared to 4.2 years at private colleges.[8] One possible explanation for these differentials is that per student instructional spending is lower, on average, at public colleges than at comparable private colleges. In part, this may be a lingering after effect of the financial crisis; almost all states cut funding to public colleges in 2008 or shortly thereafter, and very few states have wholly restored those funding levels.[9]

Finally, there may be structural differences in the supply of public colleges and universities across states that impact student choices and postsecondary outcomes. Since students are broadly tied to in-state public colleges, students who reside in states with relatively small populations often do not have access to an in-state public college that matches their academic qualifications. Hillman and Weichman (2016) expand this observation to the local level, noting that 57.4% of freshman attending public four-year colleges travel less than 50 miles from home to college. In many states, the supply of seats in four-year public colleges is less than the number of students with sufficient academic credentials for admission, further exacerbating the matching process for students who hope to stay closer to home and pay in-state tuition. The inevitable result of this imbalance between supply and demand at the state level is "undermatching", as defined by Smith, Pender and Howell (2013) to occur "when a student's academic credentials permit them access to a college or university that is more selective than the postsecondary alternative they actually choose." Undermatching has been linked to lower rates of degree completion, particularly among students from underresourced backgrounds.[10]

In this paper, we consider policies designed to address each of these constraints, which could be used to boost bachelor's completion rates at public colleges. We simulate the effects of four separate policies: (1) eliminating tuition for two-year public colleges (aligned to free community college proposals that have gained considerable prominence in recent policy discussions); (2) reducing tuition at all public four-year colleges; (3) increasing funding for public four-year institutions to reduce the gap in spending between the otherwise comparable public and private colleges in the same state; and (4) eliminating undermatching by relaxing institutional capacity constraints so that it is possible for all currently undermatched students to

[8] Authors calculations from results provided by Shapiro et al. (2017)..

[9] See https://www.cbpp.org/research/a-lost-decade-in-higher-education-funding-state-cuts-have-driven-up-tuition-and-reduced It is also possible that selection of students into the public vs. private sector may account for some portion of these differences in graduation rates and time to completion; we conducted exploratory regression analysis of graduation rates (with a single college as the unit of observation) and continued to find large and significant differences in graduation rates after controlling for observable differences in the average characteristics of students enrolling at public vs. private colleges

[10] See for example, Bowen, Chingos, and McPherson (2009); Roderick et al. (2008); Smith, Pender, and Howell (2013).

attend the Best In-State Public Option (BISPO) to which they could be admitted. We consider two versions of the BISPO policy, one where all undermatched students are moved to more appropriate four-year colleges, and another, likely more realistic, where we assume that colleges face supply constraints and may not be able to accommodate the number of new students required to eliminate undermatching.

We compare the efficacy of these four policy changes using the primary metric of projected expenditure per additional bachelor's degree since the policies vary considerably in cost. This summer, two states have taken well publicized stands related to our simulations: Illinois launched "Illinois Commitment", which covers the cost of tuition and fees at the flagship state public university, University of Illinois, for students from families with less than $61,000 in income.[11] By contrast, the state of Alaska enacted a new budget that cuts funding to its university system by more than 40%; after subsequent negotiations, the state agreed to reduce the budget cuts by half and to spread them over three years.

We evaluate the four different policy changes using micro-level simulations using data on PSAT- and SAT-takers who graduated from high school in the spring of 2007. In our simulations, students respond to the differing policies by potentially changing educational sector (i.e., not enrolled, two-year public, four-year public, etc.), potentially changing institutions, and potentially changing the likelihood of obtaining associate's and bachelor's degrees. To capture these student level responses, we use micro-elasticities taken from the literature. Our key elasticities include parameters that describe the enrollment and graduation responses to free community college policies, to tuition cuts, and to increases in per student spending.

These policy changes have potentially important macroeconomic implications because two of the important challenges facing the U.S. economy are relatively stagnant levels of GDP and productivity growth in combination with inequality in how the distribution of gains (Pikkety and Saez (2014)). Since 2010, real GDP per capita growth has averaged 2.3 percent (authors calculations from BEA data via FRED), which is meaningfully less than the 3.0+ plus growth of earlier decades. Of greater concern are the facts that median household incomes and mean wages have both growth by less than 1% per year since 1985 (Shambaugh et al. 2017, Sacerdote 2017).[12] Investments in human capital, and in college degrees in particular, are among the most likely ways to create income growth (Goldin and Katz (2018),

[11] https://osfa.illinois.edu/types-of-aid/other-aid/illinois-commitment/

[12] Measurement of inflation (Broad and Weinstein 2008, Costa 2001), transfers (Meyer and Sullivan 2009) and of household size (Aguiar and Bils 2015) makes a big difference to this conclusion but doesn't necessarily overturn it.

Oreopoulos and Petronijevic (2014), Dynarski (2008)). There is considerable debate about whether returns to college measured at the micro level have relevance for macroeconomics (see for example Bils and Klenow (2000), Barro and Sala I Martin (1995)), but it is at least plausible that increases in BA completion rates could increase growth at the national level.[13]

The paper proceeds as follows. Section 2 expands on the points raised in this introduction to present a detailed set of stylized facts about public colleges. Section 3 reviews past literature, emphasizing studies that are relevant to the four policy simulations we conduct. Section 4 provides details of the data used in our simulation analysis. Section 5 provides technical details of the simulation. Section 6 reports our results. Section 7 concludes.

[13] Observational data suggests a clear positive correlation between educational attainment and many positive attributes connected to growth. More educated people are healthier, less likely to be on public assistance, more engaged in civic activities, and more likely to promote education in the next generation. See Tables 2.12 to 2.23 of "Education Pays". https://trends.collegeboard.org/sites/default/files/education-pays-2016-full-report.pdf.

II. Key Facts

FACT 1: The United States has a problematic college graduation rate.

As shown in Figure 1, the proportion of 25 to 29-year olds in the U.S. who have completed college degrees has grown steadily but somewhat slowly over time. In the March 1995 Current Population Survey, 24.7% of 25 to 29-year olds had completed a bachelor's degree and 33.0% completed either an associate's or a bachelor's degree. Two decades later, in the March 2017 Current Population Survey, these numbers had increased, as 35.7% of 25 to 29-year olds had completed a bachelor's degree and 46.1% had completed either an associate's or bachelor's degree.

Figure 2 illustrates similar increases in college enrollment for recent high school graduates over time. In 1975, only about half of those graduating from high school enrolled in college; today, approximately 70% of high school graduates go on to either a two-year or four-year college. Although enrollment in two-year colleges has fallen somewhat since the end of the financial crisis, enrollment in US four-year colleges is presently at an all-time high and nearly half (46.0%) of students enroll in a four-year college in the year after high school graduation.[14] But, as these numbers indicate, only about half of recent high school graduates who go on directly to college complete a BA degree and approximately one third of them do not complete either an AA degree or a BA degree within six years of high school graduation.

FACT 2. Public Colleges serve the Majority of Students

While private colleges outnumber public colleges, especially in popular rankings and lists of the most selective institutions, public colleges are important because they serve as the default option for most high school graduates. Figure 3 documents the distribution of current college students by control (public, private not-for-profit, for-profit) and level (two-year or four-year). Nearly three-quarters of all college students are enrolled in public institutions with 44% enrolled in public four-year colleges and 29% enrolled in public two-year colleges. By contrast, only 20% of college students attend private four-year colleges and less than 1% of them attend a private two-year college.

[14] Digest of Education Statistics, Table 302.10

We provide further descriptive statistics using data from the College Board database, noting that the units in Figure 4 are not directly comparable to the units in Figure 3 because Figure 4 also includes high school graduates who do not enroll in college. As shown in Figure 4, approximately half of students with combined Math and Verbal SAT scores between 1000 and 1390 enroll in public four-year colleges. Enrollment in private four-year college is highly correlated with standardized test scores. More than half of the high school graduates in the right tail of the distribution with combined PSAT/SAT scores from 1400 to 1600 enroll in private four-year colleges.

Figures 5a and 5b compare the enrollment patterns by SAT score for students from families with incomes below $40,000 and students with family income above $100,000. Perhaps surprisingly, there does not appear to be very much difference in the enrollment rates in public four-year colleges for high-income vs. low-income students by PSAT/SAT category. In each subgroup, for example, approximately half of students with combined Math and Verbal PSAT/SAT scores between 1000 and 1390 enroll in public four-year colleges. One important difference in enrollment patterns is that a much larger proportion of low-income students enroll in public 2-year or do not enroll in college compared to high-income students (except perhaps for students at the very top of the SAT distribution).

FACT 3. Graduation Rates are Lower at Public than at Private Colleges

One concern about public colleges is that their graduation rates are lower than those at private colleges.[15] Figure 6 shows the six-year graduation rates by range of PSAT/SAT score for individual students in the high school graduating class of 2007. In the lower ranges of SAT scores, high-income students have the highest six-year BA completion rates, with little difference between the graduation rates for those at private vs. public four-year colleges. In the middle ranges of SAT scores, from 1000-1090 to 1300-1390, where Figure 4 shows that approximately half of students enroll in public four-year colleges, graduation rates for private and public colleges gradually diverge. For the right-most columns, low-income students enrolled at private four-year colleges actually have higher graduation rates than high-income students enrolled at

[15] https://nces.ed.gov/programs/digest/d17/tables/dt17_326.10.asp

public four-year colleges. Figure 6 also illustrates a striking differential between BA completion rates for students enrolling at two-year vs. four-year colleges within each SAT category.[16]

FACT 4. Graduation Rates are Particularly Low at Two-Year Public Colleges

Less than 25% of recent high school graduates who enroll in two-year public colleges complete an AA degree within three years. By contrast, approximately 60% of high school graduates who enroll in two-year private colleges complete an AA degree within three years.[17] (The private two-year sector is quite small, covering only about 1% of recent high school graduates.) A total of 37.5% of recent high school graduates who enroll in two-year college complete a degree within six years of high school graduation, with 14.7% of them completing BA degrees in that time. The average length of time to completion of first degree for those starting at a two-year public college is not very different from those starting at a four-year public college.[18]

FACT 5: Public Colleges have increased in price over time.

If higher education is to be the engine of social mobility, it is critical for public colleges to be affordable for all students. One challenge to this ideal is the fact that tuition and fees have been steadily rising at all institutions, but especially at public institutions. In constant 2018 dollars, tuition and fees at four-year public colleges more than doubled from $3,690 in 1990-1991 to $10,230 in 2018-2019, corresponding to an annual rate of increase more than 4% above and beyond the rate of inflation. In comparison, tuition and fees at four-year private and two-year public colleges also increased steadily, but at a lower rate (between 2% and 3% per year) above and beyond the rate of inflation. Of course, it is important to consider not just sticker prices but net price. Using its annual survey of institutions, the College Board shows that "Net Tuition Room Board and Fees" at four-year public colleges has risen from $8,850 in 1998 to $14,880 in 2018 (all in 2018 dollars).[19]

[16] The positive outcome reported in Figure 6 is 6-year BA degree completion from first college for students who initially enroll at a 4-year college, while for other students, the positive outcome is completion at any of the 4-year colleges that NSC tracks. So this measure is skewed, if anything, towards underestimating the difference in BA completion rates for those starting at a four-year college by comparison to students in the same SAT category who start at a two-year college.
[17] Digest of Education Statistics Table 326.20
[18] Authors' calculations based on data from Appendix C of Shapiro et al. (2017) (NSC Signature Report).
[19] "Trends in College Pricing," Figure 9.

FACT 6: Enrollment in Public Colleges has expanded over time, but could expand even more

Two phenomena have led to increased absolute enrollment of recent high school graduates over time. First, after a brief decline after the end of the baby boom, the number of high school graduates has been increasing steadily from about 2.3 to 2.5 million per year in the early 1990s to above 2.8 to 3.2 million students per year from 2010 to 2016. (Digest of Education Statistics) Second, as shown in Figure 2, the proportion of high school graduates enrolling in college has increased to nearly 70% in recent years. To accommodate these increases in demand, some new colleges have opened and many existing colleges, especially public colleges, have expanded their class sizes (Kelly, 2017).

These recent trends indicate that the capacity of seats for entering freshman at many colleges is somewhat fluid and makes it difficult to pinpoint a specific capacity constraint at (say) public four-year colleges at any given point in time. At any moment in time, there are substantially more students who graduate from high school each year with the academic qualifications for colleges of a given level of selectivity than the number who actually enroll at a college at least that selective. It is not clear, however, whether this apparent discrepancy in numbers indicates limited supply or limited demand for seats at four-year public colleges. Geographic constraints may also be important to this discussion. Due to considerations of critical mass, the nearest public college to many households is a two-year public rather than a four-year public college. Similarly, since there is only one flagship public college per state, some households are located closer to a different four-year public college than to the flagship public college. Thus, the predilection for many students to choose a college that is proximate to their high school, provides a systemic reason for a certain amount of undermatching.

The top panel of Figure 7 shows that a small number of SAT-taking states, notably California, Texas, New York and Florida, stand out in the number of undermatched students, though as shown in the bottom panel, those states do not especially stand out in terms of the percentage of undermatched students. . Interestingly, these states are often lauded for the breadth and strength of their public college systems – in particular, their flagship public colleges are generally competitive with highly selective private colleges, meaning that even high-achieving students in these states tend to have a matched college option. In California, constraints on in-state enrollment are fairly explicit, and are closely tied to negotiations over year-by-year state budgets.

In the UC system, for instance, some colleges systematically respond to negative budget shocks by reducing the number of seats for in-state students in the next year's class.[20] The California State University (CSU) system has created a new designation of an "impacted" campus, as described on its website for prospective students:

> *As you get ready to apply to the CSU, you may find that a campus or undergraduate major you're considering is "impacted," meaning there are more applications from qualified applicants than there are available spaces.*[21]

Six CSU institutions (Cal Poly San Luis Obispo, Fresno State, CSU Fullerton, CSU Long Beach, San Diego State and San Jose State) are impacted at the campus level.

FACT 7: The Cost-Benefit tradeoff for marginal college students is unclear

The wage premium for a BA degree has always been sufficient to make college an appealing financial investment – at least for those who are relatively likely to complete the degree (Avery and Turner, 2012, see also Zimmerman (2014) and Goodman, Hurwitz, and Smith (2017) for causal estimates of the value of enrolling at a four-year rather than a two-year public college).[22] The cost-benefit computation for today's marginal college student, who might enroll at a two-year public college or at non-selective or less-selective four-year college, is not so clear (Athreya and Eberly, 2018; see also Benson et al. (2015)). The tradeoff between enrolling in college or entering the workforce may well turn on potential differences between marginal and average completion rates (see, for example, Denning (2017)) and the wage gains from magnitude of gains for attending "some college", which is still in question in the recent literature (Kane and Rouse (1995), Reynolds (2015), Mountjoy (2018)). Further, an expected value calculation downplays the costs of a negative outcome, as students who do not complete college are several times more likely to default on student loans than those who do complete degrees (Baum, 2016), and there may be long-lasting effects on consumption for in general for those who enroll in college but do not complete a degree (Athreya and Eberly, 2018). Given these considerations, it seems much more plausible to attempt to increase BA completion rates with policies that target increases in completion rates for inframarginal college students rather than with policies that attempt to increase college enrollment.

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[20] See, for example, https://edsource.org/2015/uc-aiming-to-add-10000-more-in-state-undergrad-students-by-2018/90321
[21] https://www2.calstate.edu/attend/impaction-at-the-csu
[22] See "Education Pays" (especially Figure 2.2), for more recent estimates of average wages by postsecondary attainment (https://trends.collegeboard.org/sites/default/files/education-pays-2016-full-report.pdf).

III. Related Literature

The twin phenomena that many students begin college but do not graduate and that well less than half of adults in the US have a BA degree have been the object of study in the academic literature for quite some time. Turner (2004), Bound, Lovenheim, and Turner (2010), and Bowen, Chingos, and McPherson (2011) documented the fact that aggregate college completion rates were low and apparently stagnating. Denning (2019) observes that college completion rates have increased, though not dramatically, in recent years.

One specific strand of related literature focuses on the connection between college costs and college enrollment as well as completion. Dynarski (2000) and Cornwell, Mustard and Sridhar (2006) found positive effects of the Georgia HOPE (merit) scholarship on college enrollment. Dynarski (2008) expanded this analysis to other state merit aid programs, estimating that these programs increase both college enrollment and completion, with effects being particularly strong for women. Many papers consider the effect of other policies that changed college prices or aid levels, typically finding a positive and significant effect on college enrollment (see, for example, Dynarski 2003, Denning 2017).

A growing set of more recent studies use regression discontinuity strategies demonstrate a formal link between financial aid and college persistence and completion. Bettinger et al. (2019) study the impacts of the California Cal Grant using discontinuities in program eligibility at high school GPA and income thresholds, finding that Cal Grant eligibility raises B.A. attainment by 3-4 percentage points. Scott-Clayton (2011) examines the West Virginal Promise Scholarship and uses ACT score thresholds to calculate the scholarship's impact. She finds that Promise receipt raises four year B.A. completion by 6-7 percent. Scott-Clayton and Zafar (2016) find that the West Virginia PROMISE scholarship impacts earnings, though in this study effects on college graduation fade out as a cohort progresses through college. Castleman and Long (2016) find a positive and significant effect of the Florida Student Access Grant on both enrollment and completion; their analysis is distinct because the eligibility for the program was determined by a cutoff in Expected Family Contribution rather than academic attainment.

A second specific strand of related literature considers unequal outcomes by demographic background. Ellwood and Kane (2001) provided descriptive evidence to suggest that family income and academic achievement in high school were broadly equivalent predictors of college enrollment. Roderick et al. (2008) and Bowen, Chingos, and McPherson (2009) introduced the concept of "undermatching", finding that low-income students are disproportionately likely not to enroll at one of the most selective colleges where they

would likely be admitted. (see Smith, Pender, and Howell (2013) and Dillon and Smith (2017) for assessments of the prevalence of undermatch at the national level). Hoxby and Avery (2013) noted that many high-achieving, low-income students do not apply to the most selective schools. Hoxby and Turner (2013) followed this work by testing an intervention designed to widen the choice set of these low-income high-achieving students and potentially lead to better matches between students and schools.

A growing set of recent studies find a causal link between undermatching and graduation: a quasi-randomly assigned student tends to adopt the graduation rate of her assigned college. Zimmerman (2014) and Goodman, Hurwitz, and Smith (2014) use regression discontinuity methods to compare the effects of college choice on students at the margin of two-year vs. four-year college enrollment, finding large positive effects of four-year colleges by comparison to two-year colleges in promoting degree completion.

A different set of studies find positive effects of attending a more selective four-year college rather than a less selective one. Hoekstra (2009) shows that students just over the margin of admission to a flagship four-year public have earnings that are 20% greater than the earnings of similar students who just missed admission. In contrast, Cohodes and Goodman (2014) study students induced to attend an in-state public by winning Massachusetts' Adams Scholarship. These students adopt the lower graduation of the MA public relative to the more selective privates attended by students who just missed eligibility for the Adams Scholarship. Using a regression discontinuity in high school GPA to qualify to participate in the Bottom Line after-school guidance program, Castleman and Goodman (2014) and Barr and Castleman (2017) find that students counseled to apply to a set of selective four-year institutions have higher persistence than peers who did not receive the counseling.

A third strand of the literature considers the effects of state funding for public colleges on students. Bound et al. (2019a) find that public colleges respond to reductions in state appropriations by increasing the share of out-of-state students, particularly international students, if possible. As a result, the most selective public four-year institutions are implicitly insured against funding declines, but a perhaps unanticipated consequence of these funding cuts is a reduction in the proportion of in-state students at those institutions. Less selective public universities have diminished capacity to increase tuition revenue, so those colleges tend to reduce student services in response to funding cuts. Deming and Walters (2017) and Bound et al. (2019) conclude that reductions in state funding lead to reductions in graduation rates at public colleges; Chakrabarti et al. (2018) find that reductions in state funding lead to significant reductions in measures of

student financial success beyond age 30. Deming and Walters particularly find that spending on student support is linked to increased graduation rates (see also Clotfelter, Hemelt, and Ladd (2018) and Evans et al. (2017) for related evidence that one-on-one guidance, academic or otherwise, can promote college completion).

Several previous studies have conducted analyses related to the simulations we carry out below. Dynarski (2008) and Denning, Marx, and Turner (2019) estimate the social welfare effects of increases in grant aid (see Deming (2017) for a detailed proposal for a dramatically expanded federal college grant program). Chingos (2012) and Pender and Howell (2016) simulate the effects of changes in enrollment across campuses to address undermatching of low-income students. Chingos takes the supply of college seats as fixed, so the reallocation of some low-income students to more selective colleges in that simulation requires a corresponding reallocation of other students to less selective college; it is not surprising that this approach is estimated to produce only second-order effects on BA completion. Pender and Howell (2016) is the only one of these papers to conduct a simulation based on individual-level data. As in our simulations related to undermatching, Pender and Howell allow for expansion of seats at both public and private four-year colleges, but their analysis is primarily limited to undermatching and reallocation of low-income students to more selective colleges. Mayer et al. (2015) conduct randomized evaluations of six different performance based scholarship (PBS) programs targeted to low income students, estimating that these programs increase completion rates by 3.3 percentage points on average.

IV. Data Description and Empirical Approach

The data come from a comprehensive merge of College Board data with National Student Clearinghouse data. Our study uses the entire 2007 cohort of students who took the SAT or PSAT (2.3 million students); this was the most recent cohort for which six-year graduation data was available at the time that we started this project.[23] We do not have data from the ACT, and note that our sample is primarily applicable for states where the SAT is the most common college entrance exam. To the degree that there are differences in dynamics across regions of the country, our results are least applicable to the Midwest and states in the Deep South where the ACT is predominant.

Information on student demographic characteristics including race/ethnicity, gender, family income, and parent's education comes from the Student Descriptive Questionnaire (SDQ), completed by students when they register for the SAT. We have self-reported information about family income for about 40% of the students in the sample (we are missing this information for students who only took the PSAT and for students who took the SAT but omitted to answer this question). We use the method described in Howell and Pender (2016) (see Appendix A of this paper for details) to impute family income for the remaining students in the sample.

The National Student Clearinghouse (NSC) collects data from 3,600 participating colleges and universities, which represent 98 percent of enrolled students across the country. The NSC tracks individual students through their postsecondary education career. Participating institutions provide the NSC with student-level data on enrollment by semester, graduation date, degree earned, and duration of studies. We focus our analysis on those students who enroll in a public two-year, public four-year, or private nonprofit four-year college within six months of graduating from high school. Our main indicator for college graduation is the B.A. attainment within six years.[24]

Institutional net price data are from the Integrated Postsecondary Data System (IPEDS). For each of the "undermatched" students in our data set we estimate net price at both the chosen institution and the re-

[23] The sample includes PSAT/SAT takers in 2007 high school graduating cohort who enrolled in public or private nonprofit colleges on-time (within 180 days of graduating from high school) and have income data. We calculate predicted SAT score for students who only took PSAT. We do this by finding average SAT by PSAT bins (each section separately) for students who took both PSAT and SAT.

[24] Six-year bachelor's degree completion rate from first institution attended is calculated among students who first enrolled in a 4-year sector. Otherwise, for students who first enrolled in a 2-year sector, NSC tracks bachelor's degree completion at first four institutions a student attended.

matched institution. The IPEDS data provide institution-level information on the average SAT scores of students entering college in 2007-08 and instructional and total spending per student. We use these to estimate the total costs (i.e., state, federal and student) of moving a student from college A (an academic undermatch) to college B (an academic match).

Table 1 contains basic summary statistics on our sample. The sample is 45% male, 11% black and 11% Hispanic. Sixteen percent of the students are from families with income of less than $40,000 per year. Average SAT score in the sample is 1029.[25]

Table 2 provides summary statistics on students' initial college enrollment choice. Sixteen percent of students are undermatched, meaning the student has an SAT score percentile more than 15 percentile points greater than the average score percentile of students at the college in which they enroll. Fourteen percent of students enroll at a safety school, meaning a school with an average score within the band 5 to 15 percentile points below the student's own score. Academic match schools are those with an average SAT score that is within plus or minus 5 percentile points of the students own score. Reach schools are those that have average SATs more than 5 percentile points above the student's score. Roughly 78 percent of students enroll in state and 76 percent enroll at a public two or four-year college. Twenty six percent of enrollments are at two-year colleges.

[25] The College Board redesigned the SAT and PSAT assessments in 2015. Our sample includes students who took these assessments prior to the substantial redesign.

V. Methodology

We conduct four different simulations of policy changes designed to promote BA completion at public colleges. Two of these policies are tied to absolute goals and necessarily have different total (or per-student) costs: (1) eliminating tuition at two-year colleges; (2) ensuring sufficient supply of seats at selective public colleges to eliminate undermatching within a state. The other two policies – (3) reducing tuition and (4) increasing funding for academic support – could be calibrated to match the cost of any other policy. Since the first two policies are not equal in costs, we choose round number targets for the reduction in tuition and separately for the increase in funding in our simulations. We use cost-benefit ratios as the standard for comparison of the efficacies of these four policies.

Our primary goal is to produce a broad brush ranking of the four policy options to see if any policy seems to dramatically outperform or underperform the others. Since there are multiple sources of underlying uncertainty in each case, we do not attempt to produce confidence intervals for any of our cost-benefit measures.[26] Instead, we provide bounds in terms of underlying elasticities to provide context for assessing the magnitude of differences in our results – how much would our underlying elasticity values have to change for each pairwise cost-benefit comparison to reverse in order?

A. Identifying Elasticity Values

Each policy either changes enrollment patterns (directly or indirectly through changes in prices), improves graduation rates conditional on enrollment at a particular college, or both. Our simulations use a set of elasticities to quantify the separate effects of each aspect of these policies. We use recent empirical studies to guide our choices for these elasticity values. We summarize our modeling choices in this section; see the Appendix for more details about how and why we chose these particular values for the elasticities.

<u>Elasticities for Tuition Changes at the Two-Year Enrollment Margin</u>

Several states have eliminated tuition for two-year public colleges. While it is too early to assess the long-term effects of these policies, recent difference-in-difference analyses provide estimates of

[26] In our Monte Carlo simulations, draws in which elasticities are all set at the most extreme values in the literature imply massive high or low benefits to the policies. Thus, the confidence intervals on our estimated benefits are very wide until we are willing to home in on what we think are the most credible elasticity estimates in the literature.

enrollment effects of changes in price for two-year colleges in Oregon (Gurantz, 2019) and Tennessee (Carruthers 2019, Caruthers et al. 2018 and Tennessee Higher Education Commission 2019). We use the average implied elasticities from these two states to identify the price elasticities for enrollment at two margins: (1) four-year college vs. two-year public college; (2) no college vs. two-year public college.

Caruthers (2019) implies an elasticity of .265 for the movement of not enrolled students into the two-year public sector. Gurantz (2019) implies an elasticity of .135. We average these two numbers and use an elasticity of .20. To estimate the elasticity of four-year students to enroll in public two-year institutions with respect to the two year price, we again average results from the two studies and arrive at an elasticity of .075.[27]

Elasticities for Tuition Changes on Four-Year Enrollment

We consider a range of studies (Bettinger et al. (2019) [Cal Grant], Dynarski (2003) [Social Security Benefits], Castleman and Long (2016) [FSAG], Deming and Walters (2017), Scott Clayton (2011) [WV Promise]) to inform our choice of price elasticity of enrollment at the no-college / four-year public college margin. These studies are not precisely comparable; several of them study policies with eligibility requirements and so pertain to students with particular and distinct characteristics.

We summarize many of the papers in this literature in the appendix "Enrollment Coefficients". The modal finding in this literature is that $1000 in aid (translated to 2019 dollars) raises enrollment in four-year colleges by 2-3 percentage points. We took five of the most well-identified papers in the literature (the five listed above) and translated the findings into elasticities of enrollment with respect to price of between 0 and 9 percent; a 100% drop in the price of four-year publics increases enrollment by 0 to 9 percent of baseline enrollment. For example, Castleman and Long study a 57% tuition subsidy in Florida. This leads to increased four-year enrollment of 3.2 percentage points on a base of 61 percentage points. The implied elasticity of enrollment with respect to price is .32/.61 / .57 = .09. We use an elasticity of .07 for our simulations.

We use results from Bettinger et al. (2019) to identify the price elasticity of enrollment for switching from

[27] Technically we mean price elasticities of -.265, -.135, -20 etc. Most of the literature and our simulations are estimating the positive impacts of price reductions which is why we are reporting positive elasticities with respect to a price cut.

four-year privates to four-year publics in a response to a change in the relative price of the two. The logic is that Cal Grant eligibility is a large reduction in the relative cost of attending a private in-state school and the discontinuity in eligibility identifies the impact of that price change. We also considered the results of Cohodes and Goodman (2014), which finds a larger price elasticity at the four-year private / four-year public margin as well as Castleman and Long, which estimates a price elasticity close to zero at this enrollment margin. Results from the Cal Grant study imply a price elasticity of switching from four year private to four year public of .22 while results from the FSAG study imply a price elasticity of 0 and the Adams Scholarship evidence implies an elasticity of 1.45. We combine these estimates into our preferred elasticity of .50.

Elasticities for Price Changes on Completion Rates

Carruthers et al. (2018) estimate that eliminating community college tuition increased the completion rate for AA degrees by 1 percentage point for students in Knox County, TN on an Intent-to-Treat (ITT) basis; this estimate is drawn from their analysis of the results of Knox Achieves, the predecessor program to the state-wide program, Tennessee Promise, which is currently active. This is from a base of 4 percentage points of people earning an Associates and would imply an elasticity of .25. But most of this increase likely stems from the additional 5 percentage points of the cohort attending community college, as opposed to a price effect on graduation holding community college attendance constant. Denning (2017) finds an elasticity of 0 for the effect of community college tuition on Associates completion. For our simulations we use a modest elasticity of .05.

We use Bettinger et al. (2019) for our estimate of the elasticity of BA completion with respect to community college tuition for students already enrolled in community college. In the Online Appendix, Bettinger et al. (2019) find a 3 percentage point impact on bachelors attainment for students intending to enroll in community college at the time they file the Cal Grant application. The 3 percentage point effect averages across the income and GPA discontinuities studied. The Cal Grant is essentially a 100% price cut on all tuition and fees (both two- and four-year institutions across four years of funding). We assume that community college portion of the tuition cut represents only 10% of the total complete tuition cut that such BA bound community college students experience. Hence a community college tuition price cut

would have one-tenth the impact on BA attainment that the full Cal Grant program has for community college students. The 3 percentage point impact for the Cal Grant in BA completion is on a base of 36 percentage points. This implies an elasticity of BA completion with respect to community college tuition of (.03/.36)/10 = .008.

We use the overall estimated effect of the Cal Grant on BA completion rates – an increase of 4.6 or 3.0 percentage points across all sectors for an offer of a 100% reduction in price in any sector (again on an intent-to-treat basis) to estimate the change in BA completion rates conditional on enrollment.[28] Since the 3.0 and 4.6 percentage point graduation rate increases are on a base of 46 percentage points, this implies an average elasticity of graduation with respect to price of [(.03+.046)/(2*.46)]/ 1 = .08.

Elasticities for Funding/Spending Changes

We draw elasticities for the effect of changes in funding for public colleges from Deming and Walters (2017). This paper has among the most credible estimates to date of the effects from changes in spending at public colleges. The authors' instrument for spending per student using state budget shocks and legislated tuition caps and freezes.

We assume that changes in spending that result from increases in funding are concentrated in the most efficient use (academic support), as identified by Deming and Walters, for promoting BA completion. We use the spending/enrollment elasticities implied by the estimates from Tables 3 and 4 of that paper. Specifically, we use an enrollment elasticity of spending of 1.05 for two-year public and 0.66 for four-year public colleges,[29] and a degree completion elasticity of spending of 1.46 for associates degrees at two-year and 0.46 for BA degrees at four-year public colleges. Deming and Walters make the point that since these BA attainments are two years after the shock (as opposed to four or more years after), these elasticities likely represent the impacts of spending shocks on persistence and graduation for already enrolled students. This is exactly the elasticity we want for our simulation.

[28] Carruthers et al. (2018) estimate a negative net effect of Knox Achieves on BA completion, but do not attempt to disentangle the separate effects of (1) increased enrollment at two-year colleges, drawing students both from four-year college and non-college options; (2) the effect of the elimination of community college tuition on graduate rates for students. The elasticity values we use for BA completion rates are broadly consistent with their findings.

[29] These estimates may seem unexpectedly large given that students would likely have little information about funding and spending changes at public colleges. One possibility is that admissions officers respond to spending increases by accepting more applicants, perhaps surmising that the funding increase will allow the college to serve more students.

Effects of Educational Attainment on Income

We use a background value of 9% return per year of education; this estimate is within the range of 6% to 10% suggested by the review study of Gunderson and Oreopoulos (2010). We further assume that students who enroll but do not attain a particular degree complete 50% of the years of education required for the degree – 1 year for those enrolling at two-year colleges and 2 years of postsecondary education for those enrolling at four-year colleges.

B. Details of the Simulations

Our price or spending based policy simulations (free community college, increased spending at publics, and lower tuition at four-year publics) use three basic steps. 1) Students always start with their actual institutional choice and actual degree(s) earned. 2) We then add the relevant policy shock which lowers tuition and fees or increases spending. The shock leads each student to have some (modest) probability that they switch across educational sectors within their home state. A sector is defined as: not enrolled, two-year public, four-year public, four-year private.

For each student we estimate a probability of switching sectors. This estimate is the interaction of the general price elasticity for that switch (e.g., not enrolled to enrolled in two-year public) taken from the literature AND a student specific probability of choosing that sector. The latter comes from an OLS regression using our full data set and actual outcomes. For example, every student has her own predicted probability of choosing the two-year public sector given her state, family income, SAT scores, gender, race and age. The tuition elasticity for not enrolled students to switch to two-year publics is .20, which is the average elasticity estimated from the Oregon and Tennessee policies. This .20 estimate is then scaled up or down (in a mean preserving way) for each not enrolled student given her propensity to choose a public two-year.

The probability of BA or Associates attainment can vary for two reasons. First, each policy impacts graduation probability holding institution constant via lowering price (or raising spending). Second, each

policy can also impact Associates or Bachelor's attainment by altering the probability that a student is in a given sector.[30]

Each student has a probability (predicted value) that she obtains a bachelors (associates) given an educational sector. These predicted values come from OLS regressions in which we predict a student's outcome for each sector given her state, SAT scores, family income, race, age and gender.

We predict earnings for students at baseline and given the policy shock. We predict earnings conditional on choosing a given educational sector using an OLS regression and all student characteristics including home state. Baseline earnings are simply the medians from Chetty et al. (2017) who calculate median earnings for students who begin their educational career at a given institution (or no institution). These earnings are then modified in the simulation because sector may change under the new policy AND/OR graduation probability may change even given the original institution.

Given the probability of changing sectors and the new graduation probabilities (both at the old institution and the new sector), we can then calculate outcomes under the new policy. The outcomes are the probabilistic blend of the student's original outcome, which inherently gets the most weight, and the probability that she switches to a different sector, and her predicted outcomes for that new sector.[31] We also include the effects on attainment and earnings that stem from higher graduation probabilities holding institution/ sector constant.

When a student is changing sectors, she is assigned her estimated graduation probability and estimated earnings which are specific to her state, her test scores and demographics. For price and spending simulations (other than BISPO), we do not assign her to a specific new institution but rather give her the predicted outcomes which are a student specific amalgam across institutions she might attend within that sector.

A given policy shock can have very different price change implications for high versus low income students (or California versus Texas students). We estimate a student specific net cost of attendance at both the actual initial school choice and at a potential new choice of educational sector in response to a given policy

[30] We also include the second order effect that students can switch sectors and face the new (more favorable) price or spending per student regime in that sector.

[31] We assume that a student who originally attained a particular degree will attain at least that same degree if she does not change colleges as a result of a particular policy.

change. We perform this calculation using IPEDS data and the student's state and family income. For the initial institution chosen we use the average net price faced by students at that institution with the same family income. We use the IPEDS figure for that institution and family income category. For prices a student faces in other educational sectors (eg two year public , four year public) after the policy shock, we assume that the student faces the average net price (post policy shock) in the sector within her state and family income category. These average prices are weighted by the number of students in that state*sector*income category.

VI. Results

We produce a standard set of results in our simulations, focusing on cost per student, enrollment, degree completion, and projected median income. For each student we have the actual outcomes of institutional choice, graduation and expected earnings AND the simulated outcomes (under the policy shock) of sector choice, graduations, and expected earnings. We report the means for enrollments by sector (not enrolled, two year college, four year public college, four year private college), BA and AA attainment and median expected earnings.

A. Free Community College

We apply the elasticity values for enrollment at the two-year / four-year and the two-year / no college margins to simulate the effects of a policy that eliminates tuition at two-year public colleges. We maintain enrollments at specific colleges for students who do not change colleges as a result of this policy. We assign each student who is induced to choose a two-year public college by this policy to a (fictitious) college with the average characteristics of all two-year public colleges in that student's home state. There are three mechanisms by which this policy affects projected outcomes: (1) it increases degree completion probabilities (both associates and BA) for students who enrolled originally at two-year public colleges; (2) it induces some students who would not have enrolled to enroll at two-year public colleges; (3) it induces some students to switch from four-year to two-year colleges, thereby increasing their chances of competing an associate's degree, but reducing their changes of completing a BA.

As shown in Table 3, our simulation yields a 6.5 percentage point increase in enrollment at two-year colleges, from 27.5 to 34.0 percent of high school graduates, along with a corresponding 3.3 percentage point decrease in enrollment at four-year colleges. Since the net change in enrollment at four-year colleges is roughly half the magnitude of the net change in enrollment at two-year colleges, the number of students who move from four-year to two-year colleges is roughly equal to the number of student who move from no college to a two-year college in this simulation.

We project a BA completion rate of less than 10% for students who did not enroll in the baseline case and who are induced to enroll in a two-year college as a result of this policy. This relatively low completion rate reflects the fact that students at the margin between no college and two-year college tend to have less than average academic credentials. But we also project a reduction in BA completion rate of

approximately 40 percentage points for students induced to move from a four-year to a two-year public college as a result of the policy. Combining these effects, we find a net increase in the percentage of students completing an associates degree along with a slightly smaller reduction in the percentage of students completing a BA degree. In the full sample of students, these two effects roughly offset each other with regard to earning potential; we project minimal change in median income overall.

The cost per-year of this policy is relatively low ($566 per student enrolling in a two-year public college and approximately $200 per high school graduate) both because tuition levels are much lower in two-year than in four-year colleges and because students (e.g. those receiving Pell Grants) pay less than full tuition in any case.[32] As shown in the right panel of Table 3, we project little to no effect of the policy for low-income students, because those students typically qualify for Pell Grants and often already have zero net-cost for attending a two-year public college.

Since our sample consists of PSAT/SAT takers, it may tend to exclude less-academically oriented students who disproportionately opt out of taking either of these standardized tests.[33] For this reason, there could be an even greater absolute response to a free community college policy, especially from students who would not otherwise enroll in any college, than is indicated in our simulations. Nevertheless, the results of our simulations are qualitatively consistent with descriptive statistics provided in early analyses of Oregon and Tennessee Promise (Gurantz (2019); Carruthers, Fox, and Jepsen (2018)).

B. Reduced Tuition at Four-Year Colleges

We consider two policies that reduce tuition and fees at both two-year and four-year public colleges. The first is a 10 percent reduction in tuition and fees for all students. The second policy eliminates tuition and fees at four-year public colleges for students with family income less than $60,000; this second policy is inspired by Illinois Commitment, which uses a similar threshold but only includes the state flagship college (whereas our analysis considers a policy that extends to all in-state four-year public colleges). Reductions in tuition and fees at four-year public colleges affect long-term outcomes through two channels, first by improving graduation rates for students who enrolled in a four-year public college in the

[32] The free college policy that has been enacted in most states is a "last dollar" policy, whereby there is still a list price for enrolling in a public two-year college and the state covers only the remaining cost of attendance after accounting for all other sources of aid for a student.

[33] There are some states (e.g. Maine) where by state policy, all high school students take the SAT, but these states are not likely to be representative of the population of the U.S. as a whole.

baseline case, and second, by inducing some students to change plans and enroll in the four-year public sector. We assume that there is a single four-year public college option for students not already enrolling at a particular four-year public college; this single fictitious college has the average characteristics of the four-year public colleges in the state.[34] As a result, students face a price change in the four year sector that is specific to the student's state and income level.

As shown in Table 4a, our simulation of a 10% reduction in tuition and fees yields a 1.2 percentage point increase in enrollment at four-year public colleges and a 0.2 percentage point decrease in enrollment at two-year public colleges. The biggest projected effect on enrollment, however, is a shift of students from four-year private to four-year public colleges. The overall result is a modest increase of 0.3 percentage points in BA completion; one reason that this increase is not larger is that students induced to change from four-year private to four-year public colleges typically reduce their chances of graduation by doing so (Cohodes and Goodman (2014)). At the same time, the cost of the reduction in tuition and fees is not that large. As with the elimination of tuition at two-year colleges, the average cost per student affected by the change is not that large, on the order of $400 per year in 2007 dollars (less than $200 per year after averaging over all students).

As shown in Table 4b, our simulation of elimination of tuition and fees at four-year public colleges for students from families with income below $60,000 yields a 3.1 percentage point increase in enrollment at four-year public colleges and a 1.0 percentage point decrease in enrollment at two-year public colleges. We project that low income students (with family income less than $40,000) to exhibit a substantial response to this policy, with a 4.0 percentage point in increase in enrollment at four-year colleges, a 9.1 percentage point increase in enrollment at four-year public colleges and a net increase of 2.9 percentage points in BA completion. The result of the simulation is that about 10 percent of high school graduates would enroll in a four-year public college, with average cost (averaging over all students) of about $260 per year, a 30 to 40 percent increase over a universal reduction of 10 percent in tuition and fees.

C. Increased Spending at Public Colleges

[34] We made a specific choice not to assume that a student who moves into the four-year sector enrolls at the college that best matches her academic credentials, as this assumption would implicitly incorporate elements of the last policy that we consider – eliminating undermatching.

Our third policy is an increase in state funding. We first calculate the gap in spending per student between each public four-year institution and the average of the four-year privates in the same state. We then increase spending at each four-year public to remove 10 percent of the spending gap between that specific four-year public and the average of in-state privates. For community colleges we simply raise per student spending by 10 percent of that institution's spending.[35] We assume that the increase in funding is directed in the manner observed in historical analysis by Deming and Walters (2017). By definition, this policy increases completion rates for students conditional on enrollment at a particular college. It also induces movement both into college and across the two-year / four-year college margin; we do not know in advance how these changes affect degree completion rates.

As shown in Table 5, our simulation yields a 0.7 percentage point increase in enrollment at four-year colleges and a 0.4 percentage point decrease in enrollment at two-year public colleges. The policy primarily changes outcomes, however, by increasing completion rates at public colleges conditional on enrollment. The overall result is an increase of 1.1 percentage points in BA completion, combining the effects of students enrolling in two-year and four-year public colleges, as BA completion rates increase for students who enroll at any type of public college in response to this policy. The cost of the policy is approximately $350 per student, averaging over students who enroll in some college, and approximately $280 per student, averaging over all students in the sample.

D. Best Available In-State Public College (BISPO)

Our last policy is a reallocation of students who are currently "undermatched" to an academically matched in-state four-year public college. We refer to this policy as BISPO using the acronym for "Best Available In-State Public College"; we specifically consider a counterfactual world where (some) undermatched students change colleges and enroll at a specific "match" public college in their home state. Following Hoxby and Avery (2013), we define any student as undermatched if enrolled at a college with median SAT composite score at least 15 national percentile points above her own composite SAT score. By this definition, approximately 16% of the students in our sample are undermatched. We include some

[35] We note that comparably selective four-year private colleges have always exhibited higher levels of spending than four-year public colleges, so we consider a policy that increases spending at four-year public colleges, but only to the point of reducing a fraction of this gap in spending.

students at two-year colleges in our definition of undermatch, but exclude students who do not enroll in college. Eliminating undermatching requires a switch of many students from less selective to more selective public colleges and thus incurs increased costs, since the less selective colleges are generally characterized by relatively low expenditures per student. We assume that expenditure per student is held constant for each public college in response to enrollment changes, and thus that the underlying probability of graduation for a particular student at a particular college is not affected by this policy.

A related challenge is that the policy of eliminating undermatching requires an increase in the number of seats at some public colleges. We run our simulation with and without constraints on the supply of seats at any given college. To estimate an upper bound on enrollment at a given public institution, we use IPEDS data on full-time undergraduate enrollment at that institution from 2002-2017. We calculate the annual standard deviation of log(full time enrollment) for each school and impose that enrollment can grow by no more than one standard deviation in our reallocation. Almost all (93% of) undermatched students have an in-state public college that is a better match, but only about half of them can be moved under the limited supply scenario. We focus on the results for the limited supply case because changes of college under the unlimited supply assumption requires unrealistic expansions in a few states, such as California and New York, where the public college system is already overburdened.

As shown in Table 6, our simulation of the limited supply policy yields an overall 3.4 percentage point increase in enrollment at public four year colleges. This stems in part from a 1.9 percentage point increase in enrollment at four-year public from movement of students who are undermatched at two-year colleges. Many more students change from a less selective four-year to a more selective four year college. The net result is an increase of 1.0 percentage points in BA completion, with original BA completion rate of 34.2% and new BA completion rate of 35.2%. We project a slightly larger increase of 1.2 percentage points in BA completion rates for low-income students, consistent with the observation that low-income students are disproportionately likely to undermatch in the baseline case.

The reallocation of students in this scenario increases costs in two ways. First, it yields direct increases in instructional spending per student, a total of $166 per student. More generally, it yields increases in spending in other areas as well, a total of $581 per student overall, averaging across the entire sample. We use the larger figure of $581 in increased expenditures per student. The unlimited supply scenario (included in Table 7 but not reported in detail in this draft) approximately doubles the increase in BA

completion as a result of a BISPO policy, but at approximately three times the cost of the limited supply scenario. As this result suggests, the states that are most constrained in enrollment of undermatched students are also states with relatively large expenses per student at their most selective public colleges.

VII. Discussion and Conclusion

Table 7 provides decomposition analysis of the effects of these policies on different subpopulations of students based on their current college choices. Since we are considering interventions with different costs per student, it is not necessarily meaningful to compare the absolute magnitudes of the interventions for a given subgroup. Instead, this table highlights the relative merits of each policy as well as the subgroups of students most affected by each of them.

As shown in the top panel of Table 7, we project that a free community college policy would induce many students to change their choices of colleges, with 15% of students who would otherwise not enroll in any college and 6-7% of students who would enroll in four-year colleges switching to two-year colleges. As shown in the bottom panel of Table 7, the effects on BA completion are naturally mixed, but on balance negative in the simulation. That is, we project the policy to change outcomes both positively and negatively for different subpopulations of students.

The other policies are projected to have broadly positive effects on BA completion for all of these subgroups of students based on choice of college in practice. As shown in the bottom panel of Table 7, we project that the policies of increasing funding or reducing tuition at four-year public college would especially improve BA completion rates for students who enroll in four-year public colleges under the status quo. At the same time, we project these two policies to have similarly positive effects on students would otherwise not have enrolled at any college – highlighting the fact that we assume positive elasticities for new enrollment of students in response to each of these policies. By contrast, BISPO has much greater effect on students currently enrolled in two-year public colleges than any other group of students, thereby highlighting the policy importance of undermatching at the margin of two-year vs. four-year enrollment.

We present cost-benefit comparisons for these policies in Table 8. Tables 3 through 6 present changes in outcomes and cost-per-student of each policy in 2007 dollars for a single year. We compute the total cost of each policy by multiplying by the average number of years of enrollment (3.8 for students starting at four-year) and then scale up those figures to present day dollars with a 1.27 multiplier.[36]

[36] We use the BLS Inflation calculator to derive this multiplier. http://data.bls.gov/cgi-bin/cpicalc.pl It could be argued that we should use a larger multiplier to convert 2007 college costs into present day college costs given that tuition and fees have outpaced inflation during that time. The choice of this multiplier affects only the absolute values of these estimated cost-benefit ratios, not the relative rankings of the four policies. It could be argued that we should use a larger multiplier to convert 2007 college

Free community college stands out among these four policies, as it is the only one that produces ambiguous results. On the one hand, it increases the proportion of high school graduates who complete a post-secondary degree, but it does so at the expense of BA degrees. With this background, it is interesting that this policy has gained so much traction in recent practice. On the positive side, with 70% of high school graduates proceeding immediately to college, free community college is one of relatively few policies that both increase funding for public colleges and also target lowest quartile students in terms of academic achievement (and thus likely also in terms of future earning potential). Even so, the design of most free community college policies excludes students from lowest-income families as these students would already been eligible for Pell Grants that would cover most, if not all, of tuition cost for community college.

Another important effect of the free community college policy that is not incorporated in our cost-benefit analysis for degree completion is the fact that the predominant effect of the policy is to induce students who would otherwise not enroll to complete some time in college without attaining a degree. It is unclear whether the positive effects of exposure to the college environment and acquisition of skills in college courses outweigh the opportunity costs of time enrolled and the subsequent (potential) costs of repaying student loans for these students.

While there is a great deal of uncertainty surrounding each estimate from our simulation, we interpret these results as providing strong evidence that a free community college policy is a poor vehicle for promoting BA completion. To have a neutral effect on BA completion, a free community college policy would need to attract approximately 4 new students who would otherwise not have enrolled in any college for each student who moves from a four-year college to a two-year college in response to the policy. Yet, in practice, this rate has been observed to be approximately 1 to 1. We conducted an alternative simulation (not reported here) to consider the extreme case where no student moved from a four-year college to a two-year college in response to a free community college policy; we project that the cost-benefit result for the policy would be approximately equal to that of reduced four-year tuition, and still not comparable to the result of increasing spending at public colleges. To reiterate the conclusion of Athreya and Eberly (2018), increasing college enrollment is not an attractive route for increasing BA completion at this point.

costs into present day college costs given that tuition and fees have outpaced inflation during that time. (For example, Trends in College Pricing, Figure 9, reports a 35% increase in published prices for four-year public colleges from 2008 to 2018 in 2018 dollars, but it also reports a 30% increase in grant aid in 2018 dollars during that time period.) The choice of this multiplier affects only the absolute values of these estimated cost-benefit ratios, not the relative rankings of the four policies.

Reducing tuition is projected to have positive results, but at about twice the cost per degree of increasing spending at public colleges. The success of this policy on a cost-benefit basis is limited by two main structural factors. First, the tuition discount applies to many inframarginal students who completed BA degrees at public colleges in the baseline case.[37] Second, reduced tuition at four-year public colleges induces some students to switch from four-year private to four-year public colleges with lower expenditure per student and lower graduation rates. Thus, while the policy increases BA completion rates for students already enrolled at four-year public colleges and who are induced to enroll at a four-year college as a result of the policy, it is projected to reduce BA completion rates for those who respond by switching from four-year private to four-year public colleges.

Targeted elimination of tuition and fees at four-year public colleges with an income threshold is projected to be much more efficient than partial reduction in tuition and fees for all students in terms of the cost per additional BA degree. This result stems, at least in part, from our use of elasticities in modeling, which in turn imply relatively large proportional responses to the elimination of tuition and fees (because these are "zero prices"). As shown in Table 7, we project this policy to produce a substantial response in terms of enrollment and completion for low-income students at relatively minimal cost. Interestingly, the simulation indicates a similar change in median income to the partial reduction in tuition and fees for all students – the combination of these results suggests that increases in degree completion especially affects incomes for students who are below the median income level (with and without the change in policy).

Some current proposals combine tuition reductions at two-year and four-year public colleges. While we do not explicitly consider hybrid policies of this sort, we believe that a weighted average of the results of the individual policies gives a reasonably accurate approximation of a more involved simulation. For example, we project the negative effect of free community college on BA degrees to be about 3.7 times as large as the positive effect of a 10% tuition reduction at four-year public colleges on BA degrees. Thus, a policy that combines free community college with a 30% to 40% tuition reduction at four-year public colleges would likely be projected to be nearly neutral in terms of its effect on BA degree completion.

The BISPO policy is projected to have effects on the same order or slightly worse than reducing college tuition. Each of these policies has approximately twice the cost of increased spending at public colleges

[37] As such, we could consider the tuition discount to these inframarginal students as a transfer payment from the government, which would have benefits for those students, but not of the sort that we are prioritizing in this analysis.

per additional BA degree. In essence, the comparison of the BISPO and increased spending policies is a question of relative efficiency within the public college system on a state-by-state basis. Is it more cost-effective to produce BA degrees by moving students to high-cost, high graduation rates institutions or to increase expenditures at lower-cost institutions? Our simulations suggest, in fact, that investments in the lower-cost institutions produce higher relative returns; this result may reflect the broader mission of more selective public colleges than on simply educating undergraduates.

A. Limitations of the Simulations

We believe that it is important to highlight a number of limitations to our approach. In particular, the results of each simulation are dependent on point estimates of one or more crucial elasticities. While we make an effort to choose estimates of these elasticity values that correspond to the consensus of well-designed studies in recent literature, the estimates in the prior literature are typically local estimates that pertain to the context of the program studied and may not necessarily generalize to the broad distributions of students in the College Board sample. Further, we acknowledge that we have to draw on modest amounts of evidence in the choice of some parameters. For example, we have the luxury of observing initial evidence from two separate state-wide programs (Tennessee and Oregon) to assess the enrollment effects of a free community college, but even then, these programs are quite young and may not yet be producing stable results.

The BISPO policy is distinct from the others because it specifically defines the college choices of individual students and thus, its results are not dependent on the choice of enrollment elasticity values at any margin. Yet, the results of the BISPO policy still rely on the critical assumption that graduation rates will not change after the implementation of reasonably large scale movements of students to new colleges. Beyond this specific example, there is some possibility that unmodeled general equilibrium effects to any of these individual policy interventions could affect the results of those interventions.

<u>Decisions by Marginal Students</u>

As shown in Table 7, we project largest or near-largest increases in BA completion in response to the two "highest-ranked" policies from the group of students who would not otherwise enroll in any college. We reiterate the fact that projected results for this subgroup are especially uncertain. First, our sample may underweight this group relative to its true size, as students who do not enroll in college are relatively unlikely to take PSAT/SAT and thus are unusually likely to be excluded from the sample. Second, our

elasticity estimates for this subgroup may not adequately account for selection bias: these students may be unusually unlikely to enroll in college in response to a change in incentives or may not be as likely to compete a BA degree conditional on enrollment as would be suggested by our quantitative predictions. It is not clear whether the net effect of these issues is positive or negative in terms of the evaluation of the effects of these policies.

Robustness Analysis with Varying Elasticity Values

As we note above in Footnote 26, we believe that it would be difficult to identify meaningful confidence intervals for any of the results of interest, such as the cost-benefit ratios for each policy, given the dependence of the results on the choices of more than one elasticity value. The resulting estimates are somewhat delicate. What we can do is report how much our point elasticities would have to change in order to flip our broad conclusions about the merits of Free Community College and increased spending at public colleges. Consider first the Free Community College policy. The Achilles heel of that policy is the tendency to draw students away from four year options and into two year publics. Based on the Tennessee and Oregon policy shocks, we estimate the propensity of four year college students to switch to two year publics to have a price elasticity (with respect to the two year tuition price) of .075. This is the midpoint between the TN and OR estimates. To eliminate the negative BA graduation effects of the policy (and also the negative earnings impacts of the policy), we need to drop this key elasticity to .025. This creates BA impacts of zero while raising Associates degrees and expected earnings. To justify this elasticity one needs to believe that the impact of Free Community College is half or less than the elasticity observed in Tennessee (which had the smaller elasticity). We think that such an elasticity is certainly plausible though it is outside the confidence intervals from the studies of both existing shocks.

A similar question is whether the cost per additional BA of increased spending per student is truly half the cost per BA of reducing tuition. We address this question by checking the robustness of our finding to different elasticities of enrollment in four year publics and bachelors attainment with respect to four year tuition and fees. Our simulations show that the impacts of the policy on bachelors attainment are roughly proportional to the changes in elasticities that we posit. In short, if we cut all of the elasticities in half, the positive impacts are roughly halved. So if the impacts of increased spending at four year public colleges as estimated by Deming and Walters (2017) are too high by a factor of two, the benefits are halved. This changes makes the cost per BA of increased spending roughly $212,000 per additional BA which is quite

similar to cost per additional BA of cutting tuition or matching students with their Best In State Public Option (in the limited supply scenario).

With this background, we emphasize the broad distinction between Free Community College, which is estimated to have a negative effect on BA degree completion and the other policies, which seem almost necessarily (with the possible exception of tuition reduction at four-year colleges – cf. Cohodes and Goodman (2014)) to have positive effects.

B. Broad Conclusions

The cost-benefit ratio for increased spending at public colleges and for targeted elimination of tuition and fees at public colleges – approximately $100,000 in 2019 dollars per additional BA degree - is roughly equivalent to that of the most positive results demonstrated in the prior literature (e.g. Barr (2014) for the GI Bill, Bettinger et al. (2019) for Cal Grant, Scott-Clayton (2011) for West Virginia Promise).[38] The cost-benefit results for reducing tuition and the BISPO policy are about 2.5 to 3 times as high, but still seem within reason as plausible policy options. It is notable that the reduced tuition option appears to be much less effective on a cost-benefit basis than a more targeted approach as well as the more specific aid programs studied in previous papers. From the perspective of targeting, most of the policies that we study are necessarily scattershot in their approach as they are designed (in some sense) to apply to all students. This observation suggests that the cost-benefit ranking of the programs as given by the point estimates in Table 8 reflects the degree to which they successful target the marginal students with greatest propensity to improve their educational outcomes.

The policies we study also vary in the degree to which they benefit low-income students. An interesting paradox is that some policies that appear to focus on low-income students may have the opposite effect. The usual explanation for this paradox is that Pell Grants cover some or all of tuition costs for low-income students. As a result, even seemingly targeted programs, such as tuition reductions with an income threshold, tend to benefit the near-poor much more than those who already qualify for Pell Grants.

[38] Castleman and Long (2016) produce a much lower estimate of $28,000 per additional BA degree for the FSAG program, but this appears to be anomalously low in the context of the estimated effects of similar programs in other states.

Table 1. Summary Statistics Simulation Sample (n = 1,388,012): 2007 Cohort

Variable	Mean	Std. Dev	Min	Max
Student demographic characteristics				
Gender				
Male	0.449	0.497	0	1
Race/Ethnicity				
White	0.659	0.474	0	1
Black	0.105	0.307	0	1
Hispanic	0.106	0.307	0	1
Asian	0.078	0.268	0	1
Other	0.052	0.222	0	1
Family Income				
>$40K	0.160	0.366	0	1
$40K-$70K	0.267	0.442	0	1
$70K-$100k	0.350	0.477	0	1
>$100k	0.224	0.417	0	1
Parent's Education				
HS or Less	0.101	0.302	0	1
Some College	0.183	0.386	0	1
Bachelor's or Higher	0.423	0.494	0	1
Missing	0.293	0.455	0	1
Student Academic Characteristics				
PSAT or SAT score/100	10.29	1.93	4	16
PSAT Taker	0.849	0.358	0	1
SAT Taker	0.781	0.414	0	1
Num. of Days Between HS Graduation and College Entrance	73.85	10.60	-2158	179

Table 2. College Characteristics by Initial Enrollment Choice: 2007 Cohort

Variable	Mean	Std. Dev	Min	Max
Pct. Graduating Within 6 Years	0.502	0.500	0	1
Academic Alignment with First College				
Undermatch	0.164	0.370	0	1
Safety	0.136	0.342	0	1
Match	0.247	0.431	0	1
Reach	0.453	0.498	0	1
Enrolled In-State	0.778	0.415	0	1
Enrolled in Public 2- or 4-Year College	0.757	0.429	0	1
First College Characteristics				
Average College SAT/ACT				
>= 1300	0.059	0.236	0	1
1200 - 1290	0.100	0.299	0	1
1100 - 1190	0.230	0.421	0	1
1000 - 1090	0.212	0.409	0	1
< 1000	0.137	0.343	0	1
Two-Year	0.263	0.440	0	1
Number of Full-time First-time undergraduates/100	22.998	18.597	0.07	75.88
Tuition and Fees, 2007-08/$1,000	10.035	10.049	0.48	39.24
Net Tuition & Fees	5856	6505	-3294	29737
Number Receiving Any Financial Aid	1694	1469	6	6523
Percentage Receiving Any Financial Aid	73.755	18.286	14	100
Instruction Expenses Per FTE/$1,000	8.263	6.960	0	78.381
Size				
< 5K	0.210	0.407	0	1
5K - 10K	0.183	0.387	0	1
10K - 20K	0.245	0.430	0	1
> 20K	0.361	0.480	0	1
Urbanicity				
City	0.564	0.496	0	1
Suburban	0.228	0.419	0	1
Town	0.130	0.336	0	1
Rural	0.079	0.270	0	1
Region				
New England	0.079	0.270	0	1
Mid-East	0.220	0.414	0	1
Great Lakes	0.122	0.327	0	1
Plains	0.041	0.199	0	1
Southeast	0.251	0.434	0	1
Southwest	0.098	0.297	0	1
Rocky Mount	0.025	0.155	0	1
Far West	0.164	0.370	0	1

Table 3

Simulation of Free Community College Policy on Enrollments, Graduation and Earnings

Using the entire cohort of SAT/PSAT takers, we simulate the impacts of free community college on student choices and outcomes. We show outcomes for all students and for low income students (family income of <$40k). Predicted earnings and graduation vary at the student level and are dependent on student demographics, state and test scores. Elasticities of enrollment and graduation with respect to the price of community college are taken from the literature as described in the text and summarized in Appendix Table 2.

	All Students			Low Income Students		
Variable	N	Mean	SD	N	Mean	SD
Net Tuition and Fees Original	1,806,094	4697.06	5873.76	291,567	614.31	1848.18
Net Tuition Fees Room and Board Original	1,805,428	13034.60	7328.89	291,353	11063.20	6058.95
Size of Community College Subsidy	629,182	566.71	799.05	131,896		
Size of Community College Subsidy Including Zeroes	2,291,621	201.46	480.88	390,728		
Start at Two Year Institution	2,291,621	0.275	0.447	390,728	0.338	0.473
Start at Four Year Institution	2,291,621	0.521	0.500	390,728	0.414	0.493
Not Enrolled	2,291,621	0.204	0.403	390,728	0.248	0.432
Start at Two Year Institution NEW	2,291,621	0.340	0.412	390,728	0.365	0.458
Start at Four Year Institution NEW	2,291,621	0.488	0.469	390,728	0.402	0.479
Not Enrolled NEW	2,291,621	0.172	0.343	390,728	0.233	0.409
Obtain Bachelors Within 6 Years: Original	2,291,621	0.386	0.487	390,728	0.250	0.433
Obtain Bachelor's Within 6 Years NEW	2,291,621	0.376	0.464	390,728	0.247	0.424
Obtain Associates Within 4 Years: Original	2,291,621	0.058	0.233	390,728	0.065	0.247
Obtain Associates Within 4 Years: NEW	2,291,621	0.070	0.229	390,728	0.071	0.245
Expected Median Income Original	1,986,342	36209.7	15734.7	338,991	32704.5	14095.2
Expected Median Income New	1,986,342	36147.5	14744.8	338,991	32738.5	13669.6

Table 4a
Simulation of Reduced Tuition at Public 4 Year Colleges:
Impacts on Enrollments, Graduation and Earnings

We simulate the impacts of a ten percent cut in tuition and fees at each four year public college. Responses of enrollment and graduation to tuition and fees are taken from estimates in the literature as detailed in Appendix Table 3 and the text.

	All Students			Low Income Students		
Variable	N	Mean	SD	N	Mean	SD
Net Tuition and Fees Original	1,806,094	4697.06	5873.76	291,567	614.31	1848.18
Net Tuition Fees Room and Board Original	1,805,428	13034.58	7328.89	291,353	11063.22	6058.95
Reduction in Tuition at Public Four Years	781,811	399.10	340.83	115,840	18.45	69.95
Reduction in Tuition at Public Four Years Including Zeroes	2,291,621	188.44	270.14	390,728	7.52	39.64
Start at Two Year Institution	2,291,621	0.275	0.447	390,728	0.338	0.473
Start at Four Year Institution	2,291,621	0.521	0.500	390,728	0.414	0.493
Start at Four Year Public Institution	2,291,621	0.348	0.476	390,728	0.302	0.459
Not Enrolled	2,291,621	0.204	0.403	390,728	0.248	0.432
Start at Two Year Institution NEW	2,291,621	0.273	0.443	390,728	0.336	0.470
Start at Four Year Institution NEW	2,291,621	0.525	0.496	390,728	0.418	0.489
Start at Four Year Public Institution NEW	2,291,621	0.360	0.468	390,728	0.311	0.453
Not Enrolled NEW	2,291,621	0.202	0.400	390,728	0.246	0.429
Obtain Bachelors Within 6 Years: Original	2,291,621	0.386	0.487	390,728	0.250	0.433
New Bachelor's Rate within 6 Years	2,291,621	0.389	0.484	390,728	0.253	0.430
Expected Median Income Original	1,986,342	36209.7	15734.7	338,991	32704.5	14095.2
Expected Median Income New	1,986,342	36147.5	14744.8	338,991	32738.5	13669.6

Table 4b
Simulation of Zero Tuition For Students with Family Income Less Than $60,000 at Public 4 Year Colleges: Impacts on Enrollments, Graduation and Earnings

We simulate the impacts of going to zero tuition and fees at each four year public college for students with family income of less than $60,000 per year. Responses of enrollment and graduation to tuition and fees are taken from estimates in the literature as detailed in Appendix Table 3 and the text.

	All Students			Low Income Students		
Variable	N	Mean	SD	N	Mean	SD
Net Tuition and Fees Original	1,806,094	4697.06	5873.76	291,567	614.31	1848.18
Net Tuition Fees Room and Board Original	1,805,428	13034.58	7328.89	291,353	11063.22	6058.95
Reduction in Tuition at Public Four Years	228,361	1973.85	2885.09	115,840	184.54	699.52
Reduction in Tuition at Public Four Years Including Zeroes	2,291,621	264.38	1131.04	390,728	75.23	396.43
Start at Two Year Institution	2,291,621	0.275	0.447	390,728	0.338	0.473
Start at Four Year Institution	2,291,621	0.521	0.500	390,728	0.414	0.493
Start at Four Year Public Institution	2,291,621	0.348	0.476	390,728	0.302	0.459
Not Enrolled	2,291,621	0.204	0.403	390,728	0.248	0.432
Start at Two Year Institution NEW	2,291,621	0.267	0.435	390,728	0.315	0.441
Start at Four Year Institution NEW	2,291,621	0.534	0.487	390,728	0.454	0.460
Start at Four Year Public Institution NEW	2,291,621	0.379	0.464	390,728	0.393	0.422
Not Enrolled NEW	2,291,621	0.198	0.393	390,728	0.231	0.403
Obtain Bachelors Within 6 Years: Original	2,291,621	0.386	0.487	390,728	0.250	0.433
New Bachelor's Rate within 6 Years	2,291,621	0.396	0.478	390,728	0.279	0.412
Expected Median Income Original	1,941,617	36531.64	15707.45	335,738	32807.91	14095.85
Expected Median Income New	1,941,617	36528.11	15545.98	335,738	32818.77	13974.90

Table 5
Simulation of Increased Per Student Spending at Public 4 and 2 Year Colleges:
Impacts on Enrollments, Graduation and Earnings

We simulate the impacts of raising per student spending on outcomes. At each public four year institution, we raise spending by 30% of the gap between that institution and the average per student spending at in state private institutions. At two year institutions, we raise spending by 20% of the current level. Elasticities of enrollment and graduation with respect to spending are taken from Deming and Walters 2017. We show outcomes for all students and for low income students (family income of <$40k). Predicted earnings and graduation vary at the student level and are dependent on student demographics, state and test scores.

	All Students			Low Income Students		
Variable	N	Mean	SD	N	Mean	SD
Net Tuition and Fees Original	1,806,094	4,697	5873.76	291,567	614.314	1848.18
Net Tuition Fees Room and Board Original	1,805,428	13034.6	7328.89	291,353	11063.2	6058.95
Spending Boost Per Student	1,764,494	364.104	765.736	282,942	477.485	898.807
Spending Boost Per Student W/ Zeroes	2,291,621	284.791	687.899	390,728	352.754	791.687
Start at Two Year Institution	2,291,621	0.275	0.447	390,728	0.338	0.473
Start at Four Year Institution	2,291,621	0.521	0.5	390,728	0.414	0.493
Not Enrolled	2,291,621	0.204	0.403	390,728	0.248	0.432
Start at Two Year Institution NEW	2,291,621	0.279	0.444	390,728	0.344	0.47
Start at Four Year Institution NEW	2,291,621	0.528	0.493	390,728	0.424	0.485
Not Enrolled NEW	2,291,621	0.193	0.382	390,728	0.232	0.406
Obtain Bachelors Within 6 Years: Original	2,291,621	0.386	0.487	390,728	0.25	0.433
New Bachelor's Rate within 6 Years	2,291,621	0.397	0.486	390,728	0.263	0.434
Expected Median Income Original	1,941,617	36531.64	15707.45	335,738	32807.91	14095.85
Expected Median Income New	1,941,617	36566.61	15413.46	335,738	32919.03	13095.01

Table 6
Simulation of BISPO Impacts on Enrollments, Graduation and Earnings

We simulate the impacts of moving undermatched students to better in-state public institution. We assume a constraint of an increase of no more than 1 standard deviation in cohort size at any public institution. We show outcomes for all students and for low income students (family income of <$40k). Predicted earnings and graduation vary at the student level and are dependent on student demographics, state and test scores.

	All Students			Low Income Students		
Variable	N	Mean	SD	N	Mean	SD
Obtain Bachelors Within 6 Years: Original	2,308,129	0.342	0.314	398,085	0.223	0.263
New Bachelor's Rate within 6 Years	2,307,979	0.352	0.317	398,041	0.235	0.272
Net Cost of Attendance	1,529,297	$16,526	$8,606	269,668	$10,580	$5,974
New Net Cost of Attendance	1,545,919	$16,582	$8,474	272,633	$10,563	$5,828
Instructional Spending per FTE Original	1,841,825	$7,658	$6,770	301,327	$6,354	$5,171
Instructional Spending per FTE NEW	1,841,825	$7,824	$6,780	301,327	$6,576	$5,257
Total Expenditures per FTE Original	1,841,825	$20,130	$17,352	301,327	$16,956	$14,033
Total Expenditures per FTE NEW	1,841,825	$20,711	$17,480	301,327	$17,672	$14,389
Start at Two Year Institution	2,308,129	0.274	0.446	398,085	0.336	0.472
Start at Four Year Institution	2,308,129	0.524	0.499	398,085	0.421	0.494
Not Enrolled	2,308,129	0.202	0.401	398,085	0.243	0.429
Start at Four Year Public Institution	2,308,129	0.343	0.475	398,085	0.295	0.456
Start at Two Year Institution NEW	2,308,129	0.247	0.431	398,085	0.304	0.460
Start at Four Year Institution NEW	2,308,129	0.551	0.497	398,085	0.453	0.498
Not Enrolled NEW	2,308,129	0.202	0.402	398,085	0.243	0.429
Start at Four Year Public Institution NEW	2,308,129	0.375	0.484	398,085	0.334	0.472
Expected Median Income Original	1,996,778	$36,078	$15,760	344,192	$32,519	$14,084
Expected Median Income New	1,999,027	$36,646	$15,931	345,678	$33,322	$14,588

Table 7
Decomposition Analysis of Effects of the Different Interventions

Change in 4-Year Public College Enrollment

Baseline Enrollment Choice	Free 2-Year College	Reduced Public College Tuition	Targeted Elimination of Public College Tuition and Fees	Increased Funding for Public Colleges	BISPO with Limited Supply
Not Enrolled	+15.5% *	+ 0.7%	+ 2.6%	+ 3.4%	X
Enrolled in 2-Year College	X	+ 0.7%	+ 2.8%	0	+ 9.8%
Enrolled in 4-Year Public College	-6.8%	X	X	X	X
Enrolled in 4-Year Private College	-5.8%	+ 5.0% **	+ 10.5% **		+ 3.1%

* Our simulation estimates that a free two-year college program would induce 15.5% of the students who did not previously enroll to enroll at a two-year college.

** With reduced public college tuition, our simulation estimates that 5.0% of the students who previously enrolled at a four-year private college would switch to a four-year public college; with the targeted elimination of tuition and fees at four-year public colleges, our simulation estimate that 5.0% of the students who previously enrolled at a four-year private college would switch to a four-year public college

A value of "X" in a given cell indicates that, by assumption (or design), this policy has no effect on four-year college enrollment for this subgroup of students. By assumption, our simulations of BISPO policies do not affect the choices or outcomes of students who did not enroll in college in the baseline case.

Change in Probability of Completing a BA Degree

Baseline Enrollment Choice	Free 2-Year College	Reduced Public College Tuition	Targeted Elimination of Public College Tuition and Fees	Increased Funding for Public Colleges	BISPO with Limited Supply
Not Enrolled	+ 1.5%	+ 0.4%	+ 1.3%	+ 2.1%	X
Enrolled in 2-Year College	+ 0.1%	+ 0.2%	+ 0.7%	+ 0.1%	+ 3.0%
Enrolled in 4-Year Public College	-2.8%	+ 0.5%	+ 1.5%	+ 1.8%	+ 0.4%
Enrolled in 4-Year Private College	-2.4%	+ 0.1%	+ 0.2%	0	+ 0.3%

A value of "X" in a given cell indicates that, by assumption (or design), this policy has no effect on four-year college enrollment for this subgroup of students. By assumption, our simulations of BISPO policies do not affect the choices or outcomes of students who did not enroll in college in the baseline case.

Table 8
Projected Cost-Benefit Ratios for Each Simulated Policy

We compute cost-benefit ratios for projected increases in BA completion and median income that result from each policy. Tables 3 through 6 report costs in per-year units of 2007 dollars. We convert 2007 dollars to 2019 dollars using a 1.27 multiplier and convert per-year to lifetime costs using an estimate of 3.4 years of enrollment per student who enrolls in a four-year college. This estimate is based on the rough averages that 60% of students who enroll initially in a four-year college complete a BA degree, with an average of 4.6 years of enrollment per student who completes a BA degree and an average of 1.5 years of enrollment per student who does not complete a BA degree.

	Cost Per Student-Year	Change in BA Completion Rate	Cost Per Additional BA
Free Community College	$151.6	- .010	NA
Reduced Four-Year Tuition and Fees	$187.5	+ .003	$269,875
Targeted Elimination of Four-Year Tuition and Fees	$264.4	+ .010	$114,068
Increased Spending at Public Colleges	$280.9	+ .010	$121,293
BISPO Limited Supply	$581	+ .010	$250,876
BISPO Unlimited Supply	$1,545	$ .019	$351,122

	Cost Per Student-Year	Change in Median Income per year	Cost Per Additional $ in Median Income
Free Community College	$151.6	- $61	NA
Reduced Four-Year Tuition and Fees	$187.5	+ $320	$2.53
Targeted Elimination of Four-Year Tuition and Fees	$264.4	+ $357	$3.20
Increased Spending at Public Colleges	$280.9	+ $676	$1.79
BISPO Limited Supply	$581	+ $568	$4.42
BISPO Unlimited Supply	$1,545	+ $1,445	$4.62