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Policies and Payoffs to Addressing America's College Graduation Deficit

ABSTRACT We consider four distinct policy levers available to states for raising bachelor's degree completion rates in the United States through their public colleges and universities. We simulate these policies using elasticities from the existing literature and a matched College Board/National Student Clearinghouse data set on enrollment and degree completion. Increasing spending at public colleges 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 bachelor's 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 at raising bachelor's degree completion, though such policies do improve other outcomes. Reducing community college tuition and fees to zero does lead to more associate degrees, though 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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Despite the substantial economic returns to completing a college degree, the United States is situated in the middle of the pack within Organisation for Economic Cooperation and Development (OECD) countries for the fraction of high school students who complete a four-year college degree.[1] Most of the gap between the United States 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 but 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: 42 percent of students enrolled in college attend four-year public colleges, and approximately three-quarters of students attend either two-year or four-year public colleges.[2] Nearly 15 million students are enrolled in public colleges in the United States, 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 (Ma and others 2019, fig. 4b). 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 (Ma and others 2019, figs. 8 and 9). Students from low-income backgrounds have typically been underrepresented at selective public colleges, even after accounting for correlation between income and academic qualifications (see, for example, Pallais and Turner 2006). Although the vast majority of low-income students pay less than $5,000 per year in tuition and fees at public institutions (Ma and others 2019, fig. 11), recent evidence suggests it is an economic hardship for Pell Grant–eligible students to attend most flagship public universities (Debaum and Warwick 2019).

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 OECD Data, Graduation rate, https://data.oecd.org/eduatt/graduation-rate.htm#indicator-chart.

2. National Center for Education Statistics, Digest of Education Statistics, table 303.25; https://nces.ed.gov/programs/digest/d13/tables/dt13_303.25.asp. See figure 3 for more details.

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.[3] One possible explanation for these differentials is that per student instructional spending is lower, on average, at public colleges than at comparable private colleges.[4]

Finally, there may be structural differences in the supply of public colleges and universities across states that have an impact on 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 percent of freshmen attending four-year public 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, 247) 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 under-resourced backgrounds (Bowen, Chingos, and McPherson 2009; Roderick and others 2008; Smith, Pender, and Howell 2013).

In this paper, we consider policies designed to address each of these constraints. 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 four-year public colleges; (3) increasing funding for four-year public institutions to reduce the gap in spending between the otherwise comparable public and private colleges in the same

3. Authors' calculations from results provided by Shapiro and others (2017).

4. See Mitchell, Leachman, and Masterson (2017). It is also possible that selection of students into the public versus 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 versus private colleges.

state; and (4) eliminating undermatching by relaxing institutional capacity constraints so that it is possible for currently undermatched students to 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.[5] 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 public university, University of Illinois, for students from families with less than $61,000 in income.[6] By contrast, the state of Alaska enacted a new budget that cuts funding to its university system by more than 40 percent; after subsequent negotiations, the state agreed to reduce the budget cuts by half and to spread them over three years (Harris 2019).

We evaluate the four different policy changes with micro-level simulations using data on PSAT and SAT takers who graduated from high school in spring 2007. In our simulations, students respond to the differing policies by potentially changing educational sector (that is, not enrolled, two-year public, four-year public, and so on), potentially changing institutions, and potentially changing the likelihood of obtaining associate 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 the distribution of gains (Piketty and Saez 2003). Since 2010, real GDP per capita growth has averaged 1.5 percent, which is meaningfully less than the 2.0 plus growth of earlier decades.[7] Of greater

5. We recognize that bachelor's degree attainment is only one measure of success for college entrants. We also consider associate degree attainment and a projection of expected earnings based on Chetty and others' (2017) mobility report cards by institution.

6. See University of Illinois, Illinois Commitment, https://osfa.illinois.edu/types-of-aid/other-aid/illinois-commitment/.

7. Authors' calculations from BEA data via FRED.

concern is the fact that median household incomes and mean wages have both grown by less than 1 percent per year since 1985 (Shambaugh and others 2017; Sacerdote 2017).[8] Investments in human capital, and in college degrees in particular, are among the most likely ways to create income growth (Goldin and Katz 2018; Oreopoulos and Petronijevic 2013; Dynarski 2008). There is considerable debate about whether returns to college measured at the micro level have relevance for macroeconomics (Bils and Klenow 2000; Barro and Sala-i-Martin 1998), but it is at least plausible that increases in bachelor's degree completion rates could increase growth at the national level.[9]

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

I. Key Facts

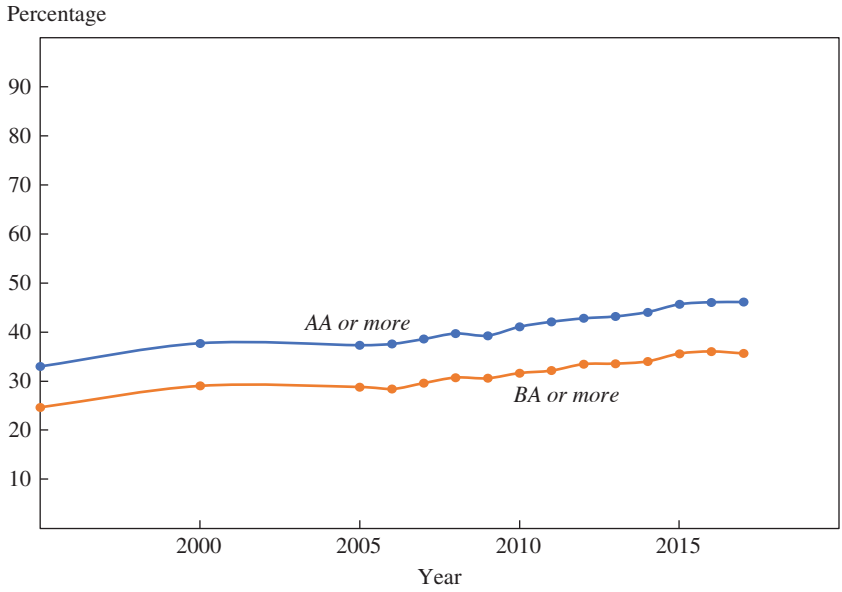
I.A. Fact 1. The United States Has a Problematic College Graduation Rate

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

8. Measurement of inflation (Broda and Weinstein 2008; Costa 2001), of transfers (Meyer and Sullivan 2009), and of household size (Aguiar and Bils 2015) make a big difference to this conclusion but don't necessarily overturn it.

9. Observational data suggest 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 in Ma, Pender, and Weltch (2016).

Figure 1. Proportion of U.S. 25-to-29-Year-Olds with College Degrees, over Time (Selected Years)

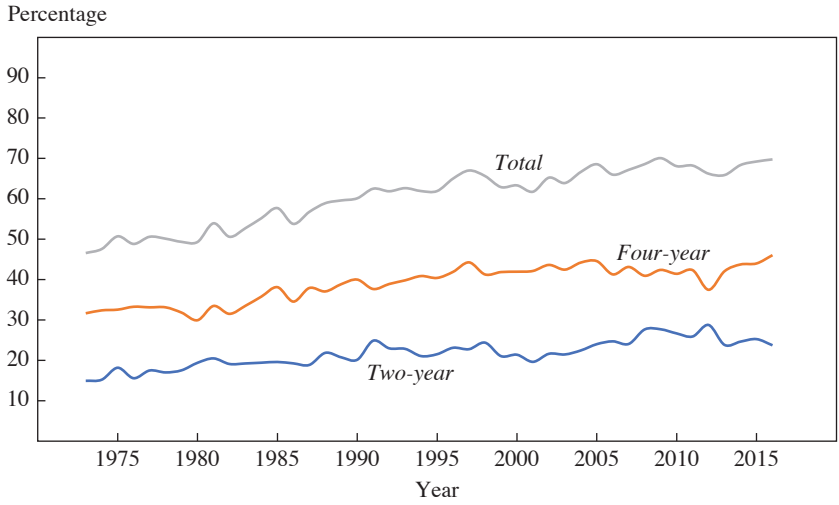


Source: National Center for Education Statistics, Digest of Education Statistics, 2017, table 104.20, https://nces.ed.gov/programs/digest/d17/tables/dt17_104.20.asp.

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 percent 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 four-year colleges in the United States is presently at an all-time high and nearly half (46 percent) of students enroll in a four-year college in the year after high school graduation.[10] But as these numbers indicate, only about half of recent high school graduates who go on directly to college complete a bachelor's degree and approximately one-third of them do not complete either an associate degree or a bachelor's degree within six years of high school graduation.

10. National Center for Education Statistics, Digest of Education Statistics, table 302.10, https://nces.ed.gov/programs/digest/d16/tables/dt16_302.10.asp.

Figure 2. Proportion of Recent U.S. High School Graduates Enrolling in College, Over Time



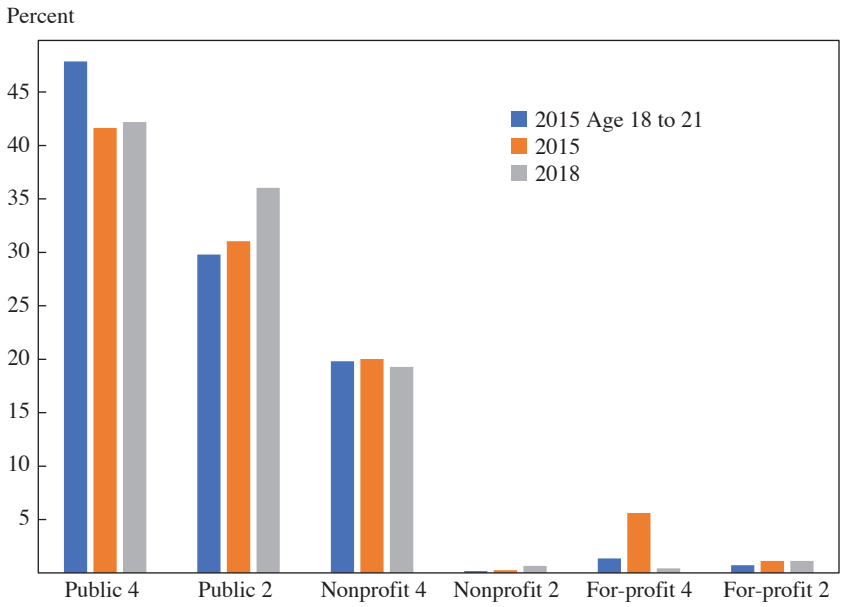
Source: National Center for Education Statistics, Digest of Education Statistics, 2017, table 302.10, https://nces.ed.gov/programs/digest/d17/tables/dt17_302.10.asp.

I.B. 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 42 percent enrolled in four-year public colleges and 31 percent enrolled in two-year public colleges. By contrast, only 20 percent of college students attend four-year private colleges and less than 1 percent of them attend a two-year private college. While for-profit institutions, have been the focus of many media stories and policy debates, they play a relatively limited role for recent high school graduates. As also shown in figure 3, about 2 percent of college students age 18 to 21 attend for-profit colleges, whereas 7 percent of all college students (and 11 percent of college students older than 21) attend for-profit colleges.

We provide further descriptive statistics using data from the College Board database, noting that the units in figure 4 are not directly comparable

Figure 3. Institutional Type for College Students in 1990 and 2015



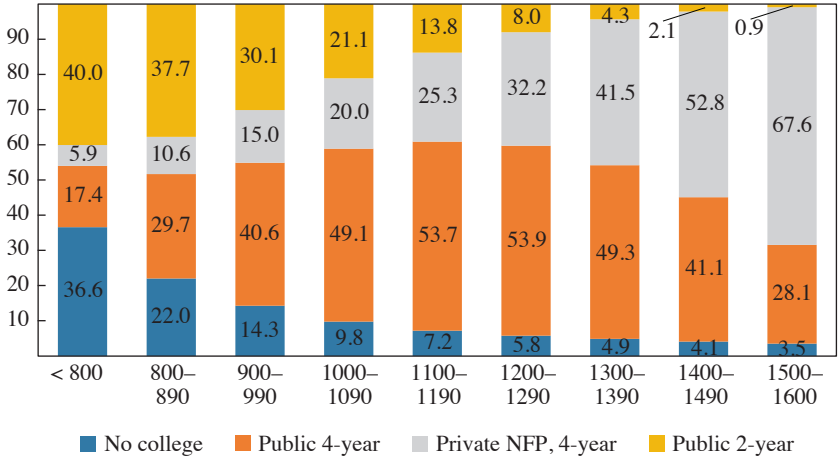
Source: National Center for Education Statistics, Digest of Education Statistics, 2017, tables 303.25 and 303.55, https://nces.ed.gov/programs/digest/d17/tables/dt17_303.25.asp and https://nces.ed.gov/programs/digest/d17/tables/dt17_303.55.asp, respectively.

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 four-year public colleges.[11] Enrollment in four-year private colleges is highly correlated with standardized test scores. More than half of the high school graduates in the right tail of the distribution with combined SAT scores from 1400 to 1600 enroll in four-year private 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 four-year public colleges for high-income versus low-income students by SAT category. In each subgroup, for example, approximately half of students with

11. We calculate estimated SAT score for students who only took PSAT (see notes in figure 4).

Figure 4. Choice of Program by SAT/PSAT Score



Source: College Board Data matched to National Student Clearinghouse, Cohort 2007.

Note: We include PSAT/SAT takers regardless of the timing of the college enrollment (approximately 2 million students). We exclude a small number of students who enrolled in for-profit sector or nonprofit two-year institutions (30K), and we also exclude students who do not have reported or predicted income (300K). 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.

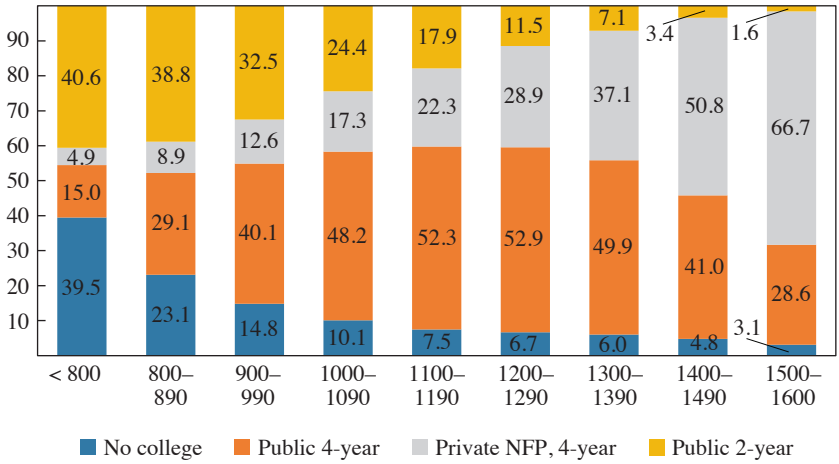
combined math and verbal SAT scores between 1000 and 1390 enroll in four-year public colleges. One important difference in enrollment patterns is that a much larger proportion of low-income students enroll in two-year public colleges or do not enroll in college compared to high-income students (except perhaps for students at the very top of the SAT distribution).

I.C. 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.[12] 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 bachelor's degree completion rates, with little difference between the graduation rates for those at four-year

12. National Center for Education Statistics, Digest of Education Statistics, table 326.10, https://nces.ed.gov/programs/digest/d17/tables/dt17_326.10.asp.

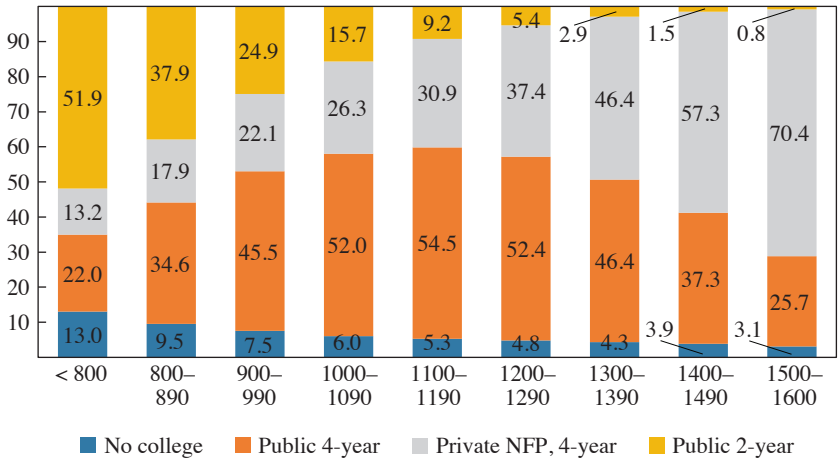
Figure 5a. Choice of Program by SAT/PSAT Score for Low-Income Students



Source: College Board Data matched to National Student Clearinghouse, Cohort 2007.

Note: We include PSAT/SAT takers regardless of the timing of the college enrollment (approximately 2 million students). We exclude a small number of students who enrolled in for-profit sector or nonprofit two-year institutions (30K), and we also exclude students who do not have reported or predicted income (300K). We calculate predicted SAT score for students who took only PSAT by finding average SAT by PSAT bins (each section separately) for students who took both PSAT and SAT.

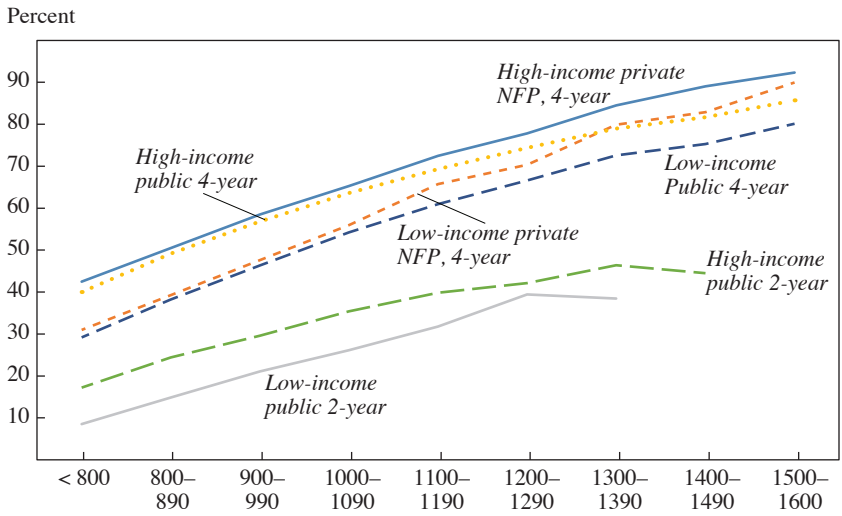
Figure 5b. Choice of Program by SAT/PSAT for High-Income Students



Source: College Board Data matched to National Student Clearinghouse, Cohort 2007.

Note: We include PSAT/SAT takers regardless of the timing of the college enrollment (approximately 2 million students). We exclude a small number of students who enrolled in for-profit sector or nonprofit two-year institutions (30K), and we also exclude students who do not have reported or predicted income (300K). We calculate predicted SAT score for students who took only PSAT by finding average SAT by PSAT bins (each section separately) for students who took both PSAT and SAT.

Figure 6. Six-Year Bachelor's Degree Completion Rates by SAT/PSAT Score, Family Income, and Institution Sector



Source: College Board data matched to National Student Clearinghouse (NSC).

Note: The sample includes PSAT/SAT takers in the 2007 high school graduating cohort who enrolled in public or private nonprofit colleges on time (within 180 days of graduating from high school). Low-income category includes students with family income of less than $40,000; high-income refers to students with family income of $100,000 or more. Six-year bachelor's degree completion rate from first institution attended is calculated among students who first enroll in four-year sector. Otherwise, for students who first enroll in two-year sector, NSC tracks bachelor's degree completion at first four institutions a student attended. We calculate estimated SAT score for students who only took PSAT.

private versus public 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 four-year public colleges, graduation rates for private and public colleges gradually diverge. As shown in figure 6, low-income students enrolled at four-year private colleges actually have higher graduation rates than high-income students enrolled at four-year public colleges. Figure 6 also illustrates a striking differential between bachelor's degree completion rates for students enrolling at two-year versus four-year colleges within each SAT category.[13]

13. The positive outcome reported in figure 6 is six-year bachelor's degree completion from first college for students who initially enroll at a four-year college, while for other students the positive outcome is completion at any of the four-year colleges that the National Student Clearinghouse tracks. So this measure is skewed, if anything, toward underestimating the difference in bachelor's degree 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.

I.D. Fact 4. Graduation Rates Are Particularly Low at Two-Year Public Colleges

Less than 25 percent of recent high school graduates who enroll in two-year public colleges complete an associate degree within three years. By contrast, approximately 60 percent of high school graduates who enroll in two-year private colleges complete an associate degree within three years.[14] (The two-year private sector is quite small, covering only about 1 percent of recent high school graduates.) A total of 37.5 percent of recent high school graduates who enroll in two-year colleges complete a degree within six years of high school graduation, with 14.7 percent of them completing bachelor's 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.[15]

I.E. 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 2019 dollars, tuition and fees at four-year public colleges more than doubled from $3,760 in 1990–91 to $10,440 in 2019–20, corresponding to an annual rate of increase more than 4 percent above and beyond the rate of inflation (Ma and others 2019, fig. 9). In comparison, tuition and fees at four-year private and two-year public colleges also increased steadily, but at a lower rate (between 2 percent and 3 percent 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 colleges, the College Board shows that net tuition, fees, and room and board at four-year public colleges has risen from $9,070 in 1999–00 to $15,380 in 2019–20 (all in 2019 dollars; Ma and others 2019, fig. 9).

I.F. Fact 6. Enrollment in Public College 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 at the end of the baby boom, the number of high school graduates has been increasing

14. National Center for Education Statistics, Digest of Education Statistics, table 326.20, https://nces.ed.gov/programs/digest/d18/tables/dt18_326.20.asp.

15. Authors' calculations based on data from appendix C in Shapiro and others (2017).

steadily from about 2.3 to 2.5 million per year in the early 1990s to about 3.2 million students per year from 2010 to 2016.[16] Second, as shown in figure 2, the proportion of high school graduates enrolling in college has increased to nearly 70 percent 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 2016).

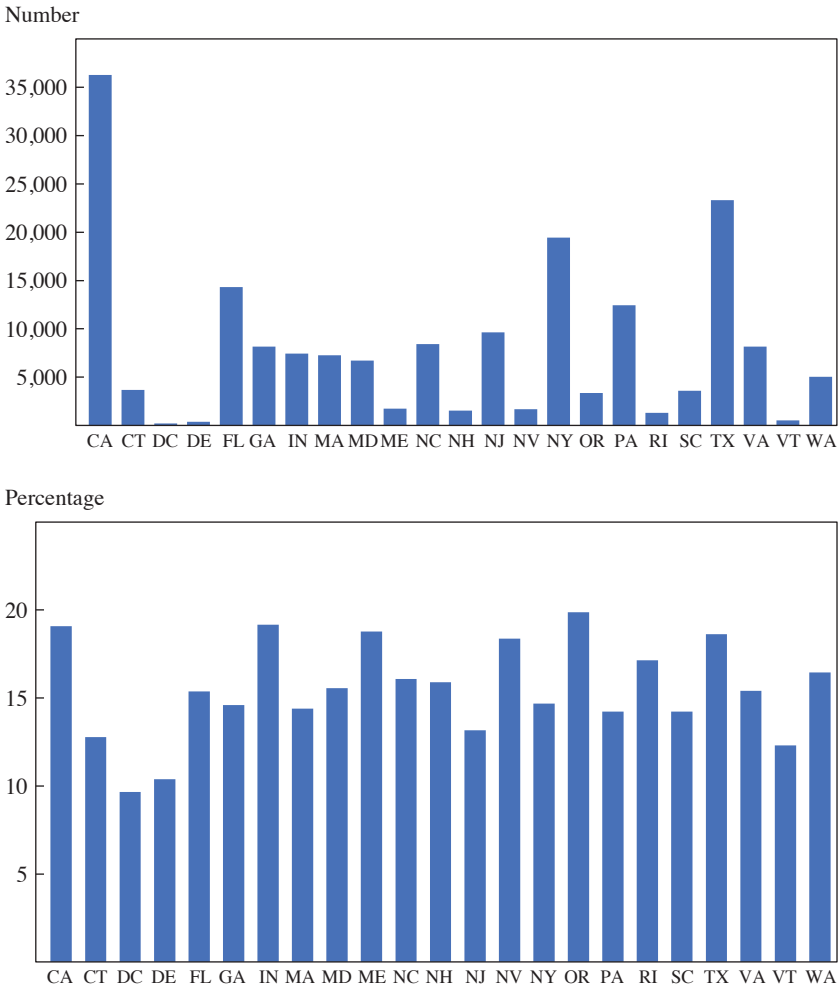
These recent trends indicate that the capacity of seats for entering freshmen at many colleges is somewhat fluid and this makes it difficult to pinpoint a specific capacity constraint at (say) four-year public colleges. At any moment in time, there are substantially more students who graduate from high 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 rather than a four-year college. Similarly, since there is typically only one flagship public college per state, some households are located closer to a four-year public college that is not 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 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 University of California 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

16. National Center for Education Statistics, Digest of Education Statistics, https://nces.ed.gov/programs/digest/d17/tables/dt17_219.10.asp.

Figure 7. The Number and Proportion of Undermatched Students by State



Source: College Board data matched to National Student Clearinghouse.

Note: Includes only students who enrolled in college on time (within 180 days of graduating from high school) and in states where the College Board has high PSAT/SAT coverage. Colleges are classified as a reach, match, safety, or undermatch following the definition established in Hoxby and Avery (2013) and used in Hoxby and Turner (2013). Essentially, the percentile of a student's SAT score is compared to the percentile associated with the average SAT score among students enrolled at their chosen college. If that difference is within five percentile points of zero in either direction, the student-college combination is considered an academic match. Lower academic-match colleges ("safety schools") are those with average SAT percentiles 5 to 15 points below the student's SAT percentile, while academic reaches are colleges with average SAT percentiles more than 5 points above the student's SAT percentile. We classify students as undermatched if they enroll in a college where their own SAT percentile is more than 15 points higher than the percentile of the college's average SAT. Institutions with admission rate of less than or equal to 20 percent are always considered reach colleges. For colleges that do not report average SAT/ACT in IPEDS, we calculate average SAT using a cohort of 2007 SAT takers.

(Leal 2015). The California State University (CSU) system has created a new designation of an "impacted" campus, as described on its website: "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."[17] Seven CSU institutions (Cal Poly San Luis Obispo, Fresno State, CSU Fullerton, CSU Long Beach, Cal State Los Angeles, San Diego State, and San Jose State) are "impacted" at the campus level.

I.G. Fact 7. The Cost-Benefit Trade-off for Marginal College Students Is Unclear

The wage premium for a bachelor's 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).[18] The cost-benefit computation for today's marginal college student, who might enroll at a two-year public college or a nonselective or less-selective four-year college, is not so clear (Athreya and Eberly forthcoming; Benson, Esteva, and Levy 2015). The trade-off between enrolling in college or entering the workforce may well turn on potential differences between marginal and average completion rates (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 1999; Reynolds 2012; Mountjoy 2019). 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 in general for those who enroll in college but do not complete a degree (Athreya and Eberly forthcoming). Given these considerations, it seems much more plausible to attempt to increase bachelor's degree completion rates with policies that target increases in completion rates for inframarginal college students rather than policies that attempt to increase college enrollment.

17. California State University, "Impaction at the CSU," accessed January 3, 2019, https://www2.calstate.edu/attend/impaction-at-the-csu.

18. See Ma, Pender, and Welch (2019), especially figure 2.1, for more recent estimates of average wages by postsecondary attainment. 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.

II. Related Literature

The twin phenomena that many students begin college but do not graduate and that well less than half of adults in the United States have a bachelor's 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 (2009) documented the fact that aggregate college completion rates were low and apparently stagnating. Denning, Eide, and Warnick (2019) observe 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 of reduction in net costs on college enrollment (Dynarski 2003; Denning 2017).

A growing set of more recent studies uses regression discontinuity strategies to demonstrate a formal link between financial aid and college persistence and completion. Bettinger and others (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 bachelor's degree attainment by 3–4 percentage points. Scott-Clayton (2011) examines the West Virginia Promise Scholarship and uses ACT score thresholds to calculate the scholarship's impact. She finds that Promise receipt raises four-year bachelor's degree completion by 6–7 percent. Scott-Clayton and Zafar (2019) find that the West Virginia Promise Scholarship has an impact on 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 Assistance Grant (FSAG) 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 (2000) provided descriptive evidence to suggest that family income and academic achievement

in high school were broadly equivalent predictors of college enrollment. Roderick and others (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.[19] 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 more recent studies finds 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 (2017) use regression discontinuity methods to compare the effects of college choice on students at the margin of two-year versus 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 finds 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 college have earnings that are 20 percent 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 college by winning Massachusetts's John and Abigail Adams Scholarship. These students adopt the lower graduation of Massachusetts's public colleges relative to the more selective private colleges 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 (2018) 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 and others (2019) find that public colleges respond to reductions in state appropriations by increasing the

19. See Smith, Pender, and Howell (2013) and Dillon and Smith (2017) for assessments of the prevalence of undermatching at the national level.

share of out-of-state students, particularly international students, if possible. As a result, the most selective four-year public 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 and others (2019) conclude that reductions in state funding lead to reductions in graduation rates at public colleges; Chakrabarti, Gorton, and Lovenheim (2018) find that reductions in state funding lead to significant reductions in measures of student financial success beyond age 30. Deming and Walters (2017) particularly find that spending on student support is linked to increased graduation rates.[20]

Several previous studies have conducted analyses related to the simulations we carry out below. Dynarski (2008) and Denning, Marx, and Turner (2018) estimate the social welfare effects of increases in grant aid.[21] Chingos (2012) and Howell and Pender (2016) simulate the effects of changes in enrollment across campuses to address undermatching of low-income students. Chingos (2012) 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 colleges; it is not surprising that this approach is estimated to produce only second-order effects on bachelor's degree completion. Howell and Pender (2016) is the only one of these papers to conduct a simulation based on individual-level data. As in our simulations related to undermatching, Howell and Pender (2016) 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 and others (2015) conduct randomized evaluations of six different performance-based scholarship programs targeted to low-income students, estimating that these programs increase completion rates by 3.3 percentage points on average.

20. See also Clotfelter, Hemelt, and Ladd (2018) and Evans and others (2017) for related evidence that one-on-one guidance, academic or otherwise, can promote college completion.

21. See Deming and Walters (2017) for a detailed proposal for a dramatically expanded federal college grant program.

III. 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 were available at the time that we started this project.[22] 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. The sample includes PSAT takers as well as SAT takers, so it is not limited, even in ACT states, to students who intend to apply to selective schools. While selection into the sample likely limits our ability to make inferences about all college-bound seniors, it is much less of an issue in sixteen states, primarily those on the East Coast, where our data include 90 percent or more of all graduating high school seniors.[23]

Information on student demographic characteristics, including race or ethnicity, gender, family income, and parent's education, comes from the Student Data Questionnaire completed by students when they register for the SAT. We have self-reported information about family income for about 40 percent of the students in the sample (we are missing this information for students who took only the PSAT and for students who took the SAT but omitted an answer to this question). We use the method described in Howell and Pender (2016) 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 represents 98 percent of enrolled students across the country. Participating institutions provide the NSC with student-level data on enrollment by semester, graduation date, degree earned, and duration of studies. For-profit colleges tend to be underrepresented in the NSC data, particularly for the time period covered by

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

23. Very high coverage states include Georgia, Maryland, Delaware, Maine, the District of Columbia, Rhode Island, South Carolina, Florida, Nevada, New Jersey, North Carolina, Virginia, Massachusetts, Connecticut, New York, and Indiana. Coverage in Texas is roughly 88 percent.

our data (Dynarski, Hemelt, and Hyman 2015), but, as described above in our discussion of fact 2, only about 2 percent of recent high school graduates actually attend for-profit colleges.[24] We focus our analysis on those students who enroll in a two-year public, four-year public, or nonprofit four-year private college within six months of graduating from high school. Our main indicator for college graduation is bachelor's degree attainment within six years.[25]

Institutional net price data are from the Integrated Postsecondary Education Data System (IPEDS). For each of the undermatched students in our data set we estimate net price at both the chosen institution and the rematched institution. The IPEDS data provide institution-level information on the average SAT scores of students entering college in 2007–8 and instructional and total spending per student. We use these to estimate the total costs (that is, 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 percent male, 11 percent black, and 11 percent Hispanic. Sixteen percent of the students are from families with income less than $40,000 per year. Average SAT score in the sample is 1029.[26]

Table 2 provides summary statistics on students' initial college enrollment choice. Sixteen percent of students are undermatched, meaning these students have 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 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 student's own score. Reach schools are those that have average SATs more than 5 percentile points above the student's score. Seventy-eight percent of students enroll in-state and 76 percent enroll at a two- or four-year public college. Twenty-six percent of enrollments are at two-year colleges.

24. Our reference for overall enrollment at for-profit colleges is the Digest of Education Statistics, which in turn references the Integrated Postsecondary Data System, which is distinct from NSC data.

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

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

Table 1. Summary Statistics Simulation Sample: 2007 Cohort

	n = 1,388,012			
	Mean	*SD*	*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
Number of days between HS graduation and college entrance	73.85	10.60	0	179

Source: College Board Data matched to National Student Clearinghouse.

IV. Methodology

We conduct four different simulations of policy changes designed to promote bachelor's degree 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; and (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 chose round number targets for the reduction in tuition and 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 with regard to bachelor's degree completion rates (the focus of the paper)

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

	Mean	*SD*	*Min.*	*Max.*
Percentage graduating within six 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 two-year or four-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 (100s)	22.998	18.597	0.07	75.88
Tuition and fees, 2007–08 ($k)	10.035	10.049	0.48	39.24
Net tuition and fees ($)	5,856	6,505	−3,294	29,737
Number receiving any financial aid	1,694	1,469	6	6,523
Percentage receiving any financial aid	73.755	18.286	14	100
Instruction expenses per FTE ($k)	8.263	6.960	0	78.381
Size				
< 5K	0.210	0.407	0	1
5–10K	0.183	0.387	0	1
10–20K	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
Mideast United States	0.220	0.414	0	
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 Mountains	0.025	0.155	0	1
Far West	0.164	0.370	0	1

Source: College Board Data matched to National Student Clearinghouse.

and projected median income. We also consider the effects of the policy of eliminating tuition at two-year colleges on the left tail of the income distribution.

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.[27] Instead, we provide bounds in terms of underlying elasticities to provide context for assessing the magnitude of differences in our results, that is, how much would our underlying elasticity values have to change for each pairwise cost-benefit comparison to reverse in order?

IV.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 online appendix C for more details about how and why we chose these particular values for the elasticities. Below we discuss the degree to which our chosen elasticities may not apply to the marginal students in our hypothetical national-level policy. In particular, the marginal students in our simulations may have lower academic ability and smaller graduation elasticities than some of the students in well-identified studies in the existing literature.

ELASTICITIES FOR TUITION CHANGES AT THE TWO-YEAR ENROLLMENT MARGIN

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-differences analyses provide estimates of enrollment effects of changes in price for two-year colleges in Oregon (Gurantz 2019; Cox and others 2018) and Tennessee (Carruthers 2019; Carruthers, Fox, and Jepsen 2018; 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 versus two-year public college and (2) no college versus two-year public college.

27. 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 hone in on what we think are the most credible elasticity estimates in the literature.

The results reported by Carruthers (2019) imply an elasticity of .265 for the movement of not enrolled students into the two-year public sector. By contrast, the results reported by Gurantz (2019) imply 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 two-year public institutions with respect to the two-year price, we again average results from the two studies and arrive at an elasticity of .075.[28] We think of these elasticities as being roughly the ones we want to use for our national simulation. That is to say that these two states have implemented policies similar to what a national-level policy would be like, so we think of the Carruthers (2019) and Gurantz (2019) studies as studying students at the same margin as those in our simulation.

ELASTICITIES FOR TUITION CHANGES ON FOUR-YEAR ENROLLMENT We consider a range of studies—the Cal Grant (Bettinger and others 2019), Social Security benefits (Dynarski 2003), the Florida Student Assistance Grant (Castleman and Long 2016), and the West Virginia Promise Scholarship (Deming and Walters 2017; Scott Clayton 2011)—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 online appendix A. The modal finding in this literature is that $1,000 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 studies 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 percent drop in the price of four-year public colleges increases enrollment by 0–9 percent of baseline enrollment. For example, Castleman and Long (2016) study a 57 percent 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 (.032/.61)/.57 = .09. We use an elasticity of .07 for our simulations.

We use results from Bettinger and others (2019) to identify the price elasticity of enrollment for switching from four-year private college to four-year public college in a response to a change in the relative price of

28. Technically we mean price elasticities of –.265, –.135, –.20, and so forth. 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.

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 (2016), 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, Fox, and Jepsen (2018) estimate that eliminating community college tuition increased the completion rate for associate degrees by 1 percentage point for students in Knox County, Tennessee, on an intention-to-treat basis; this estimate is drawn from their analysis of the results of Knox Achieves, the predecessor to the statewide program, Tennessee Promise, which is currently active. This is from a base of 4 percentage points of people earning an associate degree 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 zero for the effect of community college tuition on associate degree completion. For our simulations we use a modest elasticity of .05.

We use Bettinger and others (2019) for our estimate of the elasticity of bachelor's degree completion with respect to community college tuition for students already enrolled in community college. In online appendix B, Bettinger and others (2019) find a 3 percentage point impact on bachelor's degree 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 percent price cut on all tuition and fees (both two- and four-year institutions across four years of funding). We assume that the community college portion of the tuition cut represents only 10 percent of the total complete tuition cut that such bachelor's degree–bound community college students experience. Hence a community college tuition price cut would have one-tenth the impact on bachelor's degree attainment that the full Cal Grant program has for community college students. The 3 percentage point impact for the Cal Grant in bachelor's degree

completion is on a base of 36 percentage points. This implies an elasticity of bachelor's degree completion with respect to community college tuition of (.03/.36)/10 = .008.

We use the overall estimated effect of the Cal Grant on bachelor's degree completion rates—an increase of 4.6 or 3.0 percentage points across all sectors for an offer of a 100 percent reduction in price in any sector (again on an intention-to-treat basis)—to estimate the change in bachelor's degree completion rates conditional on enrollment.[29] 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 uses 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 (2017), for promoting bachelor's degree completion. We use the spending/enrollment elasticities implied by the estimates from Deming and Walters's (2017) tables 3 and 4. Specifically, we use an enrollment elasticity of spending of 1.05 for two-year public and 0.66 for four-year public colleges, and a degree completion elasticity of spending of 1.46 for associate degrees at two-year public colleges and 0.46 for bachelor's degrees at four-year public colleges.[30] Deming and Walters (2017) make the point that since these bachelor's degree 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.

29. Carruthers, Fox, and Jepsen (2018) estimate a negative net effect of Knox Achieves on bachelor's degree 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 noncollege options; (2) the effect of the elimination of community college tuition on graduation rates for students. The elasticity values we use for bachelor's degree completion rates are broadly consistent with their findings.

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

IV.B. Details of the Simulations

Our price- or spending-based policy simulations (free community college, increased spending at public colleges, and lower tuition at four-year public colleges) 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, or four-year private. (3) We then compute expected outcomes in the new sector.

For each student we estimate a probability of switching sectors. This estimate is the interaction of the general price elasticity for that switch (for example, 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 ordinary least squares (OLS) regression using our full data set and actual outcomes. For example, every student has their own predicted probability of choosing the two-year public sector given state of residence, family income, SAT scores, gender, race, and age. The tuition elasticity for not enrolled students to switch to two-year public colleges is .2, which is the average elasticity estimated from the Oregon and Tennessee policies. This .2 estimate is then scaled up or down (in a mean preserving way) for each not enrolled student given the student's propensity to choose a two-year public college.

The probability of bachelor's degree or associate degree attainment can vary for two reasons. First, each policy affects graduation probability, holding institution constant via lowering price (or raising spending). Second, each policy can also affect associate degree or bachelor's degree attainment by altering the probability that a student is in a given sector.[31]

31. 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.

Each student has a probability (predicted value) of obtaining a bachelor's (or associate) degree given an educational sector. These predicted values come from OLS regressions in which we predict a student's outcome for each sector given 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 and others (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 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, the probability that the student switches to a different sector, and the student's predicted outcomes for that new sector.[32] We also include the effects on attainment and earnings that stem from higher graduation probabilities, holding institution/sector constant.

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

A given policy shock can have very different price change implications for students with different characteristics (for example, high- versus low-income students; student in California versus Texas). 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 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

32. We assume that students who originally attained a particular degree will attain at least that same degree if they do not change colleges as a result of a particular policy.

(for example, 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 the student's state and family income category. These average prices are weighted by the number of students in that state-sector-income category.

As mentioned above, the marginal student in our national simulations likely differs from the marginal student in the best identified studies in the literature. For example, nearly all of the students in the Cal Grant study are college bound and 46 percent of that sample completes a bachelor's degree. Our simulations deal with this mismatch in two ways. First we are not imposing that our marginal entrants have the average level of bachelor's degree attainment. Rather our predicted graduation probabilities are specific to the student and are estimates (via OLS) using all available demographics and SAT/PSAT scores. Hence our marginal students are already estimated to have significantly lower probabilities of bachelor's degree completion than average students. The elasticities in the simulation are applied to these lower probabilities. Furthermore we have robustness checks in which we assume that the actual price elasticities with respect to graduation are half of our preferred elasticity estimates from the literature.

V. Results

We report results for a given set of outcomes for each of our simulations: cost per student, enrollment, degree completion, and projected median income. For each student we have the results in practice from the College Board and National Student Clearinghouse data *and* simulated outcomes for these same variables. We report both actual and simulated averages for these variables for each of the four policy shocks that we consider.

V.A. Free Community College

We first consider 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. If a student is induced by the policy to switch to the two-year sector, we assign that student to a (fictitious) college with the average characteristics of all two-year public colleges in the student's home state. There are three mechanisms by which the policy affects projected outcomes: (1) it increases degree completion probabilities (both associate and bachelor's) 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; and (3) it induces

some students to switch from four-year to two-year colleges, thereby increasing their chances of competing an associate degree, but reducing their chances of completing a bachelor's degree.

As shown in table 3a, our simulation yields a 6.5 percentage point increase in enrollment at two-year colleges, from 27.5 to 34 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 students who move from no college to a two-year college in this simulation.

We project a bachelor's degree completion rate of less than 10 percent 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 bachelor's degree 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 associate degree along with a slightly smaller reduction in the percentage of students completing a bachelor's 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 (about $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 colleges than in four-year colleges and because students (for example, those receiving Pell Grants) pay less than full tuition in any case.[33] As shown in table 3a, 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.

Our choice of bachelor's degree completion rates and median income as outcome measures is not wholly appropriate for evaluating a free community college policy because that policy is targeted, in large part,

33. 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 two-year public college and the state covers only the remaining cost of attendance after accounting for all other sources of aid for a student.

Table 3a. Simulation of Free Community College Policy on Enrollments, Graduation, and Earnings

	All students			*Low-income students*		
	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 bachelor's degree within six years original	2,291,621	0.386	0.487	390,728	0.250	0.433
Obtain bachelor's degree within six years new	2,291,621	0.376	0.464	390,728	0.247	0.424
Obtain associate degree within four years original	2,291,621	0.058	0.233	390,728	0.065	0.247
Obtain associate degree within four 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

Source: College Board Data matched to National Student Clearinghouse.

Note: 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 <$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 online appendix C.

Table 3b. Simulation of Free Community College Policy: Detailed Results for Educational Attainment

Attainment level	*Original (actual outcome)*	*Free community college (projected outcome)*
Percentage of students in the sample at each level of educational attainment		
No college	20.4	17.2
Some college, no degree	35.2	38.2
Associate degree	5.8	7.0
Bachelor's degree	38.6	37.6
Cumulative distribution for educational attainment		
No college	20.4	17.2
Some college, no degree	55.6	55.4
Associate degree	61.4	62.4
Bachelor's degree	100	100

Source: College Board Data matched to National Student Clearinghouse.

to students who would not otherwise attend college. The issue is that substantial improvements in outcomes for these students might not have any effect on either median income or bachelor's degree completion. Table 3b reports the partial and cumulative distributions for educational attainment to highlight the likely distributional effects of the free community college policy. Of particular importance, we project that the free community college policy yields a 3.2 percentage point reduction (from 20.4 percent to 17.2 percent) for not attending college and a corresponding 3 percentage point increase (from 35.2 percent to 38.2 percent) for attending college but not receiving a degree. Thus, we might expect this projected shift from "No college" to "Some college, no degree" to influence outcomes somewhat below the median, perhaps around the 20th to 30th percentile of the income distribution. From this perspective, a possible positive effect of the free community college policy is that students who are prompted to enroll by this policy but who do not earn any degree might still derive higher lifetime incomes as a result of their time in college.

A counterweight to this view is the fact that our simulations also do not include a provision to account for any lasting effects of student debt. Baum (2016) and others observe that default rates are especially high for student borrowers who spend a year or less in college. Some students may need to borrow to enroll even if community college is free; it is not certain that these students would benefit financially from attending community college but not completing a degree.

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. For this reason, there could be an even greater absolute response to a free community college policy than is indicated in our simulations, as students who are excluded from our data are relatively unlikely to enroll in college. The direction of this selection effect on our cost-benefit estimates is not clear, as these students who are omitted from the sample are also presumably relatively unlikely to complete college if they are induced to enroll by a policy intervention. In any case, the results of our simulations remain qualitatively consistent with descriptive statistics provided in early analyses of the Oregon program and Tennessee Promise (Gurantz 2019; Carruthers, Fox, and Jepsen 2018), and as discussed above, our data cover at least 90 percent of high school graduates in sixteen states.

An important point raised by our discussants is that explicitly advertising community college as *free* can have larger effects than a similar-sized price subsidy (for example, the Pell Grant) that is more complex, requires an application, has a set of requirements, and may not cover all of tuition and fees. We agree; our simulation is calibrated to the Tennessee and Oregon shocks where an advertised promise of free community college was put in place. Our other tuition reduction simulations are not as closely matched to an actual state policy.

Another important point raised by our discussants is that our analysis does not account for the effect of free community college on students who would otherwise enroll in a for-profit college. In fact, students at community colleges have somewhat better job prospects than do students at for-profit colleges, while graduation rates and default rates on loans are quite similar for community colleges and for-profit colleges (Looney and Yannelis 2015). Given the small proportion (about 2 percent) of recent high school graduates who enroll in for-profit colleges, these aggregate results suggest that our results would not change much if we were able to identify and include all students who enrolled at for-profit colleges in our analysis.

V.B. Reduced Tuition at Four-Year Colleges

We consider two policies that reduce tuition and fees at 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 flagship state 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 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 percent reduction in tuition and fees yields a 1.2 percentage point increase in enrollment at four-year public colleges and a .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 .3 percentage points in bachelor's degree 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 about $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 .8 percentage point decrease in enrollment at two-year public colleges. We project lower-income students (with family income less than $40,000) to exhibit a substantial response to this policy, with a 4.0 percentage point 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 bachelor's degree completion. The

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 their academic credentials, as this assumption would implicitly incorporate elements of the fourth policy that we consider—eliminating undermatching.

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

	All students			*Low-income students*		
	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 bachelor's degree within six years original	2,291,621	0.386	0.487	390,728	0.250	0.433
New bachelor's degree rate within six 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

Source: College Board Data matched to National Student Clearinghouse.

Note: We simulate the impacts of a 10 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 online appendix C and the text.

Table 4b. Simulation of Zero Tuition for Students with Family Income Less than $60,000 at Public Four-Year Colleges: Impacts on Enrollments, Graduation, and Earnings

	All students			*Low-income students*		
	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 bachelor's degree within six years original	2,291,621	0.386	0.487	390,728	0.250	0.433
New bachelor's degree rate within six 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

Source: College Board Data matched to National Student Clearinghouse.

Note: 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 online appendix C and the text.

result of the simulation is that about 10 percent of high school graduates would enroll in a four-year public college, with an average cost (averaging over all students) of about $260 per year, a 30–40 percent increase over a universal reduction of 10 percent in tuition and fees.

V.C. Increased Spending at Public Colleges

Our third policy is an increase in state funding. We first calculate the gap in spending per student between each four-year public institution and the average of the four-year private institutions in the same state. We then increase spending at each four-year public college to remove 10 percent of the spending gap between that specific four-year public college and the average of in-state private colleges. 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.

As shown in table 5, our simulation yields a .7 percentage point increase in enrollment at four-year colleges and a .4 percentage point increase 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 bachelor's degree completion, combining the effects of students enrolling in two-year and four-year public colleges, as bachelor's degree 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 $360 per student, averaging over students who enroll in some college, and approximately $280 per student, averaging over all students in the sample.

V.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 in-state public option"; we specifically consider a counterfactual world where

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.

Table 5. Simulation of Increased per Student Spending at Public Four-Year and Two-Year Colleges: Impacts on Enrollments, Graduation, and Earnings

	All students			*Low-income students*		
	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 ($)	1,764,494	364.104	765.736	282,942	477.485	898.807
Spending boost per student including zeroes ($)	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 bachelor's degree within six years original	2,291,621	0.386	0.487	390,728	0.25	0.433
New bachelor's degree rate within six 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

Source: College Board Data matched to National Student Clearinghouse.

Note: We simulate the impacts of raising per student spending on outcomes. At each public four-year institution, we raise spending by 30 percent 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 percent 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 <$40k). Predicted earnings and graduation vary at the student level and are dependent on student demographics, state, and test scores.

(some) undermatched students change colleges and enroll at a specific matched 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 below a student's own composite SAT score. By this definition, approximately 16 percent of the students in our sample are undermatched. We include some 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 to 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 percent) 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 3.2 percentage point increase in enrollment at four-year public colleges. This stems in part from a 1.9 percentage point increase in enrollment at four-year public colleges from movement of students who are undermatched at two-year colleges. Many more students change from a less selective four-year college to a more selective four-year college. The net result is an increase of 1 percentage point in bachelor's degree completion, with an original bachelor's degree completion rate of 34.2 percent and new bachelor's degree completion rate of 35.2 percent. We project a slightly larger increase of 1.2 percentage points in bachelor's degree completion rates for low-income students, consistent with the observation

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

	All students			*Low-income students*		
	N	*Mean*	*SD*	*N*	*Mean*	*SD*
Obtain bachelor's degree within six years original	2,308,129	0.342	0.314	398,085	0.223	0.263
New bachelor's degree rate within six 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

Source: College Board Data matched to National Student Clearinghouse.

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

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 8 but not reported in detail here) approximately doubles the increase in bachelor's degree 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.

VI. Discussion and Conclusion

Table 7a provides a 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.

As shown in table 7a, we project that a free community college policy would induce many students to change their choice of college, with about 15 percent of students who would otherwise not enroll in any college and about 6–7 percent of students who would enroll in a four-year college switching to a two-year college. As shown in table 7b, the effects on bachelor's degree 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 bachelor's degree completion for all of these subgroups of students based on choice of college in practice. As shown in table 7b, we project that the policies of increasing funding or reducing tuition at four-year public colleges would especially improve bachelor's degree 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 who would otherwise not have enrolled at any

Table 7a. Decomposition Analysis of Effects of the Different Interventions: Change in Four-Year Public College Enrollment

Baseline enrollment choice	*Free two-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[a]	+ 0.7	+ 2.6	+ 3.4	X
Enrolled in two-year college	X	+ 0.7	+ 2.8	0	+ 9.8
Enrolled in four-year public college	–6.8	X	X	X	X
Enrolled in four-year private college	–5.8	+ 5.0[b]	+ 10.5[b]		+ 3.1

Source: College Board Data matched to National Student Clearinghouse.

Notes: 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.

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

b. With both reduced public college tuition and targeted elimination of tuition and fees at four-year public colleges, our simulation estimates that 5.0 percent of the students who previously enrolled at a four-year private college would switch to a four-year public college.

Table 7b. Decomposition Analysis of Effects of the Different Interventions: Change in Probability of Completing a Bachelor's Degree

Baseline enrollment choice	*Free two-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 two-year college	+ 0.1	+ 0.2	+ 0.7	+ 0.1	+ 3.0
Enrolled in four-year public college	–2.8	+ 0.5	+ 1.5	+ 1.8	+ 0.4
Enrolled in four-year private college	–2.4	+ 0.1	+ 0.2	0	+ 0.3

Source: College Board Data matched to National Student Clearinghouse.

Note: 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

	Cost per student-year ($)	*Change in bachelor's degree completion rate*	*Cost per additional bachelor's degree ($)*
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	1,545.0	+ 1,445	4.62

Source: Authors' calculations.

Note: We compute cost-benefit ratios for projected increases in bachelor's degree 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 percent of students who enroll initially in a four-year college complete a bachelor's degree, with an average of 4.6 years of enrollment per student who completes a bachelor's degree and an average of 1.5 years of enrollment per student who does not complete a bachelor's degree.

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 a 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 versus 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. The tables provide the cost averaged over *all* students (including students affected and unaffected by the policy) for a single year. The tables also contain the average change

in the bachelor's degree rate computed across all students. To turn these numbers into a cost per additional bachelor's degree, we need to multiply the annual cost by the average years spent in college and then divide by the increase in the bachelor's degree completion rate. The average number of years of enrollment is 3.4 for students starting at four-year institutions. Finally we scale up our cost per bachelor's degree from 2007 dollars to present-day dollars with a 1.27 multiplier.[36]

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 postsecondary degree, but it does so at the expense of bachelor's degrees. With this background, it is interesting that this policy has gained so much traction in recent practice. On the positive side, with about 70 percent 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 the lowest quartile of students in terms of academic achievement and future earning potential. Even so, the design of most free community college policies excludes students from lowest-income families as these students would already be 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 bachelor's degree completion. To have a neutral effect on bachelor's

36. We use the Bureau of Labor Statistics' CPI inflation calculator to derive this multiplier; see 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. For example, Ma and others (2019, fig. 9) report a 35 percent increase in published prices for four-year public colleges from 2008 to 2018 in 2018 dollars, but they also report a 30 percent 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.

degree completion, a free community college policy would need to attract approximately four 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 one to one. 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 (forthcoming), increasing college enrollment is not an attractive route for increasing bachelor's degree completion at this point.

Reducing tuition is projected to have positive results, but at about twice the cost per degree of increasing spending at public colleges. On average reducing tuition yields a cost per additional bachelor's degree of $270,000. 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 bachelor's 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 bachelor's degree 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 bachelor's degree 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 bachelor's degree. The cost per additional bachelor's degree is $114,000. 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"). This modeling choice accords with the point Dynarski and others (2019) make about the high impact of advertising college as free. As shown in table 7b, we project

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.

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 affect 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 bachelor's degree completion to be about 3.7 times as large as the positive effect of a 10 percent tuition reduction at four-year public colleges. Thus, a policy that combines free community college with a 30–40 percent tuition reduction at four-year public colleges would likely be projected to be nearly neutral in terms of its effect on bachelor's degree completion.

The BISPO policy is projected to have effects on the same order as, or slightly worse than, reducing college tuition. BISPO with limited supply expansion costs roughly $250,000 per additional bachelor's degree. This is approximately twice the cost of increased spending at public colleges ($121,000 per bachelor's degree). In essence, the comparison of 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 bachelor's degrees by moving students to high-cost institutions with high graduation rates 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 observation that more selective public colleges have a broader mission than simply educating undergraduates.

To test this further, we have tried subdividing our sample of students into quartiles of the bachelor's degree completion rate of their starting institution. Because of IPEDS data limitations, we can do this only for students who begin at a four-year institution. These results confirm our intuition that there is a lot of bang for the buck in increasing spending or lowering tuition for students at less expensive, lower-performing public institutions.

Consider the policy of boosting spending at four-year public institutions. Students who begin at four-year public institutions in the bottom quartile

of bachelor's degree completion rates see increased rates of 2.7 percentage points and the cost per additional bachelor's degree is $156,000. Students in top quartile institutions see only a .1 percentage point increase in the bachelor's degree completion rate and the cost per bachelor's degree is $323,000. Note that because this is only for the subset of students starting in four-year public institutions, these outcomes will not add up to the average outcome of the policy for all students.

A similar result obtains for the policy of free tuition and fees for students with family incomes of less than $60,000. Students from bottom quartile public institutions see increases in the bachelor's degree completion rate of 1.9 percentage points at a cost per bachelor's degree of $94,000. Students from top quartile institutions see a smaller increase in the bachelor's degree completion rate (1.2 pp) and a larger cost per bachelor's degree at $248,000. This higher cost stems from the higher costs of attendance at the higher-performing institutions. Overall these results suggest that there is significant value in increased spending or free tuition at the four-year public colleges with lower bachelor's degree completion rates.

VI.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 statewide 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.

DECISIONS BY MARGINAL STUDENTS As shown in table 7b, we project largest or near-largest increases in bachelor's degree 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 complete a bachelor's 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.

The above discussion highlights the problems of identifying elasticities for the marginal college entrant in our simulations. As one robustness check, we rerun our simulations, cutting the graduation responses to the policies in half. Interestingly we still find that boosting spending and cutting tuition for families with less than $60,000 in income are still highly cost effective. The cost per additional bachelor's degree for the spending boost policy rises to $133,000 and the cost per additional bachelor's degree for the income-targeted free tuition policy rises to $126,000.

ROBUSTNESS ANALYSIS WITH VARYING ELASTICITY VALUES As we note above in footnote 35 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 public colleges. Based on the Tennessee and Oregon policy shocks, we estimate the propensity of four-year college students to switch to two-year public colleges to have a price elasticity (with respect to the two-year tuition price) of .075. This is the midpoint between the Tennessee and Oregon estimates. To eliminate the negative bachelor's degree graduation effects of the policy (and also the negative earnings

impacts of the policy), we need to drop this elasticity to .025. This creates bachelor's degree impacts of zero while raising associate 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 bachelor's degree of increased spending per student is truly half the cost per bachelor's degree of reducing tuition. We address this question by checking the robustness of our finding to different elasticities of enrollment in four-year public colleges and bachelor's degree attainment with respect to four-year tuition and fees. Our simulations show that the impacts of the policy on bachelor's degree 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 roughly halved. With smaller elasticities we estimated the cost per bachelor's degree of increased spending at $212,000 per additional bachelor's degree which is quite similar to cost per additional bachelor's degree 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 bachelor's degree completion and the other policies, which seem almost necessarily to have positive effects.[38]

VI.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 $121,000 in 2019 dollars per additional bachelor's degree—is roughly equivalent to that of the most positive results demonstrated in the prior literature.[39] The cost-benefit results for reducing tuition and the BISPO

38. The possible exception to this is tuition reduction at four-year colleges; see Cohodes and Goodman (2014).

39. For example, Barr (2015) for the GI Bill, Bettinger and others (2019) for the Cal Grant, and Scott-Clayton (2011) for the West Virginia Promise Scholarship. Castleman and Long (2016) produce a much lower estimate of $28,000 per additional bachelor's 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.

policy are about 2.5–3 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 successfully target the marginal students with greatest propensity to improve their educational outcomes.

The actual cost (in terms of tuition and fees) for sending a single student through a public college to bachelor's degree completion is roughly $22,800. We estimate this in two ways. The mean net tuition and fees in our data is $3,990 in 2007 dollars. Once we adjust this to 2019 dollars and calculate the average number of years in school to complete, we obtain $\$3{,}990 \times 1.27 \times 4.5 \approx \$22{,}800$. If we instead use the College Board's *Trends in College Pricing 2018*, we obtain an estimate of $\$3{,}780 \times 4.5 \approx \$17{,}000$. Naturally the cost of creating additional bachelor's degrees via price or spending subsidies exceeds the actual cost of sending the single marginal student through college. In fact our results suggest that even for a successful policy like eliminating tuition for families with less than $60,000 in annual income, for each $1 spent on a marginal student who is induced to complete a bachelor's degree, an additional $5 is spent on each inframarginal student.

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.

In general, we view the cost-benefit estimates of table 8 as presenting the clear message that it is important and likely cost effective to increase spending on one or more policies to increase completion of four-year bachelor's degrees. But it is imperative to avoid the temptation of enacting low-cost policies that are politically viable but that do not take on the systemic problems in current practice that limit completion rates. Reducing or eliminating tuition at two-year public colleges may seem superficially attractive and also inexpensive, but this policy only indirectly addresses the

challenge of low completion rates at two-year colleges. Similarly, a policy that reduces tuition but simultaneously cuts expenditures to compensate for lost tuition revenue cannot be expected to have a substantive effect on student outcomes.

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Comments and Discussion

COMMENT BY

SUSAN M. DYNARSKI This paper presents a timely and thorough analysis of policies to increase the supply of college graduates. The authors analyze a number of options for increasing the production of baccalaureate degrees in the United States, from free college to improving the quality of public postsecondary institutions.

Degrees matter in the labor market. The earnings of workers with some college credits but no bachelor's degree look more like those of high school graduates than college graduates (Autor 2014). The bachelor's degree is a clear dividing line in the earnings distribution. Expanding the supply of college graduates holds the promise of both reducing income inequality and increasing worker productivity (Goldin and Katz 2010).

The divide is even starker when we consider historical growth in earnings. For nearly half a century, earnings growth has been concentrated among those who have at least a bachelor's degree. The fastest growth of all is among those with advanced degrees, such as a master's in business or medicine. The earnings of workers without a bachelor's degree have either stagnated or dropped, depending on the deflator used (Autor 2014).

Yet the United States has stumbled in increasing the supply of college graduates. College entry has grown rapidly, with 70 percent of high school graduates now heading to college. Almost all of them intend to earn a degree (Jacob and Wilder 2011), but many of them will drop out before reaching that goal. Six years after starting college, just about half of students have earned a bachelor's degree.

The United States has a much higher college dropout rate than other developed countries. In part, this is because our postsecondary system is far more open than most. Our nonselective schools, including community colleges, give students who want to try out college the opportunity to

fail. By contrast, in many countries, colleges—especially those that grant baccalaureate degrees—are open only to the very top performers in secondary school (OECD 2019).

The optimal dropout rate is certainly not zero. Students learn about themselves and about college when they matriculate, and for some the right decision is to leave (Manski 1989; Stange 2012). But it is also certain that the optimal dropout rate is not as high as 50 percent. There is room for improving the degree production of U.S. colleges, and this paper examines paths to that end.

THE GOAL OF THE PAPER It is important to understand what the paper does and does not set out to do. The authors examine the effect of a set of policies on the production of bachelor's degrees. The goal of the paper is to predict which policy will most efficiently increase the supply of bachelor's degrees, that is, which policy delivers the biggest baccalaureate bang for the buck.

The paper does *not* attempt a social welfare analysis of the four policies it examines. The paper does not tell us which policy is best because that depends on one's policy goals and distributional preferences. The paper's metric of policy success is efficient production of baccalaureate degrees.

Making community college free has little impact on baccalaureate production, the authors conclude, and so that policy ranks low in this particular horse race. In a different horse race—one focusing on boosting earnings at the bottom of the distribution or reducing student debt burdens—free community college might well move up in the rankings.

THE ELASTICITIES The paper uses a simulation model to estimate the effect of each policy on the supply of bachelor's degrees. The authors calibrate the model using parameters from a growing body of well-identified evidence that estimates the causal impact of a range of postsecondary policies on educational attainment. They do a heroic job of converting parameter estimates from multiple methodologies, settings, and policies into a set of elasticities that they apply in the simulation model.

The elasticities are at the heart of the authors' findings. They are used to predict how efficiently a given policy will convert dollars into baccalaureate degrees. The authors survey a broad range of research in pursuit of estimates that will help them predict the effectiveness of postsecondary policies. There are no perfect matches between the existing evidence and the proposed policies. There never are, of course. The important question is whether gaps in the evidence produce any serious blind spots in our policy predictions.

First, what we know.

We have pretty strong evidence that getting students enrolled in colleges with better resources will increase the likelihood those students will graduate (Hoekstra 2009; Zimmerman 2014; Dillon and Smith 2018). In the past it was unclear whether selection was the whole story, with better students going to better colleges. But we have compelling evidence that at least some of the correlation is causal. Expanding the supply of strong four-year colleges will almost certainly boost the production of baccalaureate degrees. We also have solid evidence that reducing the price of four-year colleges gets more students to attend college and graduate with a bachelor's degree (Page and Scott-Clayton 2016; Dynarski 2000; Cornwell, Mustard, and Sridhar 2006; Dynarski 2008; Dynarski 2003; Bettinger and others 2019; Scott-Clayton 2011; Scott-Clayton and Zafar 2019; Castleman and Long 2016).

All of this evidence provides a strong foundation for the simulations that estimate the effect on baccalaureate production of investing in four-year public colleges and reducing the price of those colleges.

Second, what we don't know.

We have a relatively weak understanding of how policy changes in the community college sector affect the production of baccalaureate degrees.

Do cheaper community colleges divert students from four-year colleges, thereby reducing the production of bachelor's degrees? Or do they so widen the pipeline of students entering postsecondary education, some of whom transfer to four-year colleges, that they increase the production of bachelor's degrees (Rouse 1995)? Which causal channel dominates determines whether making community college free will increase or decrease the supply of bachelor's degrees.

Which causal channel dominates also depends heavily on the institutional context, which varies from state to state (Kane and Rouse 1999). We have evidence on these questions from a couple of states, but the institutional context is so important here that the external validity of this evidence is likely very limited. California has a robust community college system and a robust state university system, and legislation governs students' ability to transfer credits between the two. Michigan has no community college system or state university system, and credit transfers depend on the existence and extent of pairwise articulation agreements between each community college and university. Evidence on the effect of free college in Michigan is unlikely to validly extrapolate to California, and vice versa.

THE POWER OF ZERO Demand elasticities have a straightforward functional form. A given percentage change in price charged is predicted to produce a given percentage change in quantity purchased.

Prices in postsecondary education are anything but straightforward. The price a student pays is a function not just of tuition prices but of financial aid provided by the federal and state governments, as well as colleges themselves. The sticker price is a poor predictor of this net price, especially for low-income students who qualify for need-based grants. As the authors rightly point out, in almost every state, the net price of community college is already zero for low-income students, since federal Pell Grants more than cover tuition costs. They conclude that free community college initiatives will have little effect on the schooling choices of low-income students because their net price is unchanged.

But a growing body of evidence shows that students don't know of or respond to the aid for which they are theoretically eligible (Bettinger and others 2012; Dynarski and Scott-Clayton 2006). The aid system in the United States is complicated and opaque, and students can't respond to a price subsidy they don't know about. A policy that prominently sets community college tuition to zero may well boost the enrollment of students who, in principle, already faced a net price of zero.

In Michigan, an initiative promised upfront the free tuition for which students would be eligible, *in expectation*, after they completed the financial aid process (Dynarski and others 2018). From a purely financial perspective, there was zero change in college prices for these students. An elasticity analysis would predict zero change in demand. Yet students who got this offer were three times as likely to apply as students who did not. The implication is that a "free college" program may have a much larger effect on educational attainment than an elasticity would predict.

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COMMENT BY

CAROLINE HOXBY Once, in the not too distant past, I sat down with a governor of the state of New Jersey to discuss higher education policy. The governor turned to boasting about the state's New Jersey Student Tuition Assistance Reward Scholarship (NJ STARS) program which, according to the governor, was increasing the state's share of students who obtained high-quality baccalaureate degrees, thereby making the state a more attractive location for employers who needed skilled workers.

My immediate thought was that NJ STARS was one of the most ill-conceived policies ever implemented in American higher education. Any serious economist of higher education would recognize, as soon as he or she learned how the program worked, that NJ STARS was unlikely to produce the intended effect. Worse, the program was at least somewhat likely, if not very likely, to produce the *opposite* of the intended effect. Since I did not know the governor well, I tried to explain these points in a tactful manner.

Briefly, NJ STARS offers a college scholarship to New Jersey's highest achieving students (those in the top 15 percent), but only if the student begins postsecondary education at his or her local two-year public college. After two years there, if the student is interested in transferring to a four-year public college and has accumulated all the necessary credits with strong grades, he or she can apply to transfer and receive some additional scholarship benefits.[1]

1. The source is "NJ STARS Fact Sheet for 2019 High School Graduates" (Higher Education Student Assistance Authority 2019).

NJ STARS is ill-conceived for two main reasons that should be obvious to any economist of higher education. First, the state's highest-achieving students are precisely those who are best prepared for the curriculum offered by four-year institutions. Most of them, in the absence of the program, would be among the most likely to attain a baccalaureate degree creditably and on time so long as they initiated their postsecondary education at a four-year school—which the vast majority of them would do. However, if the same students were induced to start their postsecondary education at a two-year school, the evidence suggests that they would be less likely to attain a baccalaureate degree at all or would attain it more slowly.[2] Through this channel, the share of students attaining a high-quality baccalaureate degree in the state would be likely to fall—exactly the opposite of the intended effect.

Now, some might argue that this negative channel would likely apply mainly to middle- or higher-income students whose families could afford tuition in the absence of the scholarship. According to this argument, the scholarship might induce *poor* high achievers, who might otherwise fail to enroll at all, to attend at least a two-year school. Might not this potentially positive effect offset the aforementioned expected negative effect? Unfortunately, here again, NJ STARS was ill-conceived. Poor students were already qualified for the federal Pell Grant which covered most costs at the state's two-year schools. So, in fact, the NJ STARS scholarship had little value for poor students initiating their education at such institutions. Thus the positive channel was likely to be moribund.

In my meeting, I tried to walk the governor and the governor's aides through these points but with little success. They could not keep track of the moving parts. Students induced to begin at two-year colleges being less likely to graduate from four-year colleges? Two-year college tuition already being paid for poor students by Pell Grants? It was all too confusing. Who could possibly know about these effects or understand the interactions? In any case, NJ STARS was already in place and had developed its own brand of policy inertia.

I begin my discussion of "Policies and Payoffs to Addressing America's College Graduation Deficit" by Christopher Avery, Jessica Howell, Matea Pender, and Bruce Sacerdote with this long anecdote for a reason. As I read their paper, I realized that it was exactly what I had needed in my conversation with the governor. While the paper has limitations, noted below, what it does well is produce plausible answers to policy

2. See, for instance, Long and Kurlaender (2008).

questions along the lines of "Is a program like NJ STARS likely to generate its intended effects?" Specifically, the paper sets up a "machine" for answering such questions. It cannot produce answers of the same quality that one could obtain by conducting a very credible evaluation of the program itself—an evaluation that would probably require randomized assignment of the scholarship, something anathema to most policymakers. But the advantage of the authors' machine is that it can answer questions before an actual program is put in place and has the opportunity to develop the inertia that makes evaluation difficult. There are some questions that the authors' machine cannot answer and the inputs to the machine might be improved in the future, but for a range of questions one can crank the handle and their machine will produce reasonable predictions.

WHAT THE PAPER DOES The authors do a good job of explaining what they attempt to do and how the attempt is made. Nevertheless, it may help readers understand what the paper does if I consider how I might run NJ STARS through the machine. In the anecdote above, I implicitly relied on certain information to predict the most basic effects of the program:

1. Which students would be induced by the program to switch from four-year to two-year schools when initiating their postsecondary education? From which four-year schools would they switch? From selective public schools? From nonprofit private schools?

2. Which students (if any) would be induced by the program to switch from no college to at least some postsecondary education?

3. What would be the family incomes of the students who switched from four-year to two-year schools? Of the students (if any) who switched from no college to at least some postsecondary education?

4. What would be the causal effect of all this induced switching on the receipt of baccalaureate degrees, quality-adjusted (since four-year colleges differ substantially)? What would be the causal effect on the receipt of two-year degrees? On how quickly degrees were obtained?

If I had wanted to produce a fuller accounting of the likely effects of the program on the state of New Jersey, I would have needed some additional information:

5. How much would costs change vis-à-vis having no program in place? Would the cost of a four-year degree fall (since it would be more likely to have started at a cheaper two-year school) or rise (since it might take longer to obtain or be less likely to be obtained at all)? Similar cost questions arise for two-year degrees.

6. How would cost changes be split between families and taxpayers? Would there be distributional effects?

7. How would prospective students' earnings change? Would changes in lifetime discounted earnings likely produce a reasonable return on social investment?

8. Since the program would be unlikely to affect poorer and richer students equally, would there be distributional effects of the program—redistribution from poorer to richer students, say?

9. Would the program affect the supply side of postsecondary education, especially the supply of private, as opposed to public, college education?

10. Would the program affect migration of prospective students out of state?

11. Would the program alter the incentives of students to be high achievers? If so, which students would be affected?

The authors attempt to tackle, to at least some degree, the first seven of the questions posed above. They also discuss, much more lightly, some of the remaining questions. They take on these questions by deploying data on individual students who appear in the College Board's data and applying to these students estimates of the answers to the questions posed above. Thus, if they were evaluating NJ STARS, they would take existing estimates from the economics literature on the extent to which a scholarship would induce switching from four-year to two-year institutions. They would apply it to their student data in an attempt to answer the first question posed above. And, they would proceed in that manner through the remaining questions that they attempt to tackle. Eventually, they would gather up the results from all of the questions and attempt to answer questions along the lines of "Did NJ STARS increase quality-adjusted baccalaureate degree attainment?" and "What was the return on investment of the NJ STARS program, from society's point of view (that is, including taxpayer-funded costs and students' future earnings)?"

Of course, the authors do not consider NJ STARS; that is just my evocative example. However, they do consider several policies that are highly relevant to current policy debates. In particular, they consider free community college, reductions in the tuition of four-year public colleges, higher spending at public colleges, and the speculative idea of moving students to what the authors call the "best available in-state public college." (It is unclear how the last of these options would be implemented, but it is an interesting thought experiment.)

THE STRENGTHS OF THE AUTHORS' MACHINE There are two features that are indispensable to the working of the authors' machine. First, they have fairly rich data on individual students so that, when they apply estimates from

the literature, they can—for instance—differentiate between the effects for high-achieving and low-achieving students or between the effects for high-income and low-income students. Second, the authors use estimates of the effects ("estimated parameters") that are credibly causal. This last feature is absolutely crucial because all of the questions posed above are causal questions. Identification strategies that do not produce credibly causal estimates are likely to produce biased answers to the questions.

For instance, consider that—without the inducement of an NJ STARS-like program—it is anomalous for high achievers to commence college at a two-year school rather than a four-year school.[3] Thus, when we observe high achievers at a two-year school, we might reasonably infer that some unobserved factor (such as the need to live at home to support a disabled family member) has caused them to make an unusual choice. One cannot simply take the outcomes of current high achievers at two-year schools and assume that those outcomes would apply to high achievers induced to attend two-year schools by some policy. One needs to have a credibly causal estimate of how high achievers' outcomes change when they are induced by a scholarship, financial aid, or some other tuition policy to attend a two-year school.

This is just one example of the sort of credibly causal parameter estimate the authors need. They need a good number of others, and a lot of their work for this paper went into scouring the literature and making careful decisions about the estimates to use. This work is somewhat hidden because much of it appears only in appendices. Nevertheless, it matters greatly.

Summing up, the strength of the authors' machine is that it allows them credibly to distinguish effects among different types of students and among different types of schools. Even if we should not put much faith in the exact estimates produced by the machine, it tends to reveal the key forces and the basic magnitudes of those forces. For instance, it reveals that free community college has at best ambiguous effects on degree completion: fewer baccalaureate degrees somewhat offset by more associate degrees. It also reveals that free community college conveys few benefits to low-income students because financial aid already covers most of their tuition and fees at two-year public schools.

3. The source is my calculations based on College Board, ACT, and National Student Clearinghouse data. These data are described in detail in Hoxby and Avery (2013). These data are the best source and also have the benefit of being largely aligned with the data used in the paper on which this is a comment. (The difference is that ACT data were not available to the authors of the paper under discussion. This point is discussed below.) Another calculation that I made to confirm this fact is based on the High School Longitudinal Study (HSLS), the most recent NCES longitudinal data set.

THE LIMITATIONS OF THE AUTHORS' MACHINE So far, I have emphasized the machine's strengths and its usefulness. What are its limitations? First, the machine is only as good as the parameter estimates fed into it. There are a few reasons why the estimates are problematic. Some of the estimates are based on fairly weak empirical strategies, even if they are among the best available. On many causal questions, there just is not a convincing, recent study that has produced reasonably precise estimates. Also, the estimates used are frequently local to some population: a single state or even a single county; a group of students near some peculiar policy threshold such as a test score cutoff. Some of the estimates are generated by evaluations of idiosyncratic policies that are only modestly related to the far more general policies considered by the authors. Furthermore, the estimates used are often noisy, and the authors' machine is not built to account for all of the potential sources of error. In short, since the estimates have a variety of problems, I encourage the reader to view the findings as a good starting place and as a showing of the main forces, not as precise predictions.

To be clear, the problems associated with the parameter estimates could be remedied over time as new, more credible, more applicable estimates are produced by researchers. Thus, this is not a fundamental limitation of the authors' machine: it is an opportunity for future improvements. While I would not task the authors with revising their paper as each new estimate is released, I would not be surprised if another scholar comes along in the future and—starting from the authors' work—revises their evaluations or evaluates additional policies that may be under consideration at that future time.

A more serious limitation is that the data that the authors use are not representative of possible college students in the United States. This is for several reasons. Although about 80 percent of students in current U.S. high school cohorts will eventually enroll in some postsecondary school, only about 44 percent of them take one of the College Board tests (the PSAT or SAT).[4] This is partly because some students take one of the ACT tests instead

4. The source for the 80 percent number is my calculations based on projecting detailed educational attainment of 30-year-olds using the American Community Survey from 2000 to 2018 (Ruggles and others 2019) along with the percentages of the population of 18- to 24-year-olds from the same birth cohorts who were enrolled in various levels of school from National Center for Education Statistics, Digest of Education Statistics, table 103.20 (Snyder, de Brey, and Dillow 2019). The sources for the approximate rates of College Board test taking are *2014–15 College-Bound High School Sophomores: Summary Report* (College Board 2015) and *2016 College Bound Seniors: Total Group Profile Report* (College Board 2016).

(PLAN, the PreACT, or ACT) and partly because about a third of students take neither a College Board nor an ACT test.[5] Moreover, the students who are missing from the authors' data are by no means a random sample.

Why? States located in the middle of the country tend to be severely underrepresented in the authors' data because those states tend to contract with ACT.[6] In such states, it is typically only those students who aspire to attend a very selective out-of-state college who take the SAT in addition to the ACT. The result of this limitation is that the authors' findings are local to states that are not dominated by ACT. The findings are also somewhat skewed toward the behavior of high-achieving students who are not too concerned about attending close to home. These are issues that could potentially be addressed by future authors who have access to ACT as well as College Board data.

Moreover, students who are less well prepared for college tend not to take a College Board test or any college aptitude examination. We know this from studies of what occurs when a school district or state makes the SAT or ACT mandatory.[7] The students who are shifted from being non–test takers to test takers are very disproportionately low achievers. When testing is not mandatory, students who would end up with top decile scores are almost certain to take a test anyway while students who would end up with bottom decile scores are almost certain *not* to take one. Between the top and bottom deciles, the probability that a student takes a test—when it is not mandatory—declines monotonically. This

5. Because some students take both College Board and ACT tests, it is hard to determine exactly how many students are tested by at least one of the organizations. However, in the cohorts relevant to the paper, the ACT tested about 32 percent of students and about 15 percent of students took both organizations' tests. Thus, a reasonable estimate is that 61 to 66 percent of students in recent cohorts are tested by one of the two organizations. Another way to calculate a similar number is to focus on sophomores, many of whom are required to take an ACT or College Board test even as the tests for juniors and seniors are optional. Also, compared to seniors, sophomores who take an ACT test are less likely to take a College Board test and vice versa. Thus, sophomores are less likely to be double-counted in the test-taking rate. The sophomore-focused reports are *2014-15 College-Bound High School Sophomores: Summary Report* (College Board 2015) and *Building Momentum: The Condition of Progress toward College Readiness* (ACT 2016).

6. States that are dominated by ACT as opposed to the College Board change every year as the two organizations write new contracts. However, ACT is more likely to be dominant in states that are in the middle of the country, and the College Board is more likely to be dominant in coastal states. For instance, in recent years that are reflected in the authors' data for this paper, the following states have been ACT-dominant states: Alabama, Arkansas, Hawaii, Kentucky, Illinois, Louisiana, Michigan, Mississippi, Missouri, Montana, Nebraska, Nevada, North Carolina, North Dakota, South Carolina, Utah, Wisconsin, and Wyoming.

7. See Klasik (2013), Bulman (2015), and Hyman (2017).

limitation of the data has serious consequences for the usefulness of the authors' machine, as described in the next section. Before that discussion, though, let me briefly note some other limitations of the exercise.

In my experience, the income measures contained in the College Board data are poor in accuracy. Many students do not report their family income at all in the Student Data Questionnaire, a survey that they are asked to fill out before taking the SAT. Students who do answer the question often give replies that appear implausible when we compare their replies to tax data and American Community Survey data. None of this is really surprising: many students may have only a vague idea of their family income, especially as they are asked to report it before their parents have filled out the Free Application for Federal Student Aid (FAFSA). Nevertheless, using inaccurate income data is obviously a problem for evaluating policies that change the availability of financial aid or the level of tuition.

On a related note, nearly all of the policies that the authors consider have consequences for the regressivity or progressivity of government policy. For instance, policies that reduce tuition or increase funding at selective public universities may be regressive because affluent students are substantially more likely to be well qualified for admission there. If those same affluent students end up with higher earnings in consequence, those earnings will also affect the income distribution. Despite the fact that so many Americans are currently interested in income inequality, and therefore in the regressivity or progressivity of policies, the paper does not give much attention to such issues. This inattention may be a reflection of the low accuracy of the income data: the necessary calculations might well push the data beyond their capacities.

For-profit institutions play a larger role in American higher education with each passing year. In 2017, they accounted for 7 percent of postsecondary enrollment, about 2.2 million students.[8] The University of Phoenix alone enrolls about 180,000 students, at least half of whom make use of one of the federal grant or subsidized loan programs. An additional and large share make use of the tax benefits for tuition and fees.[9] Thus, we

8. See the National Center for Education Statistics, Digest of Education Statistics, table 303.20 (Snyder, de Brey, and Dillow 2019).

9. The source is my calculations based on the institution-level data from the Integrated Postsecondary Education Data System, micro data for 2017–18 (National Center for Education Statistics 2019). The calculation of "at least half" includes veterans benefits but, notably, does not include federal tax benefits for tuition and fees. Were the tax benefits to be included as well, nearly all students at the University of Phoenix would be found to receive some federal aid (see Hoxby 2018).

should be deeply interested in how policies play out in these institutions. Yet the authors do not include for-profit institutions in their study. This is probably because such institutions are very underrepresented in the College Board data for the reasons described above. Regardless of the reason, omitting for-profit institutions is problematic. For instance, during the Great Recession, enrollment in nonselective colleges surged since opportunity costs were low, owing to the weak labor market. Much of the increase in enrollment occurred at for-profit institutions since community colleges, apparently, could not expand rapidly enough.[10] This suggests that community colleges and for-profit schools are fairly close substitutes. Thus, a policy like free community college might have a profound effect on for-profit enrollment.

The elasticity estimates that the authors use are drawn from partial equilibrium studies whereas the policies they consider would induce general equilibrium effects. For instance, making community college free or reducing public colleges' tuition would also certainly affect students' preparation for college, the tuition charged by for-profit institutions, and the supply of nonprofit colleges. There is not much that the authors can do about the gap between partial equilibrium estimates and general equilibrium consequences. To their credit, they discuss general equilibrium issues coherently. Nevertheless, the gap exists and is a limitation.

THE ELEPHANT IN THE ROOM I began these comments with an anecdote about NJ STARS, a program for high-achieving students who are well prepared for very selective colleges. This was deliberate because the authors' machine is ideally suited for answering questions about programs like NJ STARS. However, it is much less well suited for answering questions about some of the policies that the authors actually consider—especially, but not only, free community college.

Why is this? When I consider any of the policies that the authors consider, one of my primary concerns—often my dominant concern—is whether students who will fail in college and who would be better off pursuing some other activity (vocational training, a job in which they would gain skills, the military, and so on) will be induced to enroll, often ending up with no degree, wasting valuable time, and sometimes ending up with loans that they cannot repay. The evidence indicates that a large share of American students are not prepared for college and are likely to drop out because they are unable to do the work.[11] The lack of college preparedness

10. See, for example, Deming, Goldin, and Katz (2013).
11. Some of the best evidence comes from Stinebrickner and Stinebrickner (2012).

among students is the elephant in the room in all debates about U.S. postsecondary education. Many of the things that go wrong in American higher education—the high dropout rate, the student loan crisis, the flourishing of shady institutions that deceive students or illegally receive federal aid—have origins in the country's failure to turn out high school students who are prepared for college.

The most widely used definition of *college-ready* is not arbitrary but, instead, empirical. The ACT, for instance, defines it as "the knowledge and skills a student needs to enroll in and succeed in credit-bearing first-year courses at a postsecondary institution (such as a two- or four-year college, trade school, or technical school) without the need for remediation" (ACT, n.d.). The ACT determines its threshold for college-readiness by examining which students fail to pass introductory classes and fail to get the grades to continue in academic standing as postsecondary students. Since the institutions used to set the threshold include two-year colleges, trade schools, and technical schools, the standard is not high.

The ACT and other organizations regularly recheck their thresholds for college readiness using evidence on college success so the thresholds vary slightly over the years. However, they tend to be close to the "proficient" threshold used by the National Assessment of Educational Progress (NAEP), the only test mandated to be taken at very regular intervals by a representative sample of American students.[12] In the most recent assessments of twelfth graders, 25 percent were rated as proficient in math, 22 percent proficient in science, 37 percent proficient in reading, and 27 percent proficient in writing.[13] In fact, since about 10 percent of students leave high school before the twelfth grade and therefore cannot be tested, the college-readiness rates are even lower than the above numbers suggest. For instance, the percentage of American students (as opposed to twelfth graders) who are college-ready in math is about 22.5 percent. Since about half of the students who have left before the twelfth grade will eventually earn the General Educational Development (GED) certificate and thus be eligible to enroll in college, their (lack of) college readiness matters too.[14]

12. In the states where 100 percent of high school graduates take the ACT, about the same percentage of students are rated as college-ready based on the ACT as are rated proficient based on the NAEP. Compare *The Condition of College and Career Readiness 2019: National* (ACT 2019, 14) to *Digest of Education Statistics 2018* (Snyder, de Brey, and Dillow 2019, 155).

13. The most recent assessments for twelfth graders in math, science, and reading were in 2015. The most recent assessment in writing was in 2011. See table 221.20 in *Digest of Education Statistics 2018* (Snyder, de Brey, and Dillow 2019, 155).

14. The source is my calculation based on the American Community Survey, 2000 to 2018.

Since the late 1970s, when twelfth graders first took NAEP tests, their proficiency has remained strikingly similar to the latest results, just mentioned.[15] Yet, in the late 1970s, only about 50 percent of the population eventually enrolled in postsecondary education.[16] In other words, in those days, the share of students who were college-ready was less, but not grossly less, than the share who would eventually enroll. Today, even though current students are no more likely to be college-ready than 1970s students, a reasonable projection is that about 80 percent of today's students will eventually enroll in postsecondary education.[17] This means at least 55 percent of enrollees will probably lack adequate preparation in one or more core subjects. Put another way, marginally prepared students are now not the exception: they are the rule. No one should be surprised, therefore, that the United States has a remarkably low percentage of postsecondary students who complete (within 150 percent of the normal time required) the degree that is their goal when they enroll.

Like many other economists, my assessment is that the United States needs to induce an ever-increasing share of its population to gain the skills we associate with higher education. That is just the way the economy is evolving, owing to forces from trade and technology. However, my assessment is about the need for skills, while many policies seem only to have induced a larger share of students to enroll in postsecondary education regardless of whether they were prepared and regardless of whether they were likely to acquire skills. Over the past few decades, U.S. colleges have dug deeper and deeper into the ranks of students who are only marginally prepared. These marginally prepared students are the "swing" students—the students whose conduct ultimately dominates how most policy innovations have worked out.

It is tempting for scholars to focus on fairly high-achieving students, like those in the NJ STARS program or those who are overrepresented in the College Board data. But we ought instead to be focused on marginally prepared students when we evaluate many policy innovations like free community college or reduced tuition at public colleges. Because marginally prepared students are woefully underrepresented in the College Board data, the authors' machine is not designed to allow us to focus on these crucial students. Thus the machine can deliver meaningful findings on

15. Source: author's analysis of the NAEP data available for interactive analysis (Data Explorer) on the NCES website.

16. The source is my calculation based on the detailed educational attainment of 30-year-olds in the 5 percent micro data sample of the 1980 Census of Population and Housing.

17. See note 4.

some important questions in higher education but, on other questions, it cannot. This is the elephant in the room.

SUMMING UP Despite my discussion of limitations and the elephant in the room, I plan to rely on the key findings in this paper, at least as regards their signs and general magnitudes (as opposed to the point estimates) for the sort of questions that the authors' machine answers well. That is a compliment to their work. And should I encounter another governor of New Jersey, I might just have a copy of the paper ready to hand over in order to back up my analysis.

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GENERAL DISCUSSION Drawing off Caroline Hoxby's concern about the authors' limited engagement with low levels of college preparation among high school students, Bob Gordon began by raising the additional concern that even among students who complete their college credential, many struggle to find a job that requires a college education. He noted that between 40 and 45 percent of graduates from a four-year college are underemployed and reiterated the importance of this finding, namely, that it highlights a discrepancy between the value of a college education as measured by median income and the value of a college education for those who end up in the bottom quarter of the income distribution, as those who struggle the most to find a college-level job are most often those who had the lowest levels of college preparation. Therefore, he concluded, measuring college outcomes by median income biases many of the estimates in this paper because the returns to a college education are overstated for the marginal individual who is moving from a two-year college to a four-year college.

Justin Wolfers offered two observations. First, certain institutions are better at graduating students than others. Consequently, one could imagine an entirely different approach to state education policy in which states with weak college systems stop offering postsecondary training altogether and instead send their students to states with postsecondary systems

that produce superior outcomes. Second, the central, high-level concern addressed in the paper is the impact of additional money on higher education. Therefore, while the authors' analysis using elasticities is informative, Wolfers argued, an important piece of information left relatively unaddressed is the supply-side effect of the various policies outlined in the paper.

Harry Holzer urged the authors to place greater emphasis in the paper on outcomes besides bachelor's degree attainment, particularly associate degree and certificate attainment at community colleges; these institutions, he noted, are radically under-resourced despite supporting a large number of disadvantaged students. He agreed with the authors' argument that providing significantly more funding to community colleges would have a positive effect but also acknowledged its limited feasibility given the fiscal reality of state budgets. Giving these budgetary constraints, Holzer encouraged participants to consider where money spent would have the greatest impact. In this case, he argued that occupational programs with strong labor market value are among the most optimal targets for limited state appropriations.

Ed Lazear wondered about the role of forgivable loans in boosting college retention and completion rates. Drawing off his time on a Stanford University financial aid committee, Lazear raised the point that even if students are not financially needy, the majority of their assets may be relatively illiquid, which raises the question of whether these students should be receiving forgivable loans or tuition waivers. Lazear cited data he had gathered with colleagues that examined the differential effects of forgivable loans and tuition waivers on the probability that a student would accept admission to Stanford over Harvard. Results indicated that the forgivable loan affected behavior in nearly the same way as the grant. In light of this finding, Lazear concluded that examining forgivable loans as a viable practice may be worthwhile.

Robert Hall remarked that there is a fundamental policy design issue surrounding higher education reform that is neglected both in this paper and in the broader policy arena, namely, increasing barriers of entry into the middle class. He noted that a once-poor family loses their earned income tax credit (EITC) upon moving into the middle class, along with their ability to acquire need-based postsecondary assistance, particularly Pell Grants. Problems of this sort, he concluded, must be considered in any substantive conversation about America's graduation deficit.

Richard Cooper challenged the stated objective of the paper by posing the following two questions: Why do we as a society care about the number

of bachelor's degrees? And why should that number be a focus of public policy at all? Supporting his inquiries, he remarked that a bachelor's degree surely holds market value, but because students are aware of this, post-secondary degree attainment is a private issue, not a social one. Following up on these comments, Cooper raised another concern about the paper—its disproportionate focus on the United States. Eighteen-year-olds in all rich countries face the same issues that American 18-year-olds face, he noted, and it is important when addressing this subject as a whole to draw on the experience of Western Europe.

Jason Furman advised the authors to work toward specific point estimates for the policies outlined in their paper, as opposed to general trends. He recommended starting by examining the effect of these policies on tuition, in particular, how the incidence of higher tuition rates would be distributed and how schools would allocate the additional funds. Furman also raised the question of how these policies are likely to affect the general equilibrium, that is, how much of the resulting effect is likely to be due to signaling, as opposed to a real increase in earnings. He concluded with the remark that he does not view the absence of precise point estimates as detracting from Hoxby's conclusions about the paper, only that their addition is important in future versions of the paper.

Ben Friedman raised the point that there is an unusual discontinuity in conversations about education: it is assumed that grades 11 and 12 should be provided for free, but that does not extend to grades 13 and 14. This logical disconnect, Friedman argued, bears directly on Hoxby's comment about students' low levels of college preparation. Indeed, students' performance in grade 13 will surely depend, to a certain extent, on their experience in grade 12. Friedman concluded that, while not a criticism of the paper, the literature would surely be helped if the authors' analysis was presented such that a sharp discontinuity did not exist between everything preceding grade 12 and everything following it.

Christopher Avery thanked the participants for their comments and assured them that he and his coauthors would do their best to incorporate them into the next version of the paper. Avery addressed Holzer's comment about free community colleges first. He emphasized that while those of us who study the economics of education may have a sense that free community college is bad, that is not necessarily the case among policymakers. A central objective of this paper, therefore, was to present the evidence that free community college is problematic in a clear and transparent way in the hopes of introducing that concept into the policy debate. A second important message, Avery continued, is that more spending is going to

improve student outcomes. While the magnitude of this effect may vary depending on how funds are allocated, more financial resources will have a positive effect on students.

In response to Furman's remarks about the generality of the model, and specifically whether it is revenue neutral, Avery stated that while revenue neutrality will be a useful extension of the model for future editions of the paper, the use of a non-neutral revenue model was intentional, as it eliminated corresponding outflows of money from the system and allowed estimates to be interpreted directly.

On Friedman's comment about the logical discontinuity in the consideration of grades 13 and 14 relative to grades 11 and 12, Avery noted that the higher education discourse has begun to eliminate the distinction between those two groups. He spoke specifically about Goldrick-Rab's book on the merits of free community college in which she outlines the importance of thinking about grades 13 and 14 the same way we would grades 11 and 12.[1] This is a sentiment that is becoming widely shared, Avery continued. Nevertheless, he and his coauthors decided to uphold the distinction precisely because levels of preparation for anything after grade 12 are extremely heterogeneous across students.

With respect to Lazear's remark about elasticities, Avery stated that while the Harvard versus Stanford elasticity was well-measured, certain elasticities are not applicable outside of certain contexts. Indeed, robust methodology does not render a finding universally useful.

Moving on to Susan Dynarski's remarks about the importance of considering the distributional effects of various policies, and particularly free community college, Avery responded that he and his coauthors struggled to decide on the appropriate amount of information to provide on each policy. Based on her comments, however, a useful next step may be to add in distributional detail and kernel density income estimates for the free community college policy. However, it may be unwise to provide this much detail for all of the policies, Avery noted, as it may overwhelm the reader.

Avery commented that Dynarski and Hoxby made somewhat contradictory points on the topic of pushing more students into two-year colleges. On the one hand, Dynarski spoke about the positive returns to any subbaccalaureate degree and even enrolling in a two-year college. On the other hand, Hoxby strongly emphasized that the marginal student enrolled in

1. Sara Goldrick-Rab, *Paying the Price: College Costs, Financial Aid, and the Betrayal of the American Dream* (Chicago: University of Chicago Press, 2016).

these institutions is likely to be underprepared and drop out prematurely. In response to these conflicting ideas, Avery responded that it's extremely difficult to judge what will occur out of sample. Pushing more students into two-year colleges has the potential to provide benefits by exposing them to new experiences and fostering intellectual interests. However, it may also impose unnecessary costs, including emotional and financial hardship. There are experiments being conducted in real time in Tennessee and Oregon that will provide us with rich information on this topic down the road, but we just don't know that much right now, Avery concluded.

In response to Hoxby and Dynarski's comments about the regressivity of free college proposals, Avery remarked that it is important first to understand why free college proposals are so popular. The answer is fairly simple: free college proposals sound great, and they are not that expensive. As a last dollar program, he explained, free college would require students to use all available federal funding before any tuition assistance is applied. Consequently, for students who already have their tuition covered by, say, Pell Grants, the federal government would not be required to provide any additional funds. Therefore, as Dynarski claimed, these policies are fundamentally regressive. Avery concluded by stating that he believes the policies are popular precisely because they are regressive.

On the topic of adequate representation of for-profit colleges in the data, Matea Pender clarified, first and foremost, that their sample was not composed solely of individuals who took the SAT, as that is a highly selective group composed largely of college-bound students. Instead, the sample included both SAT and PSAT takers, as the latter group is far less self-selecting and contains low-achieving students who end up attending sub-baccalaureate institutions. In addition to the initial clarification, Pender added that because their data were linked to other college outcomes, the authors had an empirically based estimate of what it means to be "college ready" based on a certain probability of students getting a C in their first semester courses in college. The authors were then able to use that estimate in their simulations as a sensitivity analysis. Indeed, they could simply condition on those who were academically ready for the opportunity they were being moved into to see how much some of the estimates were reduced.

Responding to Hoxby's remark about the limitations of the authors' in-sample elasticities, Bruce Sacerdote agreed with her critique but provided the one caveat that the state-level policies in Tennessee and Oregon are quite young and not representative of the United States. Sacerdote also offered a clarification on his earlier remarks, stating that earning a

bachelor's degree was not the only outcome of interest. Associate degrees were considered, too. One of the advantages of working with a micro data set, he continued, is that it is possible to use a more granular outcome measure, particularly credits earned, as opposed to degree attainment. While the authors did not make this choice, it could be an interesting extension to their work. Sacerdote concluded by stating his desire for U.S. Treasury data that would allow him to examine the effects of various policies on students' income, a measure that is perhaps more important than degree completion.

Returning to Holzer's comment, Avery offered a final thought on the topic of what students should be studying. He noted that there have been concerted efforts to push students into programs that will help them acquire lucrative employment following graduation, namely, occupational programs. The central policy challenge, however, is that the vast majority of students who enroll in two-year colleges intend to transfer to a four-year university. Consequently, many are resistant to pursuing programs that are not conducive to transfer, despite transfer prospects being weak for many students. This is a public policy problem that will need to be addressed behaviorally and instrumentally, Avery concluded.

In response to Cooper's question about why we care about the number of bachelor's degrees, Avery acknowledged that this is a challenging question to answer and that he will try to address it in future versions of the paper.

Similarly, Avery responded to Gordon's comment about signaling by acknowledging that attempting to isolate the human capital value of education from its signaling value is a fundamental challenge in labor economics and is difficult for the authors to address at this time.

Avery then thanked the participants for pushing him to consider the "bang for the buck" associated with various policies. Looking at the costs of these proposals relative to other social programs in education, namely Head Start, will be an objective of future versions of this paper.

In response to the question about supply, Pender concluded with the remark that while supply concerns constitute a separate paper and a separate problem, he does not disagree with the premise that fixing bad colleges by replicating good colleges is an objective to pursue.