Revisiting California Proposition 209: Changes in Science Persistence Rates and Overall Graduation Rates

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Abstract

California Proposition 209 outlawed race-based affirmative action in the University of California (UC) system in 1998. However, the UC system subsequently shifted towards race-blind affirmative action by also reweighing factors other than race in the admissions process. To evaluate the hypothetical changes in the science persistence rate and graduation rate of all applicants if racial preferences had been removed entirely, I estimate baseline and counterfactual admissions models using data from between 1995-1997. Using a general equilibrium framework to fix the total number of admits and enrollees, I find that the removal of racial preferences leads to a cascade of minority enrollees into less selective campuses and a surge of non-minority enrollees into more selective campuses. The improved matching between students and campuses results in higher science persistence rates and graduation rates across the pool of all applicants. In particular, the gains are driven by minority students who were admitted under racial preferences, because the gains from better matching across UC campuses outweigh the losses from potentially being pushed outside the UC system. Non-minority students who are originally rejected under racial preferences also benefit, as some are induced into the system in the counterfactual, where they are more likely to graduate. I also investigate claims that applicants may have strategically gamed during the admissions process by misrepresenting their interest in the sciences in order to maximize their admissions probability. While there exist incentives to apply in different majors across the campuses, I find evidence that applicants often fail to game optimally, suggesting that they may not be fully informed of their relative admissions probabilities in the sciences and non-sciences.

Keywords: STEM Persistence, Graduation Rates, Mismatch, Affirmative Action

JEL Codes: I23, I28, J24, H75

I Introduction

Attracting foreign students and employees in science, technology, engineering, and mathematics (STEM) is a priority for the Biden-Harris administration in 2022, as it helps to "strengthen our economy and technological competitiveness" (The White House, Office of the Press Secretary, 2022).[1] Increasing the size of the STEM workforce in the U.S. is of particular importance given that these fields are "critical to the prosperity, security, and health of our Nation" (The White House, Office of the Press Secretary 2022). Through programs like the National SMART grant, the federal government also attempts to incentivize domestic students to pursue STEM degrees. However, the financial incentive provided by the SMART grant fails to encourage more students to major in STEM fields. Although low-income college juniors and seniors are eligible for the $4000 grant if they major in a STEM field, regression discontinuity results at the income eligibility threshold suggest that eligible students are no more likely to major in STEM (Evans, 2017). The financial incentives to major in STEM fields extend beyond federal grants, as students' choice major is informed by the expected future earnings from each major (Arcidiacono et al., 2012). The earnings premium is typically largest in the sciences even after accounting for selection, which should motivate students to major in the sciences (Arcidiacono, 2004). However, there remains a shortage of STEM degree holders in the workforce. One potential explanation for this is that a student's uncertainty regarding whether they can complete a science major can make STEM degrees less appealing, even when ex post returns to science degrees are known (Altonji, 1993).

Not only is the number of STEM degree holders of concern, but the lack of racial diversity within STEM fields is also alarming. In fact, STEM magnet high schools schools across the country have recently come under fire for the racial composition of their student bodies,

[1] The White House, Office of the Press Secretary. (2022). *FACT SHEET: Biden-Harris Administration Actions to Attract STEM Talent and Strengthen our Economy and Competitiveness* [Press release]. Retrieved https://www.whitehouse.gov/briefing-room/statements-releases/2022/01/21/fact-sheet-biden-harris-administration-actions-to-attract-stem-talent-and-strengthen-our-economy-and-competitiveness/

which often are not representative of the surrounding jurisdictions (Natanson and Weiner, 2022). Of course, the issue of underrepresentation of minorities in STEM extends beyond STEM magnet schools. According to a report from the National Science Foundation, despite comprising 30.1% of the U.S. workforce in 2019, African Americans, Hispanics, Native Americans, and Pacific Islanders only account for 23.3% of the STEM workforce (Okrent and Burke, 2021). Moreover, this figure falls to 15.1% when considering the share of minority STEM workers with a bachelor's degree or higher. As such, it is crucial to further our understanding of how to improve the STEM graduation rates of minorities.

The STEM graduation rate of minorities is lower than that of non-minorities. One potential explanation for this phenomenon is that minorities are poorly matched with their colleges. In particular, it could be the case that minorities with low test scores who attend selective highly ranked universities would be more likely to graduate if they instead attend less selective institutions. This mismatch hypothesis has been explored extensively in the literature, with many studies focusing on the impact of California's Proposition 209 (Prop 209) on the graduation rates of both minority and non-minority students. Prop 209 banned the use of racial preferences in the University of California (UC) system's admissions process beginning in 1998, and the graduation rate of minorities within the UC system subsequently increased.[2] However, previous studies of Prop 209 and affirmative action in the UC system have come to conflicting conclusions about the impact of Prop 209 on the STEM persistence rate of minority applicants.

On one hand, Arcidiacono et al. (2014) find that 18% of the increase in the graduation rate of minorities following the passage of Prop 209 can be attributed to better sorting of minority students across the UC campuses. Another study by Arcidiacono et al. (2016) using anonymized student-level data on every applicant to the UC system from 1995-1997 finds that the most selective UC campuses have an advantage in graduating highly prepared students in the sciences, whereas the less selective campuses have an advantage in graduating

[2] In November 2020, Californians voted to reject California Proposition 16. Had it passed, Proposition 16 would have repealed Prop 209.

less prepared students in the sciences. Since the less academically prepared enrollees at the selective UC campuses are disproportionately minorities, the authors find that in a counterfactual scenario where the minority enrollees are allocated across the UC campuses according to the non-minority assignment rules, there is an increase in the STEM persistence rate and overall graduation rate for minority enrollees who intend to major in a STEM field.

On the other hand, Bleemer (2022) contradicts these results using a difference-in-differences framework. By comparing the difference in several outcome variables between minority and non-minority UC applicants before and after Prop 209 went into effect, Bleemer finds that underrepresented minority (URM) applicants to the UC system are less likely to graduate with STEM degrees because of Prop 209. Furthermore, although the academic preparation of URM students enrolled in STEM courses increased relative to their non-URM peers following Prop 209, there was no significant improvement in their grades or persistence in introductory STEM tracks.

In an attempt to reconcile his findings with those of Arcidiacono et al. (2016), Bleemer (2020) released a policy brief in which he discusses the differences between the two papers. In it, he claims that one factor that could potentially explain the different findings with regards to science persistence rates stems from differences in the definition of persistence (Bleemer, 2020). Arcidiacono et al. (2016) define persistence in the sciences as graduating with a degree in the sciences conditional on applying as a prospective science major in at least 50% of their applications to UC campuses. However, according to Bleemer (2020), the intended major listed by students on their college applications is a "low-cost signal to admissions officers." Moreover, he states that, "many applicants likely provided strategic responses to 'game' admission to UC campuses." To support his claim, he cites that less than half of all URMs who intended to major in the sciences enrolled in an introductory science course in their first year. While this could be interpreted as evidence that some of these applicants misrepresented their true preferences for their intended major, it could also be interpreted as evidence of mismatch between these students' expectations of the academic preparation required to succeed in these introductory science classes and the actual academic preparation necessary.

In this paper, I use data on all applicants to the UC system between 1995-1997 to estimate baseline logit models for admissions for both minorities and non-minorities before introducing a new parameter to the non-minority admissions model. This new parameter serves to fix the number of admits in each major when the non-minority admissions model is applied to all applicants. Then, by employing Bayes' rule, I estimate the counterfactual probability of being accepted to the UC system once racial preferences are removed, given an applicant's race and original admissions status. In particular, I focus on the counterfactual acceptance probabilities of minority students who were initially admitted to the UC system and non-minority students who were initially rejected from the system. This is because removing racial preferences from the admissions process should result in some on-the-margin minority admits no longer being admitted into the UC system, with their spots instead being filled by some on-the-margin non-minorities who were initially rejected. However, removing racial preferences should not affect the admissions results of minorities who were originally rejected and non-minorities who were initially admitted, although it may affect their allocation within the UC system.

After estimating the counterfactual admissions models, I estimate a multinomial logit model of enrollment for admits across the eight UC campuses and an "outside option." Once again, I add another parameter to the non-minority allocation model so that the model for allocation under a regime with no racial preferences maintains the number of enrollees in each major at each campus. The model reveals that there is a downward cascade of minorities into lower ranked campuses and that without racial preferences, more minority students are rejected from the UC system. Conversely, there is an upward surge of non-minorities to higher ranked campuses once racial preferences are removed, and fewer non-minority applicants are rejected from the UC system.

When estimating the graduation rates of applicants after racial preferences are removed, I must make assumptions regarding their graduation rates, since I do not have data on the graduation status of those who enroll outside the UC system. Using my preferred estimates for their graduation rate, I find that across the pool of all applicants, the science persistence rate increases and the overall graduation rate increases after removing racial preferences. The increase in the science persistence rate and overall graduation rate for minorities in particular suggests that the gains in graduation probability from the reallocation of those who remain in the UC system outweigh the losses for those who are no longer admitted.

I also investigate the incentives that applicants had to misrepresent their interest in the sciences or non-sciences by estimating logit admissions models for each campus conditional on a student's intended major. Notably, I find that it was never optimal for minority students to apply to UC Berkeley in the sciences and that some students could increase their admissions probability by as much as 25% by applying in the non-sciences instead of the sciences. Thus, although there exist incentives for students to improve their admissions probability by presenting a different intended major, most minorities who apply as science majors are applying suboptimally. That is, they have a higher admissions probability from applying in the non-sciences. Moreover, of those who attempt to apply strategically by applying to exactly one campus in the sciences or non-sciences and every other campus in the opposite major, there is minimal evidence that they are informed of their relative admissions probabilities. Applicants from high-income households are not more likely to game optimally than those from low-income households.

This paper seeks to further shed light upon the debate surrounding Prop 209 and to expand upon the existing literature in four key ways. First, it expands upon the structural model in Arcidiacono et al. (2016) to incorporate the effect of removing racial preferences on the extensive margin for two populations: minority students who were initially admitted in the presence of racial preferences and non-minority students who were initially rejected. This further allows me to predict the impact of removing racial preferences on all applicants to the UC system and not just the effect on those who are initially enrolled. Second, since almost half of all admits choose to not enroll in the UC system, the allocation rules for UC admits include an option that allocates students outside the UC system. Third, this paper employs a general equilibrium model that holds constant both the number of initial admits to the UC system by major and the number of enrollees per major at each campus. This is crucial, because if non-minority admissions and allocation rules were estimated and applied to minority applicants, then the total number of counterfactual admits and enrollees would be lower than the baseline number of admits and enrollees. While the number of non-minority admits would stay constant, fewer minority applicants would be admitted under non-minority rules than under minority rules, resulting in fewer overall admits. Lastly, to the best of my knowledge, this is the first paper that seeks to analyze whether students had an incentive to strategically game and misrepresent their intended majors and whether or not those who attempted to game did so optimally. This contributes to the literature, as it has implications for the definition of persistence in the sciences and whether an applicant's intended major can be interpreted as a strong signal for their preferences.

The remainder of the paper proceeds as follows. Section II describes the data set and provides descriptive results that motivate the rest of the paper. Section III reviews the foundational model from Arcidiacono et al. (2016) and presents the novel empirical framework. Section IV covers the results. Lastly, Section VI concludes.

II Data and Descriptive Results

The data that I used came from the University of California Office of the President (UCOP) and contains de-identified information on every applicant to the UC system from 1992-2006, although I restrict my analysis to the period before Prop 209 from 1995-1997.[3]

For each individual, there is data on which UC campus(es) they applied to, which cam-

[3]Focusing on the period before Prop 209 allows me to estimate the original admissions and allocation rules from when racial preferences were in effect, which subsequently allows me to estimate counterfactual rules where the only change comes from removing the racial preferences. I choose to not use data from after Prop 209 because there is evidence that the UC campuses changed the weight that they place on SAT scores and high school GPAs (Antonovics and Backes, 2014a).

pus(es) they were accepted to, and which campus they enrolled at, if any. Furthermore, for each campus a student applied to, there is data on whether they applied as a prospective science or non-science major, where non-science majors include social science, humanities, and undecided majors.[4]

However, there are also limitations to the data set. Firstly, the precise year in which a student applied is unknown. Instead, the data set provides a three-year interval in which they applied. The data also does not contain an applicant's raw SAT scores or high school grade point average (GPA), but instead supplies categorical bins for these values. Additionally, the UCOP provides a raw preparation score that is a linear combination of a student's total SAT score and their exact high school GPA.[5] Although there is no information on the gender of each applicant, there is information on their race. The four self-reported categories for race provided are URM, Asian, white, and other.[6] Lastly, there is parental income and parental education data, again separated into categorical bins.

II.a Applying in the Sciences and Non-Sciences

If applicants consistently signal the same intended major at each campus they apply to, then it would be difficult to gauge whether or not they applied strategically. Instead, this phenomenon could be explained by the applicants having a preference for a particular major, independent of the campus. Indeed, the majority of applicants applied exclusively in the sciences or the non-sciences across all of their applications to UC campuses. Overall, 60.6% of applicants only applied to campuses in the non-sciences and 24.9% of applicants applied exclusively in the sciences. Minority applicants are less likely to only apply as science majors and are more likely to apply exclusively as non-science majors, with 20.7% of minorities only applying in the sciences and 64.1% only applying in the non-sciences, compared to 25.8%

[4] A comprehensive table that shows how each major is classified can be found in Appendix Table A1 of Arcidiacono et al. (2016).

[5] Instead of using this raw preparation score throughout the paper, I use a standardized version of the preparation score with a mean of 0 and a standard deviation of 1.

[6] URM includes Black or African-American, Chicano, Latino, and Native American applicants.

Table 1: Cross Tabulation of the Number of Science and Non-Science Applications Submitted to UC campuses by UC Applicants

Panel A: Minorities

Number of Non-Science Applications

Number of Science Applications	0	1	2	3	4	5	6	7	8	Total
0	0	3992	4291	7405	1935	645	216	58	61	18603
1	1442	819	799	177	44	23	2	1	0	3307
2	1582	1530	181	48	7	4	3	0	0	3355
3	2201	421	63	8	4	7	0	0	0	2704
4	566	124	27	2	4	0	0	0	0	723
5	140	41	8	7	0	0	0	0	0	196
6	56	19	6	0	0	0	0	0	0	81
7	14	16	0	0	0	0	0	0	0	30
8	8	0	0	0	0	0	0	0	0	8
Total	6009	6962	5375	7647	1994	679	221	59	61	29007

Panel B: Non-Minorities

Number of Non-Science Applications

Number of Science Applications	0	1	2	3	4	5	6	7	8	Total
0	0	17024	18125	19288	12223	5361	2134	715	735	75605
1	8240	3057	2086	1171	527	213	75	75	0	15444
2	8686	3603	1117	373	129	60	55	0	0	14023
3	8517	2407	516	158	55	45	0	0	0	11698
4	4588	1123	245	56	47	0	0	0	0	6059
5	1747	504	84	64	0	0	0	0	0	2399
6	545	147	63	0	0	0	0	0	0	755
7	200	157	0	0	0	0	0	0	0	357
8	162	0	0	0	0	0	0	0	0	162
Total	32685	28022	22236	21110	12981	5679	2264	790	735	126502

Panel C: All Applicants

Number of Non-Science Applications

Number of Science Applications	0	1	2	3	4	5	6	7	8	Total
0	0	21016	22416	26693	14158	6006	2350	773	796	94208
1	9682	3876	2885	1348	571	236	77	76	0	18751
2	10268	5133	1298	421	136	64	58	0	0	17378
3	10718	2828	579	166	59	52	0	0	0	14402
4	5154	1247	272	58	51	0	0	0	0	6782
5	1887	545	92	71	0	0	0	0	0	2595
6	601	166	69	0	0	0	0	0	0	836
7	214	173	0	0	0	0	0	0	0	387
8	170	0	0	0	0	0	0	0	0	170
Total	38694	34984	27611	28757	14975	6358	2485	849	796	155509

Notes: To read this table, refer to both the row and column number. For example, in Panel A, the number 3992 in the first row and second column indicates that there were 3992 minority applicants who applied to exactly 1 UC campus in the non-sciences and 0 UC campuses in the sciences.

and 59.8% of non-minorities. While the majority of students did apply consistently in the sciences or non-sciences across the UC campuses, there were still 22,607 applicants who applied to at least one campus in the sciences and one in the non-sciences.

Since not every UC campus offers the same choice of majors, it is possible that some of these applicants correctly represented their major preferences at every campus. For example, if an applicant wishes to pursue an aerospace engineering major, but it is not offered at every campus they apply to, then they might apply as an aerospace engineering major when possible and as an undecided major otherwise. Another possibility is that these applicants have campus-specific preferences over their majors. If campus A is stronger relative to campus B in the sciences, then a rational applicant could apply to campus A in the sciences and campus B in the non-sciences. A third possibility is that these applicants applied strategically in an attempt to maximize their probability of admissions. That is, at each campus they could have chosen to list the intended major that would lead to the highest probability of admissions at that campus.

To further see that applying to one campus in the sciences does not necessarily imply that a student applied as a science major across all campuses, Table 2 shows the probability of applying to one campus in the sciences conditional on applying to another campus in the sciences for every combination of two campuses. More likely than not, an applicant who applied to one campus in the sciences also applied in the sciences at other campuses. For example, 87.0% of students who applied to UC Berkeley in the sciences also applied to UCLA in the sciences, given that they applied to UCLA. Note that conversely, only 80.7% of students who applied to UCLA in the sciences chose to apply to UC Berkeley in the sciences, conditional on also applying to UC Berkeley. In fact, this trend holds across all other campuses, where the probability of applying to UC Berkeley in the sciences conditional on applying to campus x in the sciences is lower than the corresponding probability of applying to campus x in the sciences conditional on applying to UC Berkeley in the sciences. This could be consistent with some students strategically gaming if their probability of admissions

Table 2: Probability of Applying to Campus B in the Sciences Conditional on Applying to Campus A in the Sciences and Applying to Campus B (Percentage Points)

	Campus B							
Campus A	Berkeley	UCLA	San Diego	Davis	Irvine	Santa Barbara	Santa Cruz	Riverside
Berkeley	-	87.0	89.8	86.6	90.5	84.2	77.1	53.8
UCLA	80.7	-	92.8	88.1	91.8	88.6	82.5	51.3
San Diego	74.9	83.9	-	82.5	88.9	86.5	82.9	50.6
Davis	75.9	84.2	88.8	-	88.7	86.1	79.9	53.9
Irvine	70.7	82.6	88.5	82.8	-	86.0	81.9	53.8
Santa Barbara	70.2	79.6	85.7	78.0	82.6	-	84.3	60.7
Santa Cruz	67.7	77.6	83.6	74.0	81.7	85.7	-	63.8
Riverside	72.9	80.1	84.1	79.1	85.0	84.6	80.9	-

to UC Berkeley in the sciences is lower than their probability of admissions in the non-sciences. If this were the case, then students who still apply to UC Berkeley in the sciences likely have strong preferences for majoring in the sciences, which further explains why the percentages in the first row exceed the corresponding percentages in the first column. Finally, note that the UC Riverside column has the lowest values, although they remain over 50%. There are multiple reasons for why this could be the case. For one, admissions probabilities at UC Riverside could be greater in the non-sciences, incentivizing applicants to misrepresent their preferences when they prefer to major in the sciences. Another explanation could be that there is little difference between the admissions probability in the sciences and non-sciences and that the cost of switching majors is low, leading applicants to arbitrarily list their major. Bleemer (2022) provides evidence of the latter explanation, as he demonstrates that all applicants who met the minimum requirements for their high school coursework were accepted to UC Riverside, rendering the signal from the intended major obsolete.

II.b Admissions

Because of selection, the overall admissions rates for initial science majors and initial non-science majors are not necessarily indicative of the optimal major to maximize the probability of admissions. It is nevertheless informative to see the relative admissions rates over this

Table 3: Admissions Rates Across the UC Campuses by Race and Major (Percentage Points)

	Berkeley	UCLA	San Diego	Davis	Irvine	Santa Barbara	Santa Cruz	Riverside
Panel A: Minorities								
Initial Science Majors	45.4	48.0	62.5	85.6	73.3	81.7	87.2	78.5
Initial Non-Science Majors	52.7	46.2	50.7	81.4	62.5	76.4	82.6	77.9
Panel B: Non-Minorities								
Initial Science Majors	39.7	45.7	63.1	69.5	77.9	82.7	85.9	84.1
Initial Non-Science Majors	29.2	34.4	49.0	70.9	68.0	74.9	83.0	81.4

period. Table 3 displays the admissions rates across the UC campuses by race and major. Note that the admissions rate for initial science majors regardless of race is higher than the admissions rate for initial non-science majors at each campus except for minority applicants at UC Berkeley and non-minority applicants at UC Davis. Again, it is important to reiterate that this does not necessarily imply that each individual applicant should have applied in the sciences instead of the non-sciences. Rather, it simply shows that without accounting for differences in the attributes of science and non-science applicants, science applicants are more likely to be admitted at most campuses. From Table 3, we can also see that the largest gap in admissions rate by race comes from initial non-science majors who apply to UC Berkeley. While 52.7% of minority non-science majors are admitted to UC Berkeley, only 29.2% of non-minority non-science majors are admitted. This gap becomes more striking considering that on average, non-minorities rejected from UC Berkeley have higher preparation scores than minorities who are admitted to UC Berkeley, revealing the magnitude of racial preferences at UC Berkeley (Arcidiacono et al., 2016). On the other hand, there is little difference between the admissions rates by race at UC San Diego. In fact, non-minority science applicants have an acceptance rate that is 0.6% higher than minority science applicants.

II.c Enrollment and Graduation Rates

Next, in Table 4 I examine the difference in enrollment and graduation rates in the periods immediately before and after Prop 209 was enacted. In the three years after racial preferences

Table 4: Enrollment and Graduation Rates Across the UC Campuses Before and After Prop 209

Time Period	Berkeley	UCLA	San Diego	Davis	Irvine	Santa Barbara	Santa Cruz	Riverside	UC System	Total Outside	Total
Panel A: Enrollment											
Minorities											
1995-1997	2,287	2,803	1,081	1,497	1,129	1,845	970	1,156	12,768	16,239	29,007
1998-2000	1,307	1,910	999	1,493	1,380	1,836	1,145	2,026	12,096	19,417	31,513
Non-Minorities											
1995-1997	8,073	8,256	7,525	8,638	7,445	8,277	4,511	3,415	56,140	70,362	126,502
1998-2000	9,359	10,334	8,441	9,873	8,774	8,498	5,915	5,363	66,557	87,693	154,250
Panel B: Science Persistence Rates (Percentage Points)											
Minorities											
1995-1997	30.5	28.6	31.4	25.8	24.1	25.8	19.9	20.2	26.8	n/a	n/a
1998-2000	34.2	31.8	33.1	33.4	31.9	31.3	21.1	17.4	29.7	n/a	n/a
Non-Minorities											
1995-1997	60.8	52.0	51.2	46.8	35.9	35.0	29.4	31.7	46.1	n/a	n/a
1998-2000	60.5	57.2	51.8	46.2	45.2	43.2	33.1	28.9	48.6	n/a	n/a
Panel C: Overall Graduation Rates (Percentage Points)											
Minorities											
1995-1997	68.4	66.0	66.4	54.8	63.2	60.0	60.9	59.2	63.0	n/a	n/a
1998-2000	71.5	71.8	72.5	63.2	66.4	70.5	64.4	59.5	67.2	n/a	n/a
Non-Minorities											
1995-1997	85.9	83.3	80.4	76.1	68.3	72.5	67.7	63.0	76.1	n/a	n/a
1998-2000	88.9	86.6	81.4	76.4	75.0	78.4	71.7	63.0	78.9	n/a	n/a

were banned, the number of minority enrollees fell at every UC Campus except for UC Irvine, UC Santa Cruz, and UC Riverside, despite the total number of enrollees increasing at each campus. Overall, there were 672 fewer minority enrollees across the UC campuses in the period after Prop 209, whereas there were 10,417 more non-minority enrollees.

Note that if I were to restrict my analysis to the set of enrollees in the UC system, I would fail to capture the effect of removing racial preferences on the 86,601 applicants who did not enroll at a UC campus. These applicants represent the majority of applicants and consist of both those who are admitted and choose to not enroll at a UC campus and those who are rejected from every campus they apply to. Considering that removing racial preferences could induce enrollment in the UC system for on-the-margin non-minority rejects, it is important to take those outside the system into account when evaluating the effect of Prop 209. It is also possible that Prop 209 could induce some non-minority admits who previously enrolled outside the UC system to enter the system by expanding their choice set.

Table 4 also displays the science persistence rates and overall graduation rates for minorities and non-minorities before and after Prop 209. Consistent with the mismatch hypothesis, both the science persistence rate and the overall graduation rate increase at every UC campus for minority students, with the exception of the science persistence rate at UC Riverside. The overall graduation rate for non-minorities also increases across every UC campus, although there are some campuses where the the science persistence rate of non-minorities fell. Nevertheless, overall, both the science persistence rate and the total graduation rate increased across the UC system for minorities and non-minorities.

While this might suggest that the removal of racial preferences resulted in improved matching between enrollees and UC campuses, there were many other concurrent changes to the UC system and the applicant pool. For example, there is evidence that the admissions rules at UC campuses changed after Prop 209, placing a greater emphasis on traits that are correlated with minority status (Antonovics and Backes, 2014a). Moreover, the total number of applicants to the UC system increased, and each applicant to the system applied to more campuses on average, although scholars have found little evidence of changes in the application behavior of minorities (Antonovics and Backes, 2013). Similarly, there is little evidence of changes in the enrollment behavior of admitted minority students, with Antonovics and Sander (2013) finding that the behavioral response of minorities was to slightly increase their yield rate after Prop 209. There was also selection among the pool of applicants, as the average applicant post-Prop 209 had higher SAT scores and a better high school GPA. Thus, improvements in the science persistence rate and overall graduation rate could partially be attributed to better academic preparation among students prior to college. According to the literature, this could be consistent with students facing different incentives to invest in their human capital after Prop 209 (Fryer et al., 2008). However, despite this increase in the average SAT score and high school GPA of all applicants, Antonovics and Backes (2014b) find only modest increases in academic achievement of high school students in California, casting doubt on the role that Prop 209 played in incentivizing human capital accumulation in high school. Overall, the multitude of mechanisms that could potentially affect graduation rates in the post-Prop 209 period highlights the importance of estimating the effect of lifting racial preferences over a fixed pool of applicants in one period.

III Methods and Empirical Framework

Before specifying how my model expands upon the work of Arcidiacono et al. (2016), I briefly summarize the key aspects of their foundational model, which laid the groundwork for this paper.

III.a Relevant Model from Arcidiacono et al. (2016)

In their paper, Arcidiacono et al. (2016) model a student's choice of whether to graduate with a science major, m, or graduate with a non-science major, h. Alternatively, they could choose to not graduate at all, n. Taking the college that each student attends as given, they model the utility of student i from graduating from campus k in major $j \in \{m, h, n\}$ as

$$U_{ijk} = R_{ijk} - C_{ijk} + \epsilon_{ijk} \tag{1}$$

where R_{ijk} specifies the net returns to a student's choice of college and major, and C_{ijk} specifies the cost of switching majors. Lastly, ϵ_{ijk} represents an idiosyncratic taste factor.

The net returns function was specified by the function

$$R_{ijk} = \phi_{1jk} + \phi_{2jk} AI_{ij} \tag{2}$$

with ϕ_{1jk} capturing the returns to major j at campus k that are independent of a student's prior academic preparation. On the other hand, ϕ_{2jk} captures the returns to a student's academic preparation index, AI_{ij}, for a specific college/major combination. Importantly, a student's academic preparation varies depending on their major j, and is a function of their individual characteristics $\boldsymbol{X}_i$, which include variables such as their high school GPA, SAT scores, and parental income.

$$AI_{ij} = \boldsymbol{X}_i \boldsymbol{\beta}_j \tag{3}$$

Letting the academic index differ across majors allows each major to weigh the rewards to each characteristic differently. For example, students with high SAT math scores may be rewarded more heavily in science majors than humanities majors, whereas the opposite could be true for students with high SAT verbal scores. Crucially, it should also be noted that in order to account for selection effects based on unobservables, controls based on Dale and Krueger (2002) are included in $\boldsymbol{X}_i$, such as dummy variables for whether students applied to each UC campus and whether they were accepted.[7]

Finally, the cost of switching majors is modeled by a function that includes a constant for switching out of major j, α_{0j}, a parameter that allows the cost to vary by a student's academic preparation, α_{1j}, a third parameter that allows the cost to vary according to family background factors like parental education and income, $\alpha_2^{'}$, and lastly a term, α_{3k}, that accounts for a fixed cost of switching majors at each campus.

$$C_{ijk} = \alpha_{0j} + \alpha_{1j} AI_{ij} + \alpha_2^{'} \boldsymbol{B}_i + \alpha_{3k} \tag{4}$$

In order to estimate these parameters, Arcidiacono et al. (2016) employ a nested logit model where one nest included the options to graduate in a science major or to graduate in a non-science major, and the other nest had the option to not graduate at all. According to this model, the probability of choosing to graduate with major j at campus k, conditional on $\boldsymbol{X}$ and $\boldsymbol{B}$ is

$$p_{ijk}(\boldsymbol{\theta}) = \frac{(\sum_{j'} \exp(\frac{u_{ij'k}}{\rho}))^{\rho-1} \exp(\frac{u_{ijk}}{\rho})}{(\sum_{j'} \exp(\frac{u_{ij'k}}{\rho}))^{\rho} + 1} \tag{5}$$

I incorporate both academic preparation indices, AI_{im} and AI_{ih}, into my model as inputs

[7]As a robustness check, Appendix tables A5-8 contain the results when these controls are omitted.

for the admissions and allocation probabilities. This is because the academic indices capture the differences between the initial human capital of applicants, which not only influence the probability of graduation, but also influence the probability of admissions to different campuses. Both academic indices are incorporated into the model, as campuses face uncertainty as to whether an applicant will persist in their intended major. I also utilize the probabilities of graduation $p_{ijk}(\theta)$ when estimating the science persistence rate and overall graduation rate of all applicants under different admissions and allocation rules. Finally, I use the same definition of initial major as Arcidiacono et al. (2016), where a student is considered an initial science major if they apply as a science major on at least 50% of their UC applications.

III.b New Empirical Specifications

In order to remedy the issues previously specified in Section I, I apply a new approach that expands upon the Arcidiacono et al. (2016) model by employing a general equilibrium model and Bayes' rule.

III.b.1 UC System Admissions Rules

To explore the effect of removing racial preferences on the extensive margin, admissions to the UC system, I begin by estimating the probability of student i being admitted to the UC system. Let $g = 1$ (2) if the individual is non-minority (minority). I estimate separate logit models by racial group, where the probability that student i from group g is admitted to the UC system when applying in major j is

$$r_{igj}(\boldsymbol{\psi}_{gj}) = \frac{\exp(\psi_{1gj} + \psi_{2gj}\boldsymbol{A}\hat{\boldsymbol{I}}_{im} + \psi_{3gj}\boldsymbol{A}\hat{\boldsymbol{I}}_{ih})}{1 + \exp(\psi_{1gj} + \psi_{2gj}\boldsymbol{A}\hat{\boldsymbol{I}}_{im} + \psi_{3gj}\boldsymbol{A}\hat{\boldsymbol{I}}_{ih})} \tag{6}$$

To simplify notation, I will now refer to the non-minority (minority) coefficients as $\boldsymbol{\psi}_{1j}$ ($\boldsymbol{\psi}_{2j}$). Recall that the academic preparation indices, $\boldsymbol{A}\hat{\boldsymbol{I}}_{im}$ and $\boldsymbol{A}\hat{\boldsymbol{I}}_{ih}$ come from the Arcidiacono et al. (2016) model.

Given the distinct logits for non-minority and minority admissions to the UC system, recall that if the non-minority admissions rules were applied to all applicants, then the total number of admits to the UC system would be lower than the actual number of admits since fewer minorities would be admitted than in the baseline. To account for this discrepancy, I introduce a major-specific term, γ_j, such that if $S_i = 1$ when individual i is been admitted to the UC system, then

$$\begin{aligned}
\sum_i S_i &= \sum_i \frac{\exp(\psi_{1jg} + \psi_{2jg}\boldsymbol{A\hat{I}}_{im} + \psi_{3jg}\boldsymbol{A\hat{I}}_{ih} + \gamma_j)}{1 + \exp(\psi_{1jg} + \psi_{2jg}\boldsymbol{A\hat{I}}_{im} + \psi_{3jg}\boldsymbol{A\hat{I}}_{ih} + \gamma_j)} && (7)\\
&= \sum_i P(S_i' = 1|\boldsymbol{X_i}, j) && (8)
\end{aligned}$$

where $P(S_i' = 1)$ is the probability that an applicant is admitted to the UC system without racial preferences.[8] In other words, if the non-minority admissions rules were applied to all applicants using the newly specified γ_j term, then the number of predicted admits would equal the actual number of admits to the system. Allowing γ_j to be major specific also guarantees that the number of science admits and non-science admits remains constant.

Of course, the impacts of removing racial preferences from the UC admissions process are not distributed equally. Non-minorities who were originally admitted in the presence of racial preferences should still be admitted after the removal of racial preferences, and minorities who were originally rejected should still be rejected. On the other hand, non-minorities who were originally rejected from the UC system could possibly be admitted in the absence of racial preferences, and minorities who were originally admitted to the UC system could potentially be rejected without racial preferences in place.

To account for this, I use Bayes' Rule to model the probability that a minority student would be admitted to the UC system without racial preferences given that they were admitted

[8]In this case, $\boldsymbol{X}_i$ represents individual i's academic indices.

with racial preferences as:

$$P(S_i'=1|S_i=1,g=2,\boldsymbol{X_i},j) = \frac{P(S_i'=1,S_i=1|g=2,\boldsymbol{X_i},j)}{P(S_i=1|g=2,\boldsymbol{X_i},j)} \tag{9}$$

$$= \frac{P(S_i'=1|g=2,\boldsymbol{X_i},j)}{P(S_i=1|g=2,\boldsymbol{X_i},j)} \tag{10}$$

Note that the second line follows from the assumption that minority students who would be admitted without racial preference would also be admitted with racial preferences. Thus, this probability can be expressed as

$$P(S_i'=1|S_i=1,g_i=2,\boldsymbol{X_i},j) = \left[\frac{\exp(\boldsymbol{X_i\psi}_{1j}+\gamma_j)}{1+\exp(\boldsymbol{X_i\psi}_{1j}+\gamma_j)}\right]\left[\frac{\exp(\boldsymbol{X_i\psi}_{2j})+1}{\exp(\boldsymbol{X_i\psi}_{2j})}\right] \tag{11}$$

Similarly, the probability that a non-minority applicant who was originally rejected would still be rejected if racial preferences were removed is:

$$P(S_i'=0|S_i=0,g=1,\boldsymbol{X_i},j) = \frac{P(S_i'=0,S_i=0|g=1,\boldsymbol{X_i},j)}{P(S_i=0|g=1,\boldsymbol{X_i},j)} \tag{12}$$

$$= \frac{P(S_i'=0|g=1,\boldsymbol{X_i},j)}{P(S_i=0|g=1,\boldsymbol{X_i},j)} \tag{13}$$

$$= \left[\frac{1}{1+\exp(\boldsymbol{X_i\psi}_{1j}+\gamma_j)}\frac{1+\exp(\boldsymbol{X_i\psi}_{1j})}{1}\right] \tag{14}$$

$$= \frac{1+\exp(\boldsymbol{X_i\psi}_{1j})}{1+\exp(\boldsymbol{X_i\psi}_{1j}+\gamma_j)} \tag{15}$$

Along the same vein as equation (10), equation (13) is predicated on the assumption that a non-minority who was rejected in the absence of racial preferences would certainly also be rejected in the presence of racial preferences. We can then express the probability of a non-minority being admitted when racial preferences were removed given they were rejected when racial preferences were in place as one minus the probability above:

$$
\begin{aligned}
P(S_i' = 1 | S_i = 0, g = 1, \boldsymbol{X_i}, j) &= 1 - P(S_i' = 0 | S_i = 0, g = 1, \boldsymbol{X_i}, j) && (16)\\
&= 1 - \left[\frac{1 + \exp(\boldsymbol{X_i}\boldsymbol{\psi}_{1j})}{1 + \exp(\boldsymbol{X_i}\boldsymbol{\psi}_{1j} + \gamma_j)}\right] && (17)
\end{aligned}
$$

Lastly, assuming that the admissions status for non-minority admits and minority rejects would not change after the removal of racial preferences means that

$$P(S_i' = 1 | S_i = 1, g = 1) = 1 \tag{18}$$

$$P(S_i' = 1 | S_i = 0, g = 2) = 0 \tag{19}$$

III.b.2 UC Campus Allocation Rules

After determining the probability that a student is admitted to the UC system, the next step is to determine which campus within the system that student is allocated to. Let K be the set of all UC campuses, $K = \{Berkeley,\ UCLA,\ San\ Diego,\ Davis,\ Irvine,\ Santa\ Barbara,\ Santa\ Cruz,\ Riverside\}$. For non-minority applicants originally admitted to the UC system, I estimate the multinomial logit probabilities of being assigned to each campus or being assigned outside the system. That is, conditional on being admitted to the UC system, I estimate the probability of being assigned to $k \in K^+$, where $K^+ = K + \{Outside\ System = k_1^*\}$:[9]

$$q_{igjk}(\boldsymbol{\pi}_{gjk}) = \frac{\exp(\pi_{1gjk} + \pi_{2gjk}\boldsymbol{A}\hat{\boldsymbol{I}}_{im} + \pi_{3gjk}\boldsymbol{A}\hat{\boldsymbol{I}}_{ih})}{1 + \sum_{k \in K} \exp(\pi_{1gjk} + \pi_{2gjk}\boldsymbol{A}\hat{\boldsymbol{I}}_{im} + \pi_{3gjk}\boldsymbol{A}\hat{\boldsymbol{I}}_{ih})} \tag{20}$$

The option for admits to be assigned outside the UC system, $k = k_1^*$, is vital, because in reality, not every student admitted to the system ultimately matriculates.[10] In fact, 45.2%

[9] I denote k_1^* as the outside option for admits to the UC system and k_2^* as the outside option for rejects.

[10] Note that the coefficients for k_1^* are standardized to 0.

of admits to the UC system do not enroll within the system.[11]

Define w_{igjs} as the weight assigned to individual i in the regime without racial preferences:

$$w_{igjs} = \begin{cases} 1 & \text{if } g = 1 \text{ and } S_i = 1 \\ \left[\frac{\exp(X_i\psi_{1j}+\gamma_j)}{1+\exp(X_i\psi_{1j}+\gamma_j)}\right]\left[\frac{\exp(X_i\psi_{2j})+1}{\exp(X_i\psi_{2j})}\right] & \text{if } g = 2 \text{ and } S_i = 1 \\ 1 - \left[\frac{1+\exp(X_i\psi_{1j}+\gamma_j)}{1+\exp(X_i\psi_{2j})}\right] & \text{if } g = 1 \text{ and } S_i = 0 \\ 0 & \text{if } g = 2 \text{ and } S_i = 0 \end{cases} \tag{21}$$

Recall that these are the probabilities that a student is admitted to the UC system in the absence of racial preferences. In order to hold enrollment constant at each campus, let N_{jk} represent the number of enrollees in major j at campus $k \in K$. I then choose δ_{jk} such that for each $\{j,k\} \in \{m,h\} \times K$, the following equality holds:

$$N_{jk} = \sum_i w_{igjs}\left(\frac{\exp(X_i\boldsymbol{\pi}_{1jk} + \delta_{jk})}{1 + \sum_{k'=1}^{K}\exp(X_i\boldsymbol{\pi}_{1jk'} + \delta_{jk'})}\right) = \sum_i w_{igjs}q'_{ijk} = \sum_i v_{igjks}(\boldsymbol{\pi}_{1jk}, \delta_{jk}) \tag{22}$$

q'_{ijk} denotes the probability that an admit is allocated to campus $k \in K$ in the regime without racial preferences.[12] $v_{igjks}(\boldsymbol{\pi}_{1jk}, \delta_{jk})$ denotes the probability of being admitted and allocated to campus k in the counterfactual. Note that the number of admits to the system as a whole equals the sum of the number of enrollees in the system and the number of admits who went outside the system. Hence, when the predicted number of enrollees in every major equals the actual number of enrollees at every UC campus, then the number of admits who choose to leave the system should also remain constant.[13]

[11] In our data, we do not observe where a student ultimately matriculates if they do not enroll within the UC system. However, the evidence suggests that banning affirmative action did not result in lower enrollment of Black or African-American students in colleges (Backes, 2012).

[12] The probability that applicants are admitted and do not enroll at a UC campus is given by

$$v'_{ijk_1^*s} = \frac{w_{igjs}}{1 + \sum_{k'=1}^{K}\exp(X_i\boldsymbol{\pi}_{1jk'} + \delta_{jk'})}$$

[13] Note that the total number of predicted admits actually increases slightly due to making the Bayes' Rule adjustments after having computed the γ_j terms. Thus, the difference in the total number of admits

IV Admissions, Enrollment, and Graduation Results

IV.a Admissions Rates to the UC System

I begin by discussing the estimates of how the UC system admissions rates would change in the absence of racial preferences. The estimates for the baseline and counterfactual admissions rates are presented below in Table 5.[14] Panel A presents the baseline admissions rates which were estimated using four distinct race-specific and major-specific logits. The baseline admissions rate for both minorities and non-minorities in the sciences are slightly higher than the baseline admissions rate in the non-sciences, although the admissions rates are comparable across racial groups conditional on initial major. For example, minority applicants who applied as science majors had an 84% acceptance rate, whereas non-minorities applying as science majors had an 83% acceptance rate.

When racial preferences are removed, the acceptance rate for minority prospective science majors falls to 66%, whereas the admissions rate for non-minority prospective science majors rises to 87%. Recall that in my admissions model without racial preferences, I assumed that minorities who were actually rejected under the regime with racial preferences would still be rejected in the absence of racial preferences and that non-minorities who were originally accepted with racial preferences in place would still be admitted without racial preferences. This implies that the change in acceptance rate under the regime without racial preferences is driven by minorities who were initially accepted and by non-minorities who were initially rejected. In fact, minorities intending to major in the sciences (non-sciences) who were originally admitted to the UC system only have a 79% (76%) chance of being admitted without racial preferences. On the other hand, non-minorities intending to major in the sciences (non-sciences) who were originally rejected from the UC system have a 22% (23%) chance of being admitted without racial preferences. These non-minority students who were originally rejected comprise 5.0% of all counterfactual non-minority admits in my model.

to the UC system is reflected in the outside option.

[14] The logit coefficients can be found in Table A1.

Table 5: UC System Acceptance Rates for Minority and Non-Minority Students Under Different Admissions Rules

Admissions Rule	Acceptance Rate	Number of Admits	Number of Enrollees
Panel A: Baseline			
Minority			
Initial Science Majors	0.84	7,803	4,267
Initial Non-Science Majors	0.79	15,556	8,501
Non-Minority			
Initial Science Majors	0.83	38,360	22,467
Initial Non-Science Majors	0.80	63,974	33,672
Panel B: No Preferences			
Minority			
Initial Science Majors	0.66	6,164	3,616
Initial Non-Science Majors	0.60	11,807	6,557
Non-Minority			
Initial Science Majors	0.87	40,019	23,118
Initial Non-Science Majors	0.84	67,746	35,617
Minority Admits			
Initial Science Majors	0.79	6,164	3,616
Initial Non-Science Majors	0.76	11,807	6,557
Non-Minority Rejects			
Initial Science Majors	0.22	1,659	961
Initial Non-Science Majors	0.23	3,772	2,039

Notes: The total number of admits in the baseline and counterfactual scenario are not equal. This is because γ_j is determined so that the total number of admits with preferences and without preferences is equal. However, recall that after estimating the γ_j parameter, the counterfactual probability of admissions to the UC system that is used is also a function of race and a student's original admissions status. The Bayes' rule estimates for the total number of admits in the counterfactual scenario predict that 43 more applicants would have been admitted under the regime with no preferences. However, the number of enrollees in the system is held constant through the δ_{jk} parameters. The difference in the number of admits is thus reflected in the number of admits who choose to not enroll at any UC campus.

Overall, without racial preferences, the total number of minority admits to the UC system decreases by 5388, and the number of non-minority admits increases by 5431.[15] Similarly, the number of minority enrollees falls, and there is a corresponding increase in the number of non-minority enrollees that offsets this fall, keeping the total number of enrollees constant.

IV.b Allocation of Admits Across the UC System

Of course, without racial preferences, not only would the admissions rules to the UC system change, but the allocation of admits across the campuses would also change. Table 6 presents how all applicants to the UC system would be distributed across the system according to both the baseline allocation rules and the counterfactual allocation rules.[16] Panel A shows how the allocation of minorities would change under the alternate allocation rules, with minority students from the selective highly ranked schools cascading down to the lower ranked campuses. For minority science majors, under the allocation rules without racial preferences, the share of applicants ultimately allocated to UC Berkeley, UCLA, UC San Diego and UC Davis decreases, while the share of applicants allocated to the other campuses increases. The results for minority non-science majors display the same trend.

In Panel B, we can see how non-minority students display the opposite trends under the counterfactual scenario. The share of non-minority science majors allocated to the four most selective campuses increases while the share of non-minority non-science majors increases at the four most selective campuses and UC Riverside. This is consistent with an upward surge by non-minority applicants into the more selective campuses. Lastly, note that although the total share of non-minority applicants outside of the UC system decreases in the regime without racial preferences, the share of applicants who are admitted but choose not to enroll increases.

Finally, Panel C aggregates the information from the two previous panels to demonstrate

[15]Note that these numbers are not precisely equal even after introducing the γ_j term into the logit model without racial preferences because of the Bayes' Rule adjustments that were made after computing γ_j. For a more detailed description of why this is the case, refer to the notes in Table 5.

[16]The coefficients for the multinomial logit can be found in Table A2.

Table 6: Share of Minority and Non-Minority Applicants Under Different Assignment Rules (Percent)

Assignment Rule	Berkeley	UCLA	San Diego	Davis	Irvine	Santa Barbara	Santa Cruz	Riverside	Admits Outside	Rejects Outside	Total Outside
Panel A: Minority											
Initial Major Science											
Baseline	6.4	9.5	5.4	7.0	5.5	5.5	2.7	3.9	38.1	16.0	54.0
No Preferences	1.5	2.7	4.0	6.5	8.1	6.9	4.4	4.8	27.4	33.6	61.1
Initial Major Non-Science											
Baseline	8.6	9.8	3.0	4.3	3.1	6.7	3.7	4.0	35.8	21.1	56.9
No Preferences	1.3	2.4	2.2	4.2	5.0	8.4	6.1	3.5	26.6	40.1	66.8
Panel B: Non-Minority											
Initial Major Science											
Baseline	7.8	7.2	7.8	8.2	7.2	4.8	2.4	3.2	34.5	16.7	51.2
No Preferences	8.8	8.6	8.1	8.3	6.7	4.6	2.1	3.1	36.7	13.1	49.8
Initial Major Non-Science											
Baseline	5.6	6.1	4.9	6.0	5.1	7.5	4.2	2.4	37.7	20.5	58.2
No Preferences	7.3	7.9	5.0	6.1	4.7	7.1	3.6	2.5	39.9	15.8	55.7
Panel C: Share of Minorities											
Initial Major Science											
Baseline	14.2	20.9	12.1	14.7	13.4	18.7	18.4	19.7	18.2	16.2	17.6
No Preferences	3.4	6.0	9.0	13.7	19.6	23.4	29.8	24.3	13.1	34.2	19.8
Initial Major Non-Science											
Baseline	27.5	28.1	13.0	14.8	13.0	18.0	17.5	29.1	18.9	20.2	19.3
No Preferences	4.1	6.8	9.8	14.5	21.0	22.5	29.4	25.7	14.0	38.4	22.7

how the share of minorities at each campus changes without racial preferences. For both initial science majors and initial non-science majors, the share of minorities declines at UC Berkeley, UCLA, UC San Diego, UC Davis, and the outside option for admits, with the share of minorities also declining at Riverside for non-science majors. Overall, diversity at the elite UC campuses under an admissions and allocation regime with racial preferences comes at the cost of diversity at the middle and lower ranked campuses.[17]

IV.c Average Preparation Scores Across Campuses

If the removal of racial preferences indeed causes a downwards cascade of minority students from the more highly ranked UC campuses to the lower ranked UC campuses, then the average academic preparation for minority students should increase across all campuses. Conversely, if non-minorities surge upwards towards more selective campuses in light of the removal of racial preferences, then the average academic preparation of non-minorities

[17] To a lesser degree, it also comes at the cost of a slight increase in diversity at other colleges outside of the UC system.

should decrease across all campuses. In order to see why this would be the case, consider the marginal minority (non-minority) student at UC Berkeley who is (is not) admitted when racial preferences are in place but is not (is) admitted after they are removed. This student likely has lower test scores than their peers at UC Berkeley, so the removal (addition) of a minority (non-minority) student from UC Berkeley should raise (lower) the average academic preparation of the enrolled minorities (non-minorities).

The average baseline and counterfactual preparation scores, $\bar{P}$, at each campus are presented in Table 7.[18] The average preparation scores in the counterfactual are calculated using the following equation:

$$\bar{P}_{gjk} = \frac{\sum_i P_i I(i \in N(g,j)) v_{igjk}(\hat{\boldsymbol{\psi}}_{gj}, \hat{\boldsymbol{\gamma}}_j, \hat{\boldsymbol{\pi}}_{1jk}, \delta_{jk})}{\sum_i I(i \in N(g,j)) v_{igjk}(\hat{\boldsymbol{\psi}}_{gj}, \hat{\boldsymbol{\gamma}}_j, \hat{\boldsymbol{\pi}}_{1jk}, \delta_{jk})} \tag{23}$$

This is a weighted average of every applicant's preparation score, where the weight is their probability of being admitted and allocated to a specific campus, $v_{igjk}(\hat{\boldsymbol{\psi}}_{gj}, \hat{\boldsymbol{\gamma}}_j, \hat{\boldsymbol{\pi}}_{1jk}, \delta_{jk})$. I represents the indicator function. The difference between the equation for the average preparation score in the counterfactual and in the baseline is that in the baseline, instead of using $v_{igjk}(\hat{\boldsymbol{\psi}}_{gj}, \hat{\boldsymbol{\gamma}}_j, \hat{\boldsymbol{\pi}}_{1jk}, \delta_{jk})$, I use the product of the baseline UC system admissions probability, $r_{igj}(\hat{\boldsymbol{\psi}}_{gj})$, and the baseline allocation probability for admits, $q_{igjk}(\hat{\boldsymbol{\pi}}_{gjk})$.[19]

Panel A shows that indeed, the average preparation score at every campus increases for minorities regardless of their major. This would seem to indicate that in the absence of racial preferences, there would be a downwards cascade of minority students, with those with less academic preparation matriculating to less selective institutions than they attended in the

[18] Recall that the preparation score, P, is different than the academic preparation index. The preparation score was provided by the UCOP as a linear combination of a student's exact SAT score and high school GPA.

[19] Recall that $v_{igjk}(\hat{\boldsymbol{\psi}}_{gj}, \hat{\boldsymbol{\gamma}}_j, \hat{\boldsymbol{\pi}}_{1jk}, \delta_{jk})$ can be similarly be decomposed into the probability of admissions to the UC system in the absence of racial preferences, $w_{igms}(\hat{\boldsymbol{\psi}}_{gj}, \hat{\boldsymbol{\gamma}}_j)$, and the probability of being allocated to campus k conditional on being admitted, $q'_{igjk}(\hat{\boldsymbol{\pi}}_{1jk}, \delta_{jk})$,

$$v_{igjk}(\hat{\boldsymbol{\psi}}_{gj}, \hat{\boldsymbol{\gamma}}_j, \hat{\boldsymbol{\pi}}_{1jk}, \delta_{jk}) = w_{igms}(\hat{\boldsymbol{\psi}}_{gj}, \hat{\boldsymbol{\gamma}}_j) q'_{igjk}(\hat{\boldsymbol{\pi}}_{1jk}, \delta_{jk})$$

Table 7: Average Preparation Score of Minority and Non-Minority Students Under Different Assignment Rules

Assignment Rule	Berkeley	UCLA	San Diego	Davis	Irvine	Santa Barbara	Santa Cruz	Riverside	Outside Option
Panel A: Minority									
Initial Major Science									
Baseline	0.19	0.05	-0.01	-0.37	-0.33	-0.73	-0.94	-0.77	-0.27
No Preferences	0.76	0.47	0.16	-0.06	-0.32	-0.64	-0.83	-0.55	-0.02
Initial Major Non-Science									
Baseline	-0.23	-0.22	-0.18	-0.68	-0.64	-0.89	-0.99	-1.03	-0.55
No Preferences	0.65	0.31	-0.02	-0.26	-0.54	-0.79	-0.97	-0.76	-0.22
Panel B: Non-Minority									
Initial Major Science									
Baseline	1.11	0.93	0.70	0.44	0.09	-0.11	-0.34	-0.13	0.48
No Preferences	1.08	0.87	0.63	0.35	-0.01	-0.17	-0.39	-0.22	0.39
Initial Major Non-Science									
Baseline	0.92	0.73	0.56	0.24	-0.12	-0.22	-0.36	-0.49	0.24
No Preferences	0.98	0.72	0.43	0.16	-0.16	-0.30	-0.48	-0.34	0.20

baseline. Furthermore, it should be noted that the largest increase in average preparation score occurs at UC Berkeley, suggesting that they had the strongest racial preferences in the baseline.

In Panel B, we see the opposite trend for non-minorities. With the exception of non-minorities studying non-sciences at UC Berkeley and UC Riverside, every other campus sees the average preparation score of non-minorities fall in the absence of racial preferences. This would be consistent with non-minorities experiencing an upward surge, pushing those with lower academic preparations into institutions that are more selective than the ones they would have been allocated to in the baseline. Lastly, it should be noted that even in the absence of racial preferences, there still remains a gap between the average preparation scores of minorities and non-minorities, although the magnitude of the gap does decrease in the absence of racial preferences. Recall that the preparation score is a linear combination of a student's high school GPA and SAT score, so the remaining gap in preparation score could reflect each campus' preferences for other aspects of the academic index, such as parental income and education.

IV.d Graduation Rates

Finally, I address the effect of removing racial preferences on graduation rates. Unlike the original estimates for the change in graduation rates in Arcidiacono et al. (2016), I estimate the change in the graduation rates of all UC applicants and not only the change for UC enrollees. This allows me to capture not only the effect of reallocating the initial admits across the UC system, but also the effect of shifting the least (most) prepared minority (non-minority) admits outside (inside) of the UC system. The estimated graduation probabilities are obtained from Arcidiacono et al. (2016), as specified in equation (5).

In order to estimate how the removal of racial preferences would affect the graduation rates of applicants, I must make assumptions regarding the graduation rate of applicants who do not enroll in the UC system, since the outside options of students are not observed in the data. I attempt to capture this heterogeneity in the graduation probability of applicants at their best outside option by modeling the graduation probability as a function of their original admissions status to the UC system. Denote colleges and universities outside of the UC system as k^*, where k_1^* represents the outside option when admitted to the UC system and k_2^* represents the outside option when rejected from the UC system. For students who are initially admitted to the UC system when racial preferences are in place, I model their outside graduation probability as a weighted average of their allocation probability at each UC campus

$$p_{ijk_1^*} = p_{ijk_2^*} = \frac{\sum_{k \neq k^*} p_{ijk}(\hat{\boldsymbol{\theta}}) q_{igjk}(\hat{\boldsymbol{\pi}}_{gjk})}{\sum_{k \neq k^*} q_{igjk}(\hat{\boldsymbol{\pi}}_{gjk})} \tag{24}$$

where the weight is the baseline probability of being allocated to that campus conditional on being admitted to the UC system and enrolling at a UC campus. For students who are initially rejected from every UC campus that they apply to, I model their outside graduation probability as their minimum graduation at any UC campus

$$p_{ijk_1^*} = p_{ijk_2^*} = \arg\min_{k \in K} p_{ijk}(\hat{\boldsymbol{\theta}}) \tag{25}$$

Note that I assume that $p_{ijk_1^*} = p_{ijk_2^*}$, regardless of the initial admissions status of an applicant. This is because if the set of universities that each applicant applies to is taken as given, then changes to the admissions and allocation rules in the UC system should not affect each applicant's outside option.

To determine the baseline science persistence rate, R, at campus $k \in K^+$ for students from group g with initial admissions status s, I use the following equation:

$$R_{gmks} = \frac{\sum_i I(i \in N(g,m,s)) r_{igm}(\hat{\boldsymbol{\psi}}_{gm}) q_{igmk}(\hat{\boldsymbol{\pi}}_{gmk}) p_{imk}(\hat{\boldsymbol{\theta}})}{\sum_i I(i \in N(g,m,s)) r_{igm}(\hat{\boldsymbol{\psi}}_{gm}) q_{igmk}(\hat{\boldsymbol{\pi}}_{gmk})} \tag{26}$$

where I is the indicator function, $q_{igmk}(\hat{\boldsymbol{\pi}}_{gmk})$ is the baseline probability of being allocated to campus $k \in K^+$ conditional on being admitted, and $r_{igm}(\hat{\boldsymbol{\psi}}_{gj})$ is the probability of being admitted to the UC system in the baseline.[20] Similarly, the counterfactual graduation persistence rate is calculated at campus k using the following equation:

$$R'_{gmks} = \frac{\sum_i I(i \in N(g,m,s)) w_{igms}(\hat{\boldsymbol{\psi}}_{gm}, \hat{\boldsymbol{\gamma}}_m) q'_{igmk}(\hat{\boldsymbol{\pi}}_{1mk}, \delta_{mk}) p_{imk}(\hat{\boldsymbol{\theta}})}{\sum_i I(i \in N(g,m,s)) w_{igms}(\hat{\boldsymbol{\psi}}_{gm}, \hat{\boldsymbol{\gamma}}_m) q'_{igmk}(\hat{\boldsymbol{\pi}}_{1mk}, \delta_{mk})} \tag{27}$$

where $w_{igms}(\hat{\boldsymbol{\psi}}_{gm}, \hat{\boldsymbol{\gamma}}_m)$ is the probability of being admitted to the UC system in the counterfactual, and $q'_{igmk}(\hat{\boldsymbol{\pi}}_{1mk}, \delta_{mk})$ is the probability of being allocated to campus $k \in K^+$, conditional on being admitted in the counterfactual. These values come from equation (22). Note that w_{igms} is a function of s, whereas r_{igm} is not a function of s. This is because the counterfactual admissions probabilities are informed by the original admissions status of each applicant using Bayes' Rule, but the baseline probabilities are calculated over the entire pool of applicants. Now let k_2^* denote the outside option for those who are not admitted to

[20]Note that estimating the baseline over the set of all admits using their allocation probabilities leads to nearly identical baseline persistence rates as estimating the baseline persistence rates on the actual enrollees at each campus. These estimated persistence rates are also similar to the actual persistence rates over this period from Table 4.

the UC system. The baseline and counterfactual science persistence rates for them are

$$R_{gmk_2^*s} = \frac{\sum_i I(i \in N(g,m,s))(1 - r_{igm}(\hat{\boldsymbol{\psi}}_{gm}))p_{imk*_2}(\hat{\boldsymbol{\theta}})}{\sum_i I(i \in N(g,s))(1 - r_{igm}(\hat{\boldsymbol{\psi}}_{gm}))} \tag{28}$$

$$R'_{gmk_2^*s} = \frac{\sum_i I(i \in N(g,m,s))(1 - w_{igms}(\hat{\boldsymbol{\psi}}_{gm}, \hat{\boldsymbol{\gamma}}_m))p_{imk_2^*}(\hat{\boldsymbol{\theta}})}{\sum_i I(i \in N(g,m,s))(1 - w_{igms}(\hat{\boldsymbol{\psi}}_{gm}, \hat{\boldsymbol{\gamma}}_m))} \tag{29}$$

Combining equations (28-31) to compute the science persistence rate across all colleges for all applicants to the UC system,

$$R_{gms} = \frac{\sum_i I(i \in N(g,m,s))[(1 - r_{igm}(\hat{\boldsymbol{\psi}}_{gm}))p_{imk*_2}(\hat{\boldsymbol{\theta}}) + \sum_{k \in K^+} r_{igm}(\hat{\boldsymbol{\psi}}_{gm})q_{igmk}(\hat{\boldsymbol{\pi}}_{gmk})p_{imk}(\hat{\boldsymbol{\theta}})]}{\sum_i I(i \in N(g,m,s))} \tag{30}$$

$$R'_{gms} = \frac{\sum_i I(i \in N(g,m,s))[(1 - w_{igms}(\hat{\boldsymbol{\psi}}_{gm}, \hat{\boldsymbol{\gamma}}_m))p_{imk_2^*}(\hat{\boldsymbol{\theta}}) + \sum_{k \in K^+} w_{igms}(\hat{\boldsymbol{\psi}}_{gm}, \hat{\boldsymbol{\gamma}}_m)q'_{igmk}(\hat{\boldsymbol{\pi}}_{1mk}, \delta_{mk})p_{imk}(\hat{\boldsymbol{\theta}})]}{\sum_i I(i \in N(g,m,s))} \tag{31}$$

Besides the persistence rate, I also compute the overall graduation rate of all applicants, regardless of their initial or final major. In order to do so, I utilize similar equations to equations (28)-(33), replacing $p_{imk}(\hat{\boldsymbol{\theta}})$ with $(p_{imk}(\hat{\boldsymbol{\theta}}) + p_{ihk}(\hat{\boldsymbol{\theta}}))$, $I(i \in N(g,m,s))$ with $I(i \in N(g,s))$, and any subscript m with a subscript j, where $j \in \{m, h\}$ is an applicant's initial major.

The science persistence rates and overall graduation rates are presented in Table 8.[21] Panel A shows that the science persistence rate increases for minorities originally admitted to the UC system and non-minorities originally rejected from the system, while holding constant for minority rejects and non-minority admits. For minority admits, the persistence rate increases at every campus, suggesting better matching between prospective science

[21]The underlying number of graduates and enrollees at each campus can be found in Tables A3 and A4.

Table 8: Change in Graduation Rates for Minorities and Non-Minorities Under Counterfactual Admissions and Allocation Rules (Percentage Points)

	Berkeley	UCLA	San Diego	Davis	Irvine	Santa Barbara	Santa Cruz	Riverside	Admits Outside	Rejects Outside	Overall
Panel A: Persistence Rate in the Sciences											
Minority Admits											
Baseline	27.4	27.7	32.8	23.7	22.5	21.0	19.1	19.8	24.8	n/a	24.9
No Preferences	41.0	36.8	36.9	28.7	23.1	21.3	19.7	23.0	28.9	18.6	25.6
Minority Rejects											
Baseline	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	5.8	5.8
Overall Minority											
Baseline	27.4	27.7	32.8	23.7	22.5	21.0	19.1	19.8	24.8	5.8	21.9
No Preferences	41.0	36.8	36.9	28.7	23.1	21.3	19.7	23.0	28.9	12.5	22.4
Non-Minority Admits											
Baseline	56.5	50.9	52.0	43.4	34.5	33.1	26.9	33.2	43.6	n/a	43.9
No Preferences	56.1	50.4	51.3	42.6	33.8	32.4	26.5	32.6	42.9	n/a	43.9
Non-Minority Rejects											
Baseline	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	20.5	20.5
No Preferences	46.3	41.5	39.8	31.6	26.7	23.4	22.4	26.7	24.9	19.8	21.6
Overall Non-Minority											
Baseline	56.5	50.9	52.0	43.4	34.5	33.1	26.9	33.2	43.6	20.5	40.0
No Preferences	56.0	50.2	51.0	42.1	33.3	31.8	26.2	32.1	42.2	19.8	40.2
Overall Regardless of Race											
Baseline	52.4	46.1	49.6	40.5	32.9	30.8	25.5	30.6	40.2	18.1	37.0
No Preferences	55.5	49.4	49.7	40.3	31.3	29.3	24.2	29.9	40.4	17.3	37.2
Panel B: Overall Graduation Rate											
Minority Admits											
Baseline	68.6	65.5	67.0	56.9	61.3	61.0	59.5	57.9	62.5	n/a	62.8
No Preferences	78.2	72.8	69.2	64.9	59.9	62.8	58.8	57.2	66.8	57.3	63.0
Minority Rejects											
Baseline	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	37.5	37.5
Overall Minority											
Baseline	68.6	65.5	67.0	56.9	61.3	61.0	59.5	57.9	62.5	37.5	57.9
No Preferences	78.2	72.8	69.2	64.9	59.9	62.8	58.8	57.2	66.8	47.2	58.0
Non-Minority Admits											
Baseline	86.0	83.4	80.0	75.5	68.3	72.4	68.0	63.4	76.4	n/a	76.2
No Preferences	86.4	82.8	79.2	74.8	67.9	71.8	66.6	64.4	75.8	n/a	76.3
Non-Minority Rejects											
Baseline	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	54.0	54.0
No Preferences	78.2	72.8	69.4	65.3	60.9	65.6	62.1	59.1	57.5	53.3	55.2
Overall Non-Minority											
Baseline	86.0	83.4	80.0	75.5	68.3	72.4	68.0	63.4	76.4	54.0	72.0
No Preferences	86.2	82.6	78.9	74.3	67.4	71.3	66.1	63.9	74.9	53.3	72.2
Overall Regardless of Race											
Baseline	82.2	78.8	78.4	72.8	67.4	70.3	66.5	62.0	73.8	50.9	69.3
No Preferences	85.9	82.0	78.0	73.0	65.8	69.3	64.0	62.2	73.8	51.0	69.6

students and UC campuses. By definition, none of the minority admits in the baseline are rejected and forced outside the system. However, recall from Table 5 that over 20% of minorities originally admitted to the UC system are no longer admitted without racial preferences. The average science persistence rate for these students who are rejected from the UC system in the counterfactual scenario is 18.6%, which is lower than the average persistence rate at any campus in the baseline. Since I assume that the probability of these students graduating in the sciences is a weighted average of their probability of graduating in the sciences at each UC campus, the low persistence rate for rejects in the counterfactual suggests that those with the lowest graduation probabilities within the system are most likely to be rejected from the system. Importantly, the overall science persistence rate for minority admits increases, which implies that the gains by reallocating the minorities who remain within the UC system exceed the losses from those who are no longer admitted to the system. The science persistence rates for minority rejects when racial preferences are removed are not explicitly specified within Table 8, because they are assumed to remain constant between the baseline and counterfactual scenario.

By construction, non-minorities who were initially rejected are also winners under the counterfactual scenario.[22] The science persistence rates at each campus for the non-minority rejects in the counterfactual remain below those of the non-minority admits in the baseline, which is consistent with the non-minority rejects having lower levels of academic preparation than the non-minority admits. Inducing 22% of non-minority rejects into the UC system increases the average science persistence rate of all non-minority rejects by 1.1%, the most of any group by race and admissions status.

Lastly, the overall persistence rate of non-minority admits remains constant, despite the fall in the persistence rate of non-minorities at each campus. This can be explained by these admits being shifted towards more selective campuses once racial preferences are removed.

[22]Since the outside graduation probability for non-minority rejects is assumed to be the minimum of their graduation probabilities within the UC system, an individual's graduation probability must increase if they are induced into the system once racial preferences are lifted.

Thus, while the persistence rates fall at each campus, since the admits shift towards campuses with higher persistence rates, there is no net effect on the overall science persistence rate of non-minority admits.

When focusing on the overall graduation rate of all applicants as opposed to the persistence rate of prospective science majors, there are similar trends. Minority admits and non-minority rejects still see an increase in their overall graduation rate, but now, the overall graduation rate of non-minority admits also increases slightly. Thus, when racial preferences are removed from the admissions and allocation rules, on average, the science persistence rate and the overall graduation rate of both minority and non-minority applicants to the UC system would increase. This is largely driven by gains by minority admits from better matching to UC campuses, which outweigh the losses by minority admits who are forced outside the UC system, and by gains from non-minority rejects who are induced into the system.

Importantly, Table 8 provides a potential explanation for how Arcidiacono et al. (2016) and Bleemer (2022) can be reconciled. Consistent with Arcidiacono et al. (2016), when I restrict my analysis to original enrollees in the UC system, I find that the science persistence rate of minorities increases from 25.0% to 26.4% when racial preferences are removed. Similarly, the overall graduation rate for minority enrollees increases from 63.0% to 63.1%.[23] Contrary to this, Bleemer (2022) uses a difference-in-differences model to contend that the graduation rate of minority applicants fell after Prop 209 was enforced. Panel B shows how this conclusion could potentially be reached, as the non-minority graduation rate rises by 0.2%, whereas the minority graduation rate only rises by 0.1%. Thus, it could be the case that both minorities and non-minorities benefit from higher graduation rates after Prop 209, but that greater average gains by non-minorities lead Bleemer (2022) to conclude that Prop 209 had a negative impact on minority graduation rates.

[23] These values are calculated using the number of graduates and number of enrollees from Tables A3 and A4.

IV.e Robustness Checks

In Appendix Tables A5-8, I present alternate specifications of Tables 5-8 where the Dale and Krueger controls are omitted entirely. Since these controls are embedded in the academic preparation index, AI_{ij}, I estimate new academic preparation indices, $\tilde{A}I_{ij}$ and use these academic indices to compute the admissions and allocation rules. The results when the Dale and Krueger controls are omitted are consistent with the results presented above. Table A8 shows that when no longer accounting for selection, the overall science persistence rate and graduation rate still increase, although the overall minority graduation rate falls slightly from 59.9% to 59.8%.

Finally, as the estimates for the science persistence rate and graduation rate are sensitive to my assumptions regarding the outside graduation probabilities, I specify two alternate models. In the first model, presented in Table A9, I assume that minorities who are originally admitted to the UC system but choose to enroll elsewhere have superior outside options compared to minorities who enroll in the UC system. I thus alter $p_ijk_2^*$ for minorities who originally attended the UC system by setting it equal to the minimum UC graduation probability from equation (25) as opposed to the weighted graduation probability from equation (24).[24] The second model, presented in Table A10, changes the outside graduation probability of students originally admitted to the UC system. Namely, it sets their estimated outside graduation probability to their estimated graduation probability at the UC campus they would have most likely been allocated to in the baseline

$$p_{ijk_1^*} = p_{ijk_2^*} = \sum_k p_{ijk}(\hat{\boldsymbol{\theta}}) I(k = \arg\max_k q_{ijk}) \tag{32}$$

The assumptions from the first alternate model lead to a slight decrease in the persistence rate and overall graduation rate of minority applicants, while the results from the second alternate model closely mirror the results presented in Table 8.

[24] Note that this would imply that minority enrollees have outside options more similar to those of UC rejects than those of admits who enroll elsewhere.

V Strategic Gaming

V.a Modeling Admissions at Individual Campuses

In order to determine whether or not students faced an incentive to misrepresent their intended majors at certain campuses when applying, I begin by estimating a logit admissions model at each campus, taking race into account. Let $\kappa_i = 1$ if i is a minority. We model applicant i's probability of admissions in major j at campus k as:

$$t_{ijk} = \frac{\exp(\boldsymbol{X}_i \boldsymbol{\omega}_k + AI'_{ijk} + (\kappa_i * AI'_{ijk})\zeta_{jk} + \lambda_k)}{1 + \exp(\boldsymbol{X}_i \boldsymbol{\omega}_k + AI'_{ijk} + (\kappa_i * AI'_{ijk})\zeta_{jk} + \lambda_k)} \tag{33}$$

Here, $\boldsymbol{X_i}$ once again represents the following individual characteristics: parental income, parental education, minority status, whether they applied in the sciences, and an interaction term between minority status and applying in the sciences. However, the academic preparation index in this model, AI'_{ijk}, is defined differently than it was defined in Arcidiacono, Aucejo, and Hotz (2016). Their academic preparation index differed according to a student's choice of which major to graduate in, with science and non-science majors rewarding academic characteristics differently. However, this new academic index, which importantly still varies by major, is now a function of a student's intended major, as opposed to the major they graduate in. This allows the admissions officers to weigh test scores differently depending on a student's intended major. For example, SAT verbal scores could be weighed more heavily during the admissions process for students who intend to pursue humanity majors, whereas SAT math scores could be weighed more heavily for those who intend to pursue science majors. The academic index is also campus-specific, so different campuses can weigh test scores differently. Furthermore, seeing as non-academic family background characteristics are already included in $\boldsymbol{X_i}$, I omit most background characteristics from AI_{ijk}, leaving it as a linear combination of a student's high school GPA, and SAT scores.

$$AI'_{ijk} = \tau_{1jk} \times High\ School\ GPA + \tau_{2jk} \times SAT\ Math + \tau_{3jk} \times SAT\ Verbal \tag{34}$$

Finally, note that the admissions model also includes an interaction term between minority status and the academic index, as well as a campus-specific intercept, λ_k. The interaction term allows admissions officers to place different weights on the academic index depending on the race of the applicant, while the intercept allows for selectivity to vary across campuses independent of an applicant's traits.

V.b Results

Table 9 presents the coefficients for the logit models of admissions at each UC campus. Panel A presents all of the coefficients, except for the academic index function coefficients, which are presented in Panel B. At every campus besides Riverside, the URM coefficient was positive, suggesting that there were indeed racial preferences in the admissions process. Before taking test scores and academic preparation into account, students who applied as science majors were less likely to be admitted to UC Berkeley, UCLA, UC Davis, and UC Irvine. Minorities who applied as science majors faced less of a penalty than their non-minority peers, but still faced a penalty nonetheless. Lastly, the minority status and academic index interaction terms were negative at every campus with the exception of UC Santa Barbara and UC Riverside. This would suggest that the academic preparation of minority students is weighed less heavily than the academic preparation of non-minority students during the admissions process at these campuses. The non-monotonicities in the coefficients for the parental income or education indicators lead to no discernible trend.

At UC Berkeley and UCLA, the coefficients for high school GPA and SAT scores are greater for science applicants, indicating that academic preparation played a greater role in admissions for science majors than for non-science majors. The opposite trend is observed at UC San Diego, where the non-science academic index coefficients were greater than the science academic index coefficients. Surprisingly, the SAT math coefficient for science applicants was not always greater than the corresponding coefficient for non-science applicants, and the SAT verbal coefficient for non-science applicants was not necessarily greater than the corresponding coefficient for science applicants.

Table 9: Logit Coefficients for Admissions to Individual Campuses

	Berkeley	UCLA	San Diego	Davis	Irvine	Santa Barbara	Santa Cruz	Riverside
Panel A: Logit Coefficients								
Parental Income Indicators								
-9 (Missing)	-0.406	-0.537	-1.017	-0.490	-0.219	-0.498	-0.041	-0.512
2	-0.058	-0.007	-0.147	0.042	0.168	0.164	0.241	0.005
3	-0.572	-0.669	-1.136	-0.388	-0.139	-0.591	0.020	-0.395
4	-0.347	-0.346	-0.831	-0.170	0.099	0.174	0.178	0.063
5	-0.415	-0.503	-1.102	-0.365	-0.044	-0.221	0.203	-0.064
6	-0.488	-0.604	-1.078	-0.329	0.096	-0.238	0.267	-0.090
7	-0.549	-0.620	-1.063	-0.371	0.069	-0.321	0.304	-0.082
8	-0.584	-0.631	-1.086	-0.307	0.005	-0.351	0.371	-0.106
9	-0.564	-0.565	-1.084	-0.352	0.074	-0.367	0.282	-0.167
10	-0.504	-0.593	-1.022	-0.289	0.239	-0.361	0.472	0.040
11	-0.572	-0.615	-0.943	-0.276	0.045	-0.326	0.308	0.086
Parental Education Indicators								
-9 (Missing)	-0.372	-0.691	-0.863	-0.865	-0.119	-0.499	-0.685	-0.633
2	0.037	-0.140	-0.111	-0.222	-0.045	-0.074	-0.155	-0.174
3	-0.142	-0.430	-0.417	-0.619	-0.139	-0.206	-0.503	-0.278
4	-0.291	-0.494	-0.817	-0.877	-0.099	-0.287	-0.510	-0.268
5	-0.212	-0.577	-0.866	-0.977	-0.109	-0.333	-0.597	-0.382
6	-0.514	-0.626	-0.930	-0.934	-0.208	-0.613	-0.705	-0.585
7	-0.288	-0.537	-0.774	-0.781	-0.056	-0.469	-0.611	-0.468
URM	10.659	6.922	7.293	3.153	1.210	2.856	0.824	-0.199
Applied Science	-4.734	-5.176	2.520	-2.310	-1.142	1.793	1.070	2.237
URM x Applied Science	3.121	2.781	0.615	1.014	1.059	-3.066	1.759	-0.400
URM x Non-Science AI	-0.396	-0.192	-0.188	-0.041	-0.024	-0.081	-0.010	0.040
URM x Science AI	-0.476	-0.258	-0.245	-0.047	-0.073	0.063	-0.132	0.047
Constant	-20.642	-22.485	-26.395	-18.065	-16.763	-19.718	-14.093	-12.320
Panel B: Academic Index Function								
Non-Science								
HS GPA	2.007	2.706	3.888	3.068	3.292	3.591	3.417	3.014
SAT Math	9.593	8.076	11.707	8.521	4.793	8.476	3.099	2.914
SAT Verbal	10.250	12.384	11.325	8.143	7.276	9.527	6.055	5.741
Science								
HS GPA	2.245	3.203	3.573	2.846	3.292	3.357	3.177	2.480
SAT Math	13.539	11.961	11.209	11.288	5.834	7.959	2.289	1.107
SAT Verbal	12.129	13.907	9.859	8.912	8.082	8.447	6.562	6.857

Notes: The coefficients for AI Science and AI Non-Science are normalized to 1, and the coefficient for the parental income and education indicators is normalized to 0 for the lowest level.

With these admissions logits, it is possible to predict the admissions probability of each student if they were to apply as a prospective science major and if they were to apply as a prospective non-science major. In order to gain a better general understanding of whether it is optimal to apply as a science major or a non-science major conditional on a student's academic preparation, I exploit the fact that the GPA and SAT data provided by the UCOP come in the form of categorical variables.[25] Table 10 presents the optimal major for a student to list on their application at each UC campus conditional on having select GPA and SAT combinations.[26]

At UC Berkeley, it is never optimal for a minority student to apply as a science major, although it is optimal for non-minority students with high SAT scores to apply in the sciences. UCLA displays a similar trend, although it is also optimal for minorities with high SAT scores to apply in the sciences there. The opposite is true for minority applicants at UC San Diego and UC Santa Cruz, and it is optimal for students with less academic preparation to apply as science majors and for students with more academic preparation to apply as non-science majors. Lastly, UC Riverside appears to display the same trend as UC Berkeley for minority applicants, where it is always optimal to apply in the non-sciences.[27] Note the optimal major for a minority student and a non-minority student with the same test scores often differs. These differences are driven by the minority status interactions terms.

While it is optimal for minority applicants to not apply as science majors at UC Berkeley or UC Riverside, the magnitude of the gains in admissions probability by applying in the non-sciences varies greatly between the two campuses. Figure 1 displays the probability density

[25]The numeric transformations for the high school GPAs were: 3, 3.74, 4.24, and 4.5. Only 265 out of 155,509 applicants had a GPA of 4.5, while there were roughly an even number of applicants in each of the other 3 GPA bins. The numeric transformations for the SAT scores were: 400, 474, 524, 574, 624, 674, and 724.

[26]Four of the six rows represent students in the first, thirty-third, sixty-sixth, and ninety-ninth percentiles of both the GPA and SAT distributions. The other two rows, (4.24,400,400) and (3.0, 724,724), were chosen to represent students with high GPAs but low SAT scores and students with low GPAs but high SAT scores.

[27]Note this is not necessarily always the case. For minorities in the lowest GPA and SAT Math bins and the second lowest SAT Verbal bin, it is optimal to apply in the sciences at UC Riverside. It just so happens that it is optimal for minorities to apply in the non-sciences at UC Riverside given these 6 combinations of test scores.

Table 10: Optimal Major by Academic Preparation and Race

GPA	SAT Math	SAT Verbal	Berkeley	UCLA	San Diego	Davis	Irvine	Santa Barbara	Santa Cruz	Riverside
Panel A: Minorities										
3.0	400	400	NS	NS	S	NS	NS	NS	S	NS
4.24	400	400	NS	NS	S	NS	NS	S	NS	NS
3.0	574	524	NS	NS	S	NS	S	S	S	NS
3.74	624	624	NS	NS	NS	NS	S	S	NS	NS
3.0	724	724	NS	S	NS	S	S	S	NS	NS
4.24	724	724	NS	S	NS	S	S	S	NS	NS
Panel B: Non-Minorities										
3.0	400	400	NS	NS	S	NS	NS	S	S	S
4.24	400	400	NS	NS	S	NS	NS	S	NS	NS
3.0	574	524	NS	NS	S	NS	NS	S	S	S
3.74	624	624	NS	S	S	NS	S	NS	NS	NS
3.0	724	724	S	S	S	NS	S	NS	S	S
4.24	724	724	S	S	NS	NS	S	NS	NS	NS

Notes: NS means that an applicant should optimally apply as a non-science major at that campus, while S means that they should optimally apply as a science major.

function of the difference in admissions probability between applying as a non-science major and applying as a science major for minority applicants. A positive difference indicates that a student had a higher probability of admissions as a prospective non-science major. Clearly, the average absolute gain in admissions probability by applying to UC Berkeley in the non-sciences is greater than the average absolute gain in admissions probability from applying to UC Riverside as a non-science major. In fact, a student in the 5^{th} percentile of the distribution of the difference in admissions probability at UC Berkeley has an admissions probability in the non-sciences that is 6.27% higher than their admissions probability in the science. Meanwhile, a student in the 95^{th} percentile of the distribution of the difference in admissions probability at UC Riverside has an admissions probability that is 5.70% higher in the sciences than in the non-sciences. In other words, a student in the 5^{th} percentile of the distribution at UC Berkeley still has greater potential gains in admissions probability than a student in the 95^{th} percentile of the distribution at UC Riverside.

For some applicants to UC Berkeley, their probability of admissions in the non-sciences

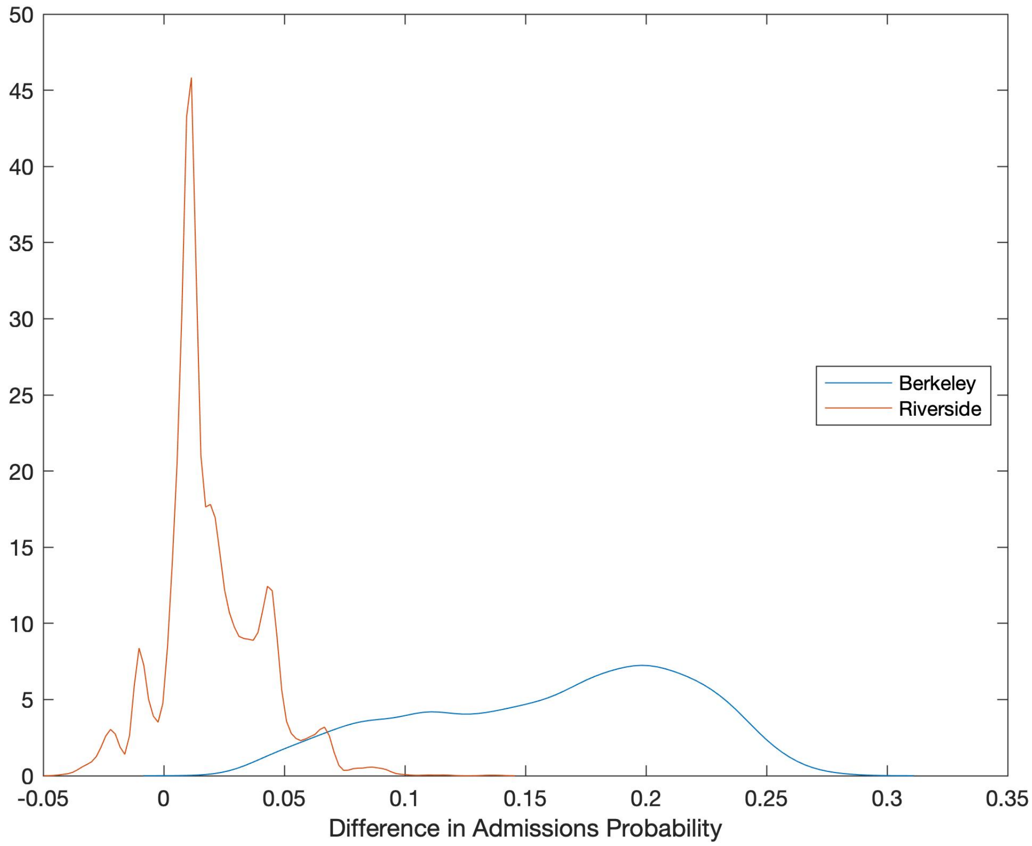

Figure 1: Distribution of the Difference Between the Probability of Admissions in the Non-Sciences and Sciences at UC Berkeley and UC Riverside for Minority Applicants

is over 25% greater than their probability of admissions in the sciences. Furthermore, since the probability density function for UC Berkeley applicants lies entirely to the right of zero, it is indeed optimal for every minority UC Berkeley applicant to apply in the non-sciences. On the other hand, for UC Riverside applicants, there are some students who should apply in the sciences.

Of course, despite these incentives to apply as a non-science major, or in some cases as a science major, students might not have applied optimally if their objective function was not to simply maximize their probability of admissions. However, if applicants were gaming strategically to optimize their admissions probability, we would expect to see the majority of students applying optimally.[28] Table 11 presents the share of applicants who apply optimally at each campus and the average loss in admissions probability for those who

[28]This assumes that the cost of switching majors once admitted is sufficiently low.

Table 11: Share of Applicants Who Applied Optimally and the Average Loss in Admissions Probability for Those Who Applied Suboptimally by Race and Intended Major (Percentage Points)

	Intended Major	Berkeley	UCLA	San Diego	Davis	Irvine	Santa Barbara	Santa Cruz	Riverside
Panel A: Minorities									
Share Who Applied Optimally	Science	0.0	47.1	36.6	33.2	56.9	28.8	57.8	33.2
	Non-Science	100.0	66.7	51.0	79.0	55.5	77.5	32.9	89.0
Average Losses for Those	Science	15.1	5.7	1.2	2.6	1.6	0.5	0.8	2.7
Who Applied Suboptimally	Non-Science	N/A	2.4	2.9	2.1	0.9	1.0	3.1	2.1
Panel B: Non-Minorities									
Share Who Applied Optimally	Science	58.6	73.3	46.9	12.4	55.5	54.8	40.3	52.4
	Non-Science	55.8	36.8	41.9	84.2	54.7	40.1	55.7	60.6
Average Losses for Those	Science	1.0	2.5	0.7	7.6	1.0	0.5	0.5	1.6
Who Applied Suboptimally	Non-Science	3.8	5.0	2.9	9.5	0.6	2.1	2.3	3.1

Notes: The average losses for minority students who applied in the non-sciences at Berkeley is N/A as none of these applicants applied suboptimally.

apply suboptimally, conditional on race and intended major.

The majority of minority students who apply as science majors apply suboptimally at every campus, except for UC Irvine and UC Santa Cruz. The opposite is true for those who apply as non-science majors, as UC Santa Cruz was the only campus where the majority of non-science applicants apply suboptimally. The largest average loss in admissions probability is incurred by minority students who apply to UC Berkeley as science majors, consistent with figure 1. This highlights the stronger incentive to apply strategically at selective schools, as they not only have the largest absolute potential gains from applying as the optimal intended major, but they also have the lowest baseline acceptance rates. This suggests that the relative importance of applying as the ideal major could be even greater.

Table 11 represents the share of all applicants who applied optimally, although not necessarily everyone gamed. For example, a student who applied to all 8 campuses in the sciences is likely not gaming strategically.[29] Thus, in order to focus on applicants who are more likely to have gamed, I will now restrict my analysis to a subset of students who apply to campuses in both the sciences and the non-sciences. More specifically, I focus on applicants who apply to exactly one campus in the sciences and at least one campus in the non-sciences

[29]For minority students, there does not exist a bundle of test scores such that it is always optimal for them to apply in the sciences, as it is never optimal to apply as a science major at UC Berkeley. It is also the case that it is never optimal for a non-minority student to apply to all eight campuses in the sciences.

and those who apply to precisely one campus in the non-sciences and at least one campus in the sciences. These applicants will now be referred to as "gamers." The campus that they applied to in a different major will be referred to as the "gamed campus," $\tilde{k}$, and the major that they applied in at campus $\tilde{k}$ will be referred to as the "gamed major," $\tilde{j}$. Of course, not all of these applicants were necessarily gaming and strategically misrepresenting their preferences over the set of possible majors. If their preferences over the set of majors are campus specific, then a rational applicant might apply as a science major at one campus, while simultaneously applying as a non-science major at another campus. That being said, if these applicants were signaling their intended majors strategically to maximize their probability of admissions, and if they applied to 1 campus in a unique major, then they should experience positive gains in their admissions probability at that campus from applying in that major.

Table 12 presents results for various analyses of these gamers. Panel A presents the results for all gamers broken down by race and the gamed major. For example, the first row displays the results for minorities who gamed in the sciences. If the set of n_i campuses that a student applies to, $K_i = \{k_1, \dots, k_{n_i}\}$, as well as their decision to game in major $\tilde{j}$ are taken as given, then there is an optimal campus, k', for the student to game at. Let the gains in admissions probability at each school from applying in the gamed major $\tilde{j}$ as opposed to j be denoted as $d_{i\tilde{j}k}$, where

$$d_{i\tilde{j}k} = t_{i\tilde{j}k} - t_{ijk} \tag{35}$$

The optimal campus to game at is thus [30]

$$k' = \arg\max_{k \in K_i} d_{i\tilde{j}k} \tag{36}$$

Note that the random probability that a gamer gamed at the optimal campus is $\frac{1}{n_i}$. The

[30]Note that the maximum is not necessarily positive. If a gamer has a higher admissions probability in major j at every campus they applied to, then the optimal campus for them to game at is actually the campus where it is least disadvantageous to apply in major j.

Table 12: Share of Gamers Who Applied Optimally (Percentage Points)

Gamed Major	Share Gamed at Optimal Campus: Random	Share Gamed at Optimal Campus: Actual	Average Gains: Random	Average Gains: Realized	Share with Positive Realized Gains: Random	Share with Positive Realized Gains: Actual	Share with Positive Gains at at least 1 Campus Applied to	Share with Positive Gains at Every Campus Applied to
Panel A: Overall								
Minorities								
Science	39.3	45.9	-4.0	-3.2	26.0	30.2	56.8	2.5
Non-Science	35.7	43.2	3.8	5.0	74.3	79.7	98.3	41.8
Non-Minorities								
Science	37.2	36.5	-0.7	-0.7	45.2	46.6	80.4	11.9
Non-Science	33.5	35.5	0.5	1.0	55.4	61.9	91.5	15.7
Panel B: Low-Income								
Minorities								
Science	38.9	46.1	-4.0	-3.1	25.3	29.8	56.4	2.1
Non-Science	35.6	42.9	3.8	4.9	74.9	80.1	98.5	42.4
Non-Minorities								
Science	37.1	36.8	-0.8	-0.7	44.5	46.2	79.7	11.8
Non-Science	33.4	35.8	0.6	1.2	55.9	62.9	91.7	16.3
Panel C: High-Income								
Minorities								
Science	40.7	45.1	-3.9	-3.3	28.4	31.5	58.0	4.0
Non-Science	36.1	44.4	3.8	5.2	72.5	78.0	97.5	39.8
Non-Minorities								
Science	37.5	35.4	-0.4	-0.5	47.5	48.3	83.0	12.2
Non-Science	33.7	34.2	0.2	0.4	53.3	58.4	90.8	13.4

Notes: Applicants who applied to exactly 1 campus in the sciences and 1 campus in the non-sciences will be counted in both rows.

average random probability that a gamer gamed at the optimal campus is specified in the first column of Table 12, while the second column specifies the share of gamers who actually gamed at the optimal campus. The next two columns present the average random gains and the average realized gains from gaming. The average random gains are the average of $d_{i\tilde{j}k}$ for $k \in K_i$, whereas the average realized gains are $d_{i\tilde{j}\tilde{k}}$. Columns five and six show the random and actual share of gamers with positive realized gains, where the random share of gamers with positive realized gains is

$$Random\ Share\ with\ Positive\ Realized\ Gains = \frac{\sum_i I(i \in N(r,\tilde{j})) \sum_{k \in K_i} I(d_{i\tilde{j}k} > 0)\frac{1}{n_i}}{\sum_i I(i \in N(r,\tilde{j}))} \quad (37)$$

Lastly, the final two columns present the share of gamers with positive gains at at least one of the campuses they applied to and the share of gamers with positive gains at every campus they applied to.

From Table 12, we can see that minorities game at the optimal campus more frequently than if they were randomly choosing which campus to game at. However, even though it is optimal to game at one campus relative to the others, recall that an applicant may still experience negative realized gains by gaming at this campus. That is, the optimal campus could be the campus where applicants lose the least by gaming. This is the case for many minorities who game in the sciences, as they have negative average realized gains, although the average realized gains are greater than the average random gains. By gaming in the sciences, minorities, on average, decrease their admissions probability by 3.2% at that the gamed campus. Only 30.2% of these gamers experience positive realized gains at the gamed campus. In fact, only 56.8% of these applicants have positive potential gains at any of the campuses they apply to. In other words, for 43.2% of minorities who game in the sciences, it was actually optimal to apply to every campus in the non-sciences.

Minorities who gamed in the non-sciences similarly have average realized gains that exceed their average random gains, and the share of these gamers with positive realized gains is 79.7%. However, this is largely driven by the fact that 41.8% of these applicants have positive gains by applying in the non-sciences at every single campus they apply to. Furthermore, the share of applicants who have positive realized gains is only slightly greater than the average random share of applicants with positive realized gains, implying that they would likely benefit by applying in the non-sciences at other campuses outside of their gamed campus.

Non-minority gamers generally display similar patterns to minority gamers, where their average realized gains are equal to or exceed their average random gains and the share of gamers with positive realized gains exceeds the random share with positive realized gains. One exception to the trend was that non-minority gamers who gamed in the sciences were worse at choosing the optimal campus to game at than if they chose randomly.

Panels B and C further separate these groups by parental income, with low-income being defined as those below the 75^{th} percentile for their race and high-income being defined as those above the 75^{th} percentile.[31] If applicants from high-income households were more informed of their admissions probabilities and more likely to apply strategically, then they should be more likely to apply optimally and maximize their admissions probabilities. However, there are no discernible differences between the low-income and high-income applicants, suggesting that high-income applicants are not more likely to apply strategically.

The fact that the average realized gains are greater than or equal to the average random gains and that the share with positive realized gains exceeds the average random share with positive realized gains suggests that applicants could be partially informed of their relative admissions probabilities in the sciences and non-sciences at each campus. Nevertheless, those who gamed in the sciences have average realized losses from gaming, and many minorities who gamed in the non-sciences have incentives to apply universally in the non-sciences. Clearly, while some gamers may have gamed correctly, not every gamer is fully informed of their admissions probabilities, or alternatively, not all of these applicants are applying strategically to maximize their admissions probabilities. One possible direction for future research would be to expand the definition of gamers and explore whether or not those who apply to multiple campuses in the sciences and multiple campuses in the non-sciences apply optimally.

VI Conclusion

This paper explores how science persistence rates and overall graduation rates for all applicants to the UC system would have changed if racial preferences were no longer in place. I find that on the extensive margin, there would have been 5388 fewer minority students admitted to the UC system between 1995-1997, while there would have been 5431 more non-minority admits. Not only are fewer minorities admitted to the UC system, but there is a downwards cascade of minorities into lower ranked UC campuses. Holding the number of enrollees at each campus constant, there is also a corresponding upward surge of

[31] The results are robust to alternate definitions of low-income and high-income, such as the 50^{th} percentile.

non-minorities into more selective campuses, resulting in a smaller share of minority students in the four most selective UC campuses and a larger share of minority students at the other four UC campuses.

The key contribution of this paper to the literature is that it investigates the impact that fully removing racial preferences would have had on all applicants, taking into account its effect on acceptance to the UC system. Ultimately, I find that on average, minorities who were originally admitted to the UC system would have had a higher science persistence rate and overall graduation rate without racial preferences in place. This is because the gains from the improved matching between the admits who remain in the system and the UC campuses where they enroll outweigh the losses from those who are forced outside the UC system. Non-minorities who were originally rejected from the UC campuses benefit from the removal of racial preferences, because they are more likely to graduate when they are induced into the system. On average, non-minorities originally admitted to the UC system experience little change in their graduation probabilities, while minority rejects remain entirely unaffected.

I also explore the incentives of students to strategically game when applying to the UC system, finding strong incentives for minorities to strictly apply in the non-sciences at UC Berkeley. In fact, the majority of minorities who apply as science majors within the UC system do so suboptimally, with no admissions incentive to apply in the sciences. When focusing on those who applied to exactly one campus in the sciences or non-sciences and at least one campus in the opposite major, I find that the gamers fare slightly better than they would have fared by random chance, suggesting that they might be partially informed of their relative admissions probabilities at each campus. However, those who game in the sciences have negative average realized gains, again implying that minorities who attempt to game in the sciences tend to do so suboptimally. Thus, there is little evidence to support the claim from Bleemer (2020) that minority applicants misrepresent their major preferences to boost their admissions probability.

One limitation of this paper is that when estimating the allocation of admits to the UC system under a regime without racial preferences, I model the outside option for minority admits as being the same as the outside option for non-minority admits. Another limitation is that by modeling the outside option as one option within the multinomial logit, I fail to capture the heterogeneity in the outside options of different applicants. Without data on the outside options of each applicant, the graduation rate results are also sensitive to my assumptions regarding the graduation rates outside the UC system. A potential avenue for future research would be to aggregate data on these outside options to better inform the model.

Ultimately, this paper provides an explanation for how Arcidiacono et al. (2016) and Bleemer (2022) can be reconciled. Supporting Arcidiacono et al. (2016), I find that the science persistence rate and overall graduation rate of minority applicants increase, even after accounting for the loss in graduation probability for applicants forced outside the system. While this would initially appear to contradict Bleemer (2022), who finds that the science persistence rate and graduation rate of minorities fall after Prop 209, I show that his difference-in-differences framework could point towards a negative impact of Prop 209 on minority graduation rates, even if the graduation rates of minorities increased. Since the graduation rate of non-minorities increases by 0.2% while the graduation rate of minorities only increases by 0.1%, the difference-in-differences model would show that Prop 209 harmed minorities relative to non-minorities, even though both groups see their graduation rates rise. Overall, the removal of racial preferences not only increases the science persistence rate and general graduation rate of enrollees within the system, but on average, it also increases the science persistence and overall graduation rate for all applicants. Finally, as there does not appear to be evidence of gaming, improving the science persistence rate should remain a focus of policy makers in order to close the gap in STEM degree attainment.

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Appendix

Table A1: Coefficients for UC Admissions Logit Model

	Non-Minorities		Minorities	
Coefficient	Sciences	Non-Sciences	Sciences	Non-Sciences
Intercept (ψ_{1gj})	-5.73	-6.26	-6.81	-7.19
Science AI Slope (ψ_{2gj})	0.14	0.29	0.21	0.26
Non-Science AI Slope (ψ_{3gj})	0.63	0.44	0.99	0.95
Gamma (γ_j)	0.36	0.40	n/a	n/a

Notes: Recall that the $gamma_j$ terms were calculated using the non-minority logit model, so $g = 1$ for the coefficients shown above.

Table A2: Coefficients for UC Allocation Multinomial Logit

Coefficient	Berkeley	UCLA	San Diego	Davis	Irvine	Santa Barbara	Santa Cruz	Riverside	Outside Option
Intercept (π_{1gjk})	-16.28	-9.31	-4.23	-0.90	2.03	5.02	6.49	3.80	0
Science AI Slope (π_{2gjk})	1.29	0.53	-0.09	-0.08	0.09	-1.01	-0.95	-0.18	0
Non-Science AI Slope (π_{3gjk})	-0.78	-0.13	0.45	0.08	-0.57	0.98	0.61	-0.41	0
Delta-Science (δ_{mk})	0.14	0.17	0.01	-0.05	-0.20	-0.19	-0.33	-0.21	0
Delta-Non-Science (δ_{hk})	0.53	0.36	-0.49	-0.49	-0.75	-0.34	-0.39	-0.74	0

Notes: Once again, recall that the $delta_{jk}$ terms were calculated using the non-minority multinomial logit model, so $g = 1$ for the coefficients shown above.

Table A3: Change in the Number of Graduates for Minorities and Non-Minorities Under Counterfactual Admissions and Allocation Rules (Percentage Points)

	Berkeley	UCLA	San Diego	Davis	Irvine	Santa Barbara	Santa Cruz	Riverside	Admits Outside	Rejects Outside	Overall
Panel A: Graduates in the Sciences Conditional on Entering in the Sciences											
Minority Admits											
Baseline	163	243	163	154	116	108	48	72	876	0	1944
No Preferences	59	92	136	173	174	137	80	104	737	306	1997
Minority Rejects											
Baseline	0	0	0	0	0	0	0	0	0	86	86
Overall Minority											
Baseline	163	243	163	154	116	108	48	72	876	86	2030
No Preferences	59	92	136	173	174	137	80	104	737	391	2083
Non-Minority Admits											
Baseline	2035	1694	1876	1638	1146	737	299	495	6931	0	16851
No Preferences	2245	1956	1869	1559	968	633	231	419	6952	0	16832
Non-Minority Rejects											
Baseline	0	0	0	0	0	0	0	0	0	1575	1575
No Preferences	25	31	38	51	59	34	20	32	174	1192	1655
Overall Non-Minority											
Baseline	2035	1694	1876	1638	1146	737	299	495	6931	1575	18426
No Preferences	2270	1987	1907	1610	1027	668	250	451	7126	1192	18487
Overall Regardless of Race											
Baseline	2198	1937	2039	1792	1262	845	347	567	7807	1661	20455
No Preferences	2328	2079	2043	1784	1200	804	330	555	7863	1583	20570
Panel B: Graduates in any Major											
Minority Admits											
Baseline	1568	1836	724	852	693	1125	577	670	6618	0	14662
No Preferences	307	524	559	931	1045	1446	952	657	5205	3089	14716
Minority Rejects											
Baseline	0	0	0	0	0	0	0	0	0	2120	2120
Overall Minority											
Baseline	1568	1836	724	852	693	1125	577	670	6618	2120	16783
No Preferences	307	524	559	931	1045	1446	952	657	5205	5209	16836
Non-Minority Admits											
Baseline	6946	6883	6024	6523	5082	5991	3066	2165	35299	0	77978
No Preferences	8469	8365	5985	6181	4265	5146	2301	1995	35334	0	78041
Non-Minority Rejects											
Baseline	0	0	0	0	0	0	0	0	0	13052	13052
No Preferences	125	175	165	284	334	425	253	193	1397	9984	13334
Overall Non-Minority											
Baseline	6946	6883	6024	6523	5082	5991	3066	2165	35299	13052	91030
No Preferences	8594	8540	6150	6464	4599	5571	2554	2188	36731	9984	91375
Overall Regardless of Race											
Baseline	8514	8719	6748	7375	5775	7116	3643	2835	41916	15172	107812
No Preferences	8901	9063	6709	7396	5644	7018	3506	2845	41936	15194	108211

Table A4: Change in the Number of Enrollees for Minorities and Non-Minorities Under Counterfactual Admissions and Allocation Rules (Percentage Points)

	Berkeley	UCLA	San Diego	Davis	Irvine	Santa Barbara	Santa Cruz	Riverside	Admits Outside	Rejects Outside	Overall
Panel A: Enrollees in the Sciences											
Minority Admits											
Baseline	595	878	497	652	515	514	250	366	3536	0	7803
No Preferences	143	250	369	605	752	641	406	450	2548	1639	7803
Minority Rejects											
Baseline	0	0	0	0	0	0	0	0	0	1482	1482
Overall Minority											
Baseline	595	878	497	652	515	514	250	366	3536	1482	9285
No Preferences	143	250	369	605	752	641	406	450	2548	3121	9285
Non-Minority Admits											
Baseline	3603	3328	3611	3775	3320	2229	1112	1489	15893	0	38360
No Preferences	4002	3881	3644	3660	2862	1956	868	1285	16203	0	38360
Non-Minority Rejects											
Baseline	0	0	0	0	0	0	0	0	0	7673	7673
No Preferences	53	75	96	163	221	146	88	120	698	6014	7673
Overall Non-Minority											
Baseline	3603	3328	3611	3775	3320	2229	1112	1489	15893	7673	46033
No Preferences	4055	3956	3739	3822	3083	2102	956	1405	16901	6014	46033
Overall Regardless of Race											
Baseline	4198	4206	4108	4427	3835	2743	1362	1855	19429	9155	55318
No Preferences	4198	4206	4108	4427	3835	2743	1362	1855	19449	9135	55318
Panel B: Enrollees in any Major											
Minority Admits											
Baseline	2287	2803	1081	1497	1129	1845	970	1156	10591	0	23359
No Preferences	393	720	808	1435	1746	2304	1619	1149	7798	5389	23359
Minority Rejects											
Baseline	0	0	0	0	0	0	0	0	0	5648	5648
Overall Minority											
Baseline		2287	2803	1081	1497	1129	1845	970	1156	10591	5648
29007											
No Preferences	393	720	808	1435	1746	2304	1619	1149	7798	11037	29007
Non-Minority Admits											
Baseline	8073	8256	7525	8638	7445	8277	4511	3415	46195	0	102334
No Preferences	9808	10099	7560	8267	6280	7170	3455	3096	46599	0	102334
Non-Minority Rejects											
Baseline	0	0	0	0	0	0	0	0	0	24168	24168
No Preferences	159	240	238	434	548	648	407	327	2431	18737	24168
Overall Non-Minority											
Baseline	8073	8256	7525	8638	7445	8277	4511	3415	46195	24168	126502
No Preferences	9967	10339	7798	8700	6828	7818	3862	3422	49030	18737	126502
Overall Regardless of Race											
Baseline	10360	11059	8606	10135	8574	10122	5481	4571	56786	29816	155509
No Preferences	10360	11059	8606	10135	8574	10122	5481	4571	56827	29774	155509

Table A5: UC System Acceptance Rates for Minority and Non-Minority Students Under Different Assignment Rules, No Dale-Krueger Controls

Admissions Rule	Acceptance Rate	Number of Admits	Number of Enrollees
Panel A: Baseline			
Minority			
Initial Science Majors	0.84	7,803	4,267
Initial Non-Science Majors	0.79	15,556	8,501
Non-Minority			
Initial Science Majors	0.83	38,360	22,465
Initial Non-Science Majors	0.80	63,974	33,673
Panel B: No Preferences			
Minority			
Initial Science Majors	0.66	6,151	3,838
Initial Non-Science Majors	0.61	12,026	7,155
Non-Minority			
Initial Science Majors	0.87	40,007	22,896
Initial Non-Science Majors	0.84	67,492	35,019
Minorities Accepted in the Baseline			
Initial Science Majors	0.79	6,151	3,838
Initial Non-Science Majors	0.77	12,026	7,155
Non-Minorities Rejected in the Baseline			
Initial Science Majors	0.21	1647	990
Initial Non-Science Majors	0.21	3518	1939

Notes: The total number of admits in the baseline and counterfactual scenario are not equal. This is because γ_j is determined so that the total number of admits with preferences and without preferences is equal. However, recall that after estimating the γ_j parameter, the counterfactual probability of admissions to the UC system that is used is also a function of race and a student's original admissions status. The Bayes' rule estimates for the total number of admits in the counterfactual scenario predicts that 17 more applicants would have been admitted under the regime with no preferences. However, the number of enrollees in the system is held constant through the δ_{jk} parameters. The difference in the number of admits is thus reflected in the number of admits who choose to not enroll at any UC campus.

Table A6: Share of Minority and Non-Minority Applicants Under Different Assignment Rules, No Dale-Krueger Controls (Percent)

Assignment Rule	Berkeley	UCLA	San Diego	Davis	Irvine	Santa Barbara	Santa Cruz	Riverside	Admits Outside	Rejects Outside	Total Outside
Panel A: Minority											
Initial Major Science											
Baseline	6.4	9.5	5.4	7.0	5.5	5.5	2.7	3.9	38.1	16.0	54.0
No Preferences	2.2	3.2	4.3	7.2	8.4	6.8	4.1	5.1	24.9	33.8	58.7
Initial Major Non-Science											
Baseline	8.6	9.8	3.0	4.3	3.1	6.7	3.7	4.0	35.8	21.1	56.9
No Preferences	1.7	2.8	2.4	4.8	5.5	9.2	6.1	3.9	24.7	39.0	63.7
Panel B: Non-Minority											
Initial Major Science											
Baseline	7.8	7.2	7.8	8.2	7.2	4.8	2.4	3.2	34.5	16.7	51.2
No Preferences	8.7	8.5	8.1	8.2	6.6	4.6	2.1	3.0	37.2	13.1	50.3
Initial Major Non-Science											
Baseline	5.6	6.1	4.9	6.0	5.1	7.5	4.2	2.4	37.7	20.5	58.2
No Preferences	7.3	7.8	5.0	5.9	4.6	6.9	3.6	2.4	40.4	16.1	56.5
Panel C: Share of Minorities											
Initial Major Science											
Baseline	14.2	20.9	12.1	14.7	13.4	18.7	18.4	19.7	18.2	16.2	17.6
No Preferences	4.8	7.2	9.6	15.1	20.4	23.2	27.8	25.7	11.9	34.2	19.1
Initial Major Non-Science											
Baseline	27.5	28.1	13.0	14.8	13.0	18.0	17.5	29.1	18.9	20.2	19.3
No Preferences	5.3	8.0	10.6	16.6	22.7	24.6	29.2	28.1	13.0	37.2	21.7

Table A7: Average Preparation Score of Minority and Non-Minority Students Under Different Assignment Rules, No Dale-Krueger Controls

Assignment Rule	Berkeley	UCLA	San Diego	Davis	Irvine	Santa Barbara	Santa Cruz	Riverside	Outside Option
Panel A: Minority									
Initial Major Science									
Baseline	0.07	-0.03	-0.05	-0.41	-0.49	-0.72	-0.95	-0.79	-0.26
No Preferences	0.66	0.43	0.17	-0.16	-0.34	-0.57	-0.74	-0.57 0.01	
Initial Major Non-Science									
Baseline	-0.36	-0.33	-0.25	-0.73	-0.85	-0.94	-1.01	-1.10	-0.56
No Preferences	0.50	0.22	-0.07	-0.42	-0.60	-0.79	-0.93	-0.80	-0.25
Panel B: Non-Minority									
Initial Major Science									
Baseline	0.97	0.80	0.64	0.33	0.12	-0.08	-0.28	-0.11	0.50
No Preferences	0.96	0.79	0.61	0.31	0.10	-0.08	-0.27	-0.11	0.47
Initial Major Non-Science									
Baseline	0.76	0.61	0.48	0.09	-0.14	-0.22	-0.31	-0.44	0.25
No Preferences	0.81	0.59	0.37	0.07 -0.12	-0.28	-0.42	-0.30	0.22	

Table A8: Change in Graduation Rates for Minorities and Non-Minorities Under Counterfactual Admissions and Allocation Rules, No Dale-Krueger Controls (Percentage Points)

	Berkeley	UCLA	San Diego	Davis	Irvine	Santa Barbara	Santa Cruz	Riverside	Admits Outside	Rejects Outside	Overall
Panel A: Persistence Rate in the Sciences											
Minority Admits											
Baseline	28.1	27.7	32.8	24.1	20.6	20.5	19.1	19.1	25.7	n/a	25.2
No Preferences	41.6	37.3	37.1	27.7	21.9	21.0	19.7	20.9	29.4	19.0	25.6
Minority Rejects											
Baseline	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	7.8	7.8
Overall Minority											
Baseline	28.1	27.7	32.8	24.1	20.6	20.5	19.1	19.1	25.7	7.8	22.5
No Preferences	41.6	37.3	37.1	27.7	21.9	21.0	19.7	20.9	29.4	13.7	22.8
Non-Minority Admits											
Baseline	56.3	50.6	51.9	43.2	34.8	32.9	26.9	33.3	44.6	n/a	44.3
No Preferences	56.0	50.3	51.4	42.7	34.3	32.4	26.6	32.7	44.0	n/a	44.3
Non-Minority Rejects											
Baseline	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	22.9	22.9
No Preferences	51.0	44.1	42.0	31.8	26.2	23.7	21.5	24.9	26.1	22.4	24.0
Overall Non-Minority											
Baseline	56.3	50.6	51.9	43.2	34.8	32.9	26.9	33.3	44.6	22.9	40.7
No Preferences	55.9	50.1	51.1	42.2	33.8	31.8	26.2	32.2	43.4	22.4	40.9
Overall Regardless of Race											
Baseline	52.3	45.9	49.6	40.4	32.9	30.6	25.5	30.5	41.1	20.5	37.7
No Preferences	55.2	49.2	49.7	40.0	31.4	29.3	24.4	29.3	41.7	19.4	37.9
Panel B: Overall Graduation Rate											
Minority Admits											
Baseline	69.2	65.7	67.0	59.0	57.8	60.2	58.2	55.5	63.4	n/a	63.0
No Preferences	78.0	72.3	69.2	62.5	58.7	61.6	59.0	56.0	67.2	57.7	62.9
Minority Rejects											
Baseline	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	46.9	46.9
Overall Minority											
Baseline	69.2	65.7	67.0	59.0	57.8	60.2	58.2	55.5	63.4	46.9	59.9
No Preferences	78.0	72.3	69.2	62.5	58.7	61.6	59.0	56.0	67.2	52.1	59.8
Non-Minority Admits											
Baseline	85.7	83.2	80.1	75.2	68.9	72.5	68.3	64.2	77.7	n/a	76.8
No Preferences	86.0	82.7	79.5	74.8	68.8	71.8	67.1	64.9	77.3	n/a	77.0
Non-Minority Rejects											
Baseline	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	58.2	58.2
No Preferences	82.2	76.8	73.5	67.9	63.8	67.4	63.9	61.0	59.9	57.9	59.4
Overall Non-Minority											
Baseline	85.7	83.2	80.1	75.2	68.9	72.5	68.3	64.2	77.7	58.2	73.3
No Preferences	85.9	82.5	79.3	74.5	68.5	71.5	66.8	64.6	76.5	57.9	73.6
Overall Regardless of Race											
Baseline	82.1	78.7	78.4	72.8	67.5	70.2	66.5	62.0	75.0	56.0	70.8
No Preferences	85.5	81.7	78.3	72.5	66.4	69.1	64.5	62.3	75.4	55.8	71.0

Table A9: Alternate Change in Graduation Rates for Minorities and Non-Minorities Under Counterfactual Admissions and Allocation Rules a) (Percentage Points)

	Berkeley	UCLA	San Diego	Davis	Irvine	Santa Barbara	Santa Cruz	Riverside	Admits Outside	Rejects Outside	Overall
Panel A: Persistence Rate in the Sciences											
Minority Admits											
Baseline	27.4	27.7	32.8	23.7	22.5	21.0	19.1	19.8	24.8	n/a	24.9
No Preferences	41.0	36.8	36.9	28.7	23.1	21.3	19.7	23.0	28.9	15.2	24.9
Minority Rejects											
Baseline	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	5.8	5.8
Overall Minority											
Baseline	27.4	27.7	32.8	23.7	22.5	21.0	19.1	19.8	24.8	5.8	21.9
No Preferences	41.0	36.8	36.9	28.7	23.1	21.3	19.7	23.0	28.9	10.7	21.8
Non-Minority Admits											
Baseline	56.5	50.9	52.0	43.4	34.5	33.1	26.9	33.2	43.6	n/a	43.9
No Preferences	56.1	50.4	51.3	42.6	33.8	32.4	26.5	32.6	42.9	n/a	43.9
Non-Minority Rejects											
Baseline	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	20.5	20.5
No Preferences	46.3	41.5	39.8	31.6	26.7	23.4	22.4	26.7	24.9	19.8	21.6
Overall Non-Minority											
Baseline	56.5	50.9	52.0	43.4	34.5	33.1	26.9	33.2	43.6	20.5	40.0
No Preferences	56.0	50.2	51.0	42.1	33.3	31.8	26.2	32.1	42.2	19.8	40.2
Overall Regardless of Race											
Baseline	52.4	46.1	49.6	40.5	32.9	30.8	25.5	30.6	40.2	18.1	37.0
No Preferences	55.5	49.4	49.7	40.3	31.3	29.3	24.2	29.9	40.4	16.7	37.1
Panel B: Overall Graduation Rate											
Minority Admits											
Baseline	68.6	65.5	67.0	56.9	61.3	61.0	59.5	57.9	62.5	n/a	62.8
No Preferences	78.2	72.8	69.2	64.9	59.9	62.8	58.8	57.2	66.8	53.1	62.0
Minority Rejects											
Baseline	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	37.5	37.5
Overall Minority											
Baseline	68.6	65.5	67.0	56.9	61.3	61.0	59.5	57.9	62.5	37.5	57.9
No Preferences	78.2	72.8	69.2	64.9	59.9	62.8	58.8	57.2	66.8	45.1	57.3
Non-Minority Admits											
Baseline	86.0	83.4	80.0	75.5	68.3	72.4	68.0	63.4	76.4	n/a	76.2
No Preferences	86.4	82.8	79.2	74.8	67.9	71.8	66.6	64.4	75.8	n/a	76.3
Non-Minority Rejects											
Baseline	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	54.0	54.0
No Preferences	78.2	72.8	69.4	65.3	60.9	65.6	62.1	59.1	57.5	53.3	55.2
Overall Non-Minority											
Baseline	86.0	83.4	80.0	75.5	68.3	72.4	68.0	63.4	76.4	54.0	72.0
No Preferences	86.2	82.6	78.9	74.3	67.4	71.3	66.1	63.9	74.9	53.3	72.2
Overall Regardless of Race											
Baseline	82.2	78.8	78.4	72.8	67.4	70.3	66.5	62.0	73.8	50.9	69.3
No Preferences	85.9	82.0	78.0	73.0	65.8	69.3	64.0	62.2	73.8	50.3	69.4

Table A10: Alternate Change in Graduation Rates for Minorities and Non-Minorities Under Counterfactual Admissions and Allocation Rules b) (Percentage Points)

	Berkeley	UCLA	San Diego	Davis	Irvine	Santa Barbara	Santa Cruz	Riverside	Admits Outside	Rejects Outside	Overall
Panel A: Persistence Rate in the Sciences											
Minority Admits											
Baseline	27.4	27.7	32.8	23.7	22.5	21.0	19.1	19.8	23.8	n/a	24.5
No Preferences	41.0	36.8	36.9	28.7	23.1	21.3	19.7	23.0	27.7	18.1	25.1
Minority Rejects											
Baseline	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	5.8	5.8
Overall Minority											
Baseline	27.4	27.7	32.8	23.7	22.5	21.0	19.1	19.8	23.8	5.8	21.5
No Preferences	41.0	36.8	36.9	28.7	23.1	21.3	19.7	23.0	27.7	12.2	22.0
Non-Minority Admits											
Baseline	56.5	50.9	52.0	43.4	34.5	33.1	26.9	33.2	44.0	n/a	44.1
No Preferences	56.1	50.4	51.3	42.6	33.8	32.4	26.5	32.6	43.3	n/a	44.0
Non-Minority Rejects											
Baseline	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	20.5	20.5
No Preferences	46.3	41.5	39.8	31.6	26.7	23.4	22.4	26.7	24.9	19.8	21.6
Overall Non-Minority											
Baseline	56.5	50.9	52.0	43.4	34.5	33.1	26.9	33.2	44.0	20.5	40.2
No Preferences	56.0	50.2	51.0	42.1	33.3	31.8	26.2	32.1	42.5	19.8	40.3
Overall Regardless of Race											
Baseline	52.4	46.1	49.6	40.5	32.9	30.8	25.5	30.6	40.3	18.1	37.0
No Preferences	55.5	49.4	49.7	40.3	31.3	29.3	24.2	29.9	40.6	17.2	37.2
Panel B: Overall Graduation Rate											
Minority Admits											
Baseline	68.6	65.5	67.0	56.9	61.3	61.0	59.5	57.9	62.8	n/a	62.9
No Preferences	78.2	72.8	69.2	64.9	59.9	62.8	58.8	57.2	66.9	58.0	63.2
Minority Rejects											
Baseline	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	37.5	37.5
Overall Minority											
Baseline	68.6	65.5	67.0	56.9	61.3	61.0	59.5	57.9	62.8	37.5	58.0
No Preferences	78.2	72.8	69.2	64.9	59.9	62.8	58.8	57.2	66.9	47.6	58.2
Non-Minority Admits											
Baseline	86.0	83.4	80.0	75.5	68.3	72.4	68.0	63.4	77.2	n/a	76.5
No Preferences	86.4	82.8	79.2	74.8	67.9	71.8	66.6	64.4	76.6	n/a	76.6
Non-Minority Rejects											
Baseline	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	54.0	54.0
No Preferences	78.2	72.8	69.4	65.3	60.9	65.6	62.1	59.1	57.5	53.3	55.2
Overall Non-Minority											
Baseline	86.0	83.4	80.0	75.5	68.3	72.4	68.0	63.4	77.2	54.0	72.2
No Preferences	86.2	82.6	78.9	74.3	67.4	71.3	66.1	63.9	75.6	53.3	72.5
Overall Regardless of Race											
Baseline	82.2	78.8	78.4	72.8	67.4	70.3	66.5	62.0	74.5	50.9	69.6
No Preferences	85.9	82.0	78.0	73.0	65.8	69.3	64.0	62.2	74.4	51.2	69.8