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AFFIRMATIVE ACTION, MISMATCH, AND ECONOMIC MOBILITY AFTER CALIFORNIA'S PROPOSITION 209

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ABSTRACT

Proposition 209 banned race-based affirmative action at California public universities in 1998. This study analyzes Prop 209's impact on student outcomes using a difference-in-difference research design and a newly-constructed longitudinal database linking all 1994-2002 University of California applicants to their college enrollment, course performance, major choice, degree attainment, and wages into their mid-30s. Ending affirmative action caused UC's 10,000 annual underrepresented minority (URM) freshman applicants to cascade into lower-quality public and private universities. URM applicants' undergraduate and graduate degree attainment declined overall and in STEM fields, especially among lower-testing applicants. As a result, the average URM UC applicant's wages declined by five percent annually between ages 24 and 34, almost wholly driven by declines among Hispanic applicants. By the mid-2010s, Prop 209 had caused a cumulative decline in the number of early-career URM Californians earning over $100,000 by at least three percent. Prop 209 also deterred thousands of qualified URM students from applying to any UC campus. Enrolling at less-selective UC campuses did not improve URM students' performance or persistence in STEM course sequences. Complementary regression discontinuity and institutional value-added analyses suggest that affirmative action's net wage benefits for URM applicants exceed its (potentially small) net costs for on-the-margin white and Asian applicants. These findings are inconsistent with the university "Mismatch Hypothesis" and provide the first causal evidence that banning affirmative action exacerbates socioeconomic inequities.

Keywords: Affirmative Action, Economic Mobility, University Admissions

> *Those who deny that preferences are not [sic] being given or that the granting of such preferences is without negative consequences do a great disservice to the need for finding reasonable solutions. Equally so, those who believe that social and economic equality of opportunity can be achieved merely by the passage of ballot initiatives, however justified the need might be, are misguided. The "heavy-lifting" to achieve a society of genuine inclusion and equality of opportunity merely begins with the removal of race-based decision-making.*
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> UC Regent Ward Connerly, in introducing SP-1 and SP-2[1]

Educational attainment, income, wealth, and economic mobility exhibit large persistent racial disparities in the United States. Access to selective universities is a key determinant of economic success and intergenerational mobility (Zimmerman, 2019; Chetty et al., 2020a). As a result, many selective universities – including public universities in at least 25 states – provide explicit

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[1] Letter to the Regents of the University of California, July 5, 1995: Berkeley Bancroft Library CU-558, Cnt. 8.

admissions advantages to applicants from disadvantaged racial and ethnic groups. Proponents of these university affirmative action policies argue that they offset applicant qualification gaps that result from systemically unequal prior educational opportunities (Johnson, 2019). Detractors argue that affirmative action limits opportunity for Asian and white applicants and may have unintended negative consequences for targeted students. This study examines three empirical questions at the basis of this disagreement. First, which students are targeted by affirmative action, and to what degree does affirmative action impact where those students go to college? Second, what are the short- and long-run effects of enrolling at a more-selective university because of affirmative action? Finally, how are the net benefits and costs of affirmative action distributed across Asian, Black, Hispanic, and white university applicants?

Prior scholarship has arrived at conflicting conclusions about the value of enrolling at a more-selective university as a result of policies like affirmative action. On the one hand, a series of recent studies have shown that on-the-margin applicants – that is, applicants who would have been admitted to a selective university if they had *slightly* higher standardized test scores – would have received substantial long-run benefits if they had been granted admission.[2] However, while studies specifically analyzing affirmative action have been hampered by data limitations, they have uncovered mixed evidence around affirmative action's impact on student outcomes (Arcidiacono and Lovenheim, 2016), with some concluding that targeted applicants would benefit from enrolling at less-selective universities where they may better "fit" with their peers.

This study combines a longitudinal administrative applicant database with a transparent difference-indifference research design to estimate the impact of affirmative action on students' enrollment, college quality, course performance, choice of major, degree attainment, and employment outcomes over the subsequent 15 years. I construct a novel highly-detailed database of all 1994-2002 freshman applicants to the University of California (UC) system, which comprises all public research universities in the state, and individually link each applicant to nationwide enrollment and degree records as well as a state administrative wage database. I then implement a difference-in-difference research design to compare the enrollment and outcomes of Black and Hispanic UC applicants with those of white and Asian applicants before and after California's Proposition 209, which ended UC's 30-year-old affirmative action policies in 1998.

Statistical biases arising from differential selection into UC application and overall trends in university selectivity are absorbed by high school fixed effects and the detailed academic metrics that comprised UC's contemporaneous "Academic Index" (*AI*), a weighted sum of high school grades and five standardized test scores.[3] I also link the applicant data to novel measures of institutional value-added to measure Prop 209's effect on URM applicants' university quality; to California K-12 educational records to examine Prop 209's effect on UC application-sending; and to five UC campuses' comprehensive university transcripts to estimate Prop 209's impact on those students' performance and persistence in introductory STEM courses. Finally, I employ a regression discontinuity design to identify the value of being admitted to a highly-selective public university for the on-the-margin white and Asian students likely to obtain greater selective public university access after Prop 209.

I begin by documenting the impact of Prop 209 on applicants' likelihood of admission to each of UC's eight undergraduate campuses. Prop 209 curbed the large admissions advantages provided to all underrepresented minority (URM) UC applicants by affirmative action, with many URM applicants becoming 50 percentage points less likely to earn admission to UC's most selective campuses relative to academically-comparable non-URM applicants.[4] As a result, UC's URM applicants cascaded into less-selective colleges and universities. After Prop 209, high-*AI* URM applicants tended to flow from UC's more-selective campuses to less-selective campuses and – especially among Black applicants – elite private universities, while lower-*AI* URM applicants mostly flowed to less-selective California colleges and universities. This resulted in a substantial net outflow of lower-income students from highly-selective public universities.

The study's baseline difference-in-difference design spans the full population of UC applicants, whether or not they enroll at UC. URM applicant outcomes after Prop 209 are reported relative to non-URM outcomes in order to account for ethnicity-neutral enrollment and market trends throughout the period. Non-URM applicants may not represent a traditional "control" group, since some likely "crowded into" more-selective universities after Prop 209. I return to the question of non-URM applicant outcomes below, but the fact that they outnumber URM applicants by more than four-to-one in the applicant pool, diluting any "crowd-in" effects, implies that at least 80 percent of the observed differences will be driven by changes in URM applicant outcomes. I summarize the effect of ending affirmative action by comparing outcomes between applicants in the two cohorts before (1996-97) and two cohorts after (1998-99) the policy change, absorbing any remaining bias with high school fixed effects and *AI* academic

[2] See Hoekstra (2009); Zimmerman (2014); Anelli (2019); Kozakowski (2019); Sekhri (2020); Smith, Goodman, and Hurwitz (2020). Few studies examine selective universities' value to applicants with poorer measured academic qualifications, but Cohodes and Goodman (2014) and Bleemer (2018a) provide evidence of substantial returns to selectivity in other contexts.

[3] *AI* and ethnicity explained 40-70 percent of admissions variation at most mid-1990s UC campuses; see Figure A-1. Cortes (2010) uses a similar design to compare enrollment and attainment between Texas's affirmative action and Top Ten policy regimes.

[4] URM includes African-American (Black), Chicano and Latino (Hispanic), and Native American students.

controls. I also estimate effect heterogeneity by URM *AI* quartile and for Hispanic and Black applicants (20 percent of URM UC applicants).

Implementing this model, I show that Prop 209 led URM UC applicants to enroll at relatively lower-quality colleges and universities, measuring quality both by traditional statistics like average test scores and graduation rates and by novel institutional value-added statistics.[5] Bachelor's degree attainment declined by 4.3 percentage points among URM UC applicants in the bottom *AI* quartile, and URM applicants' STEM degree attainment declined by 1.0 percentage points. Prop 209 also caused a 1.3 percentage point decline in each URM applicant's likelihood of earning a graduate degree, with much of that decline in STEM fields. Following these applicants into the labor market, I find that Prop 209 led URM UC applicants to earn five percent lower average annual wages between ages 24 and 34 than they would have earned had affirmative action continued, with larger proportional effects for lower-*AI* applicants. Each applicant became 1.4 percentage points less likely to annually earn $100,000 (the 95th wage percentile) in their early 30s.[6] The observed wage effects are almost wholly driven by Hispanic applicants; despite similar enrollment and degree attainment outcomes, I find little evidence of labor market deterioration among Black UC applicants after Prop 209.[7]

These estimated effects are averaged across every URM UC applicant, many of whom likely would have enrolled at the same institution whether or not affirmative action was operative. This implies that treatment effects for directly-impacted applicants were likely much higher. Nevertheless, given the magnitude of UC's applicant pool, these estimates imply that by 2014, Prop 209 had caused an aggregate decline in the number of high-earning URM Californians in their early 30s by at least three percent. American Community Survey data confirm a 2010s pattern of relative wage deterioration among high-earning early-career URM Californians.

The primary potential threat to this baseline research design is the possibility of sample selection bias arising from differential selection into UC application after Prop 209. I examine the magnitude of this potential bias by estimating a difference-in-difference model of the proportion of California public high school students who applied to UC by ethnicity and *AI* bin. I find that UC annually received about 250 fewer Black and 900 fewer Hispanic applications after Prop 209, almost 80 percent of whom would likely have been admitted to at least one UC campus.[8] While this application deterrence could generate bias, I find that the baseline estimates are highly insensitive to both a school-ethnicity-*AI* control function (following Card and Rothstein (2007)) as well as other highly-detailed socioeconomic and academic covariates, suggesting the absence of remaining bias.[9]

A second potential threat arises from the observation that some UC campuses began phasing out their affirmative action policies in 1996, immediately after the affirmative action ban was passed but before its 1998 mandatory implementation. While I find that using 1994-95 as an alternative baseline generally yields slightly larger estimates of Prop 209's effect, URM students' outcomes largely decline in exactly 1998.[10]

Next, I turn to mechanisms explaining URM UC applicants' deteriorated educational outcomes after Prop 209. Many prior studies have suggested that URM students' performance and persistence in demanding courses would improve without affirmative action, which likely would have led to the opposite of Prop 209's effect on STEM degree completion.[11] While I find that before Prop 209 URM UC students earned lower grades and were less likely to persist along introductory STEM course sequences than their non-URM peers, these gaps are largely explained by students' prior academic opportunities and preparedness, not their enrollment institution.[12] The contribution of affirmative action is observably small: While Prop 209 led URM UC students to enroll at campuses

[5] I estimate institutional value-added statistics by regressing degree attainment and wage indicators on applicants' institution of first enrollment and absorbing selection bias with either UC application/admission portfolios (following Mountjoy and Hickman (2020)) or quintics in SAT score and parental income (following Chetty et al. (2020a)). See Online Appendix G.1.

[6] These changes cannot be explained by California labor market entry or exit: 69 percent of UC applicants had positive annual CA wages between ages 24-34, and URM applicants' employment remained unchanged after Prop 209 overall and in each *AI* quartile.

[7] This finding is in line with Chetty et al. (2020b)'s argument that educational differences cannot explain the U.S.'s Black-white wage gap, though that study does not explicitly consider the role of university selectivity.

[8] Card and Krueger (2005) reach a different conclusion when they proxy university applications with SAT "score sends" from the College Board. My analysis uses actual university applications. See Online Appendix G.3.

[9] In particular, I perform a Monte Carlo exercise randomly selecting sets of detailed covariates such as family income, parental occupation and education, and additional measures of academic preparation for model inclusion. I find that specifications including the baseline *AI* covariates are highly and symmetrically insensitive to additional covariates.

[10] Appendix E also examines non-reported applicant ethnicity and imperfect National Student Clearinghouse degree reporting in the data, demonstrating that neither meaningfully contributes to the baseline findings.

[11] See Loury and Garman (1993); Holzer and Neumark (2000); Arcidiacono, Aucejo, and Hotz (2016).

[12] STEM persistence and major choice have been the subject of substantial previous affirmative action research (Griffith, 2010; Sander and Taylor, 2012; Hill, 2017; Estevan, Gall, and Morin, 2019), but available studies have faced the same challenges as the broader affirmative action literature discussed below. This study's detailed examination of students' STEM course performance also contributes to a literature interested in the production and socioeconomic composition of STEM university graduates (Ehrenberg, 2010; Sjoquist and Winters, 2015; Denning and Turley, 2017; Castleman, Long, and Mabel, 2018); this is the first known study to estimate how students' outcomes in specific STEM courses changes under different policy regimes within and across universities.

where their test scores compared more favorably with those of their peers, they were no more likely to persist in STEM curricula, and their STEM course grades were precisely unchanged.

The baseline difference-in-difference design cannot directly identify the impact of Prop 209 on non-URM applicants' outcomes. Instead, I exploit a large discontinuity in UC Berkeley non-URM admissions *before* Prop 209 to study the return to selective public university access for on-the-margin non-URM applicants, many of whom may have been admitted to Berkeley if not for affirmative action. Employing a regression discontinuity design, I find that students just below Berkeley's admissions threshold nevertheless enrolled at similar-quality universities and ended up with similar educational and labor market outcomes, though the confidence intervals cannot rule out positive treatment effects. This suggests that the value of selective public university access for on-the-margin non-URM students was small.[13]

The paper concludes with a discussion of the efficiency of university affirmative action policies. While affirmative action is unlikely to be Pareto efficient, two pieces of evidence favor its Kaldor-Hicks efficiency, which in this case requires (to a first-order approximation) that the benefit of more-selective university enrollment is greater for the URM enrollees targeted by affirmative action than for the non-URM students who would have enrolled in their place. First, the return to UC Berkeley admission for on-the-margin non-URM students appears small, while the return to more-selective enrollment among URM UC applicants is measurably large.[14] Second, that latter return substantially exceeds the average observed change in institutional value-added faced by URM UC applicants, suggesting that selective universities' positive treatment effects are considerably above-average for the URM applicants impacted by Prop 209 (as in Dale and Krueger (2014)).[15]

This study makes three primary contributions. First, while many previous studies have analyzed the intermediate effects of university affirmative action – sometimes coming to conflicting conclusions – they share common limitations. Several studies have exploited cross-state policy variation to estimate the educational impact of banning affirmative action, but students' ability to enroll at out-of-state universities confounds identification of the policies' effects on impacted students.[16] Others estimate models of applicant and university behavior to predict how affirmative action *could* impact student enrollment and outcomes, but do not validate these predictions using actual policy variation.[17]

A third set of studies have analyzed administrative university data from before and after Prop 209, but the available data's limitations – e.g., outcomes are restricted to UC enrollees, and academic qualifications like high school grades are largely unobserved – preclude research designs that identify the effect of affirmative action on students' educational outcomes separately from compositional differences among UC's applicants and students.[18] This study augments previous research by implementing a quasi-experimental research design spanning all U.S. universities that identifies the student-level effects of affirmative action, and by analyzing new intermediate outcomes like private and community college enrollment, university "value-added," STEM persistence, and graduate degree completion.

Second, this is the first study to causally link changes in university quality to wage outcomes in the context of affirmative action, bridging the affirmative action literature with a vibrant literature identifying heterogeneity in the return to higher education.[19] I estimate aggregate returns to university quality across the full distribution of URM applicants impacted by affirmative action, contrasting with most prior studies' focus on a single local margin (e.g. Hoekstra (2009); Zimmerman (2014)). I also present local regression discontinuity evidence highlighting the importance of the counterfactual options available to near-threshold applicants; in UC Berkeley's case, it appears that barely-admitted non-URM students would have otherwise enrolled at similar-quality institutions and thus faced similar long-run outcomes.

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[13] Appendix D uses a difference-in-difference research design to estimate the impact of Prop 209 on Asian applicants. Compared to academically-comparable white applicants, Asian applicants enrolled at similar universities and had indistinguishable long-run labor market outcomes after Prop 209, suggesting proportional effects of affirmative action for both groups.

[14] Black, Denning, and Rothstein (2020) also provide evidence against substantial returns to more-selective university enrollment for the students who were "crowded out" of selective Texas universities by Texas Top Ten.

[15] Each of the sets of estimated value-added statistics likely retain some degree of selection bias despite the presence of detailed covariates. Positively-selected students tend to enroll at more-selective universities, so this bias will tend to exaggerate differences across institutions. Since the large majority of URM UC applicants enroll at equally or less-selective universities after Prop 209, this implies that the true difference in average treatment effects is likely small than estimated, implying that the gap between that difference and the observed change in URM applicants' wages is even larger.

[16] See Backes (2012); Hinrichs (2012, 2014); Blume and Long (2014); Long and Bateman (2020).

[17] See Alon and Tienda (2005); Howell (2010); Arcidiacono, Aucejo, and Hotz (2016). Kapor (2020) identifies a model of affirmative action's effect on enrollment and GPA using variation from the implementation of Texas's race-blind Top Ten policy.

[18] See Antonovics and Backes (2013, 2014); Arcidiacono et al. (2014); Arcidiacono, Aucejo, and Hotz (2016). A separate literature uses administrative data to show that Indian universities' caste-based affirmative action improves targeted students' grades (Bagde, Epple, and Taylor, 2016) and wage outcomes (Bertrand, Hanna, and Mullainathan, 2010).

[19] For canonical examples, see Dale and Krueger (2002) and Arcidiacono (2004). Bowen and Bok (1998) and Arcidiacono (2005) use selection-on-observables and a structural model, respectively, to identify the effect of affirmative action on URM students' wages.

A central question in this literature is the status of the "Mismatch Hypothesis," which holds that more-selective university enrollment may harm lower-testing students, especially those admitted by affirmative action (Sowell, 1972). Most of the published evidence of "mismatch" comprises prior analyses of Prop 209. A series of online appendices to this paper discuss the limitations of that previous research and reconcile their analysis with this study's baseline findings, which are inconsistent with widespread "mismatch."[20]

Finally, this paper provides the first direct evidence that university affirmative action has first-order implications for intergenerational mobility and socioeconomic gaps by ethnicity. A growing literature examines the mechanisms explaining opportunity gaps for lower-income and Black and Hispanic youth and the efficacy of available policies to narrow observed gaps (Jackson, Johnson, and Persico, 2016; Chetty, Hendren, and Katz, 2016). I find little evidence that university affirmative action narrowed the Black-white economic mobility gap, which has received particular attention (Dobbie and Fryer Jr, 2011; Billings, Deming, and Rockoff, 2014; Chetty et al., 2020b), but find that it improved Black educational attainment and provided large long-run wage benefits to (mostly lower-income) Hispanic youths.

The remainder of the paper proceeds as follows. Section 1 provides background on the University of California's 1990s admissions policies, the study's newly-constructed longitudinal database, and UC applicants' enrollment dynamics in the years before and after Prop 209's implementation in 1998. Section 2 describes the study's baseline difference-in-difference empirical methodology. Section 3 presents estimates of how banning university affirmative action impacted applicants' enrollment quality, major choice, degree attainment, and labor market outcomes through applicants' mid-30s. Section 4 estimates the degree of URM UC application deterrence caused by Prop 209 and assesses the baseline results' robustness to alternative model specifications to test for sample selection bias. Section 5 estimates the effect of affirmative action on URM students' STEM course performance and persistence. Section 6 estimates the return to UC Berkeley admission for on-the-margin non-URM applicants while Berkeley conducted affirmative action. Section 7 discusses the efficiency of affirmative action policies, and Section 8 concludes.

1. BACKGROUND AND DATA

1.1 University of California Admissions in the 1990s

The University of California is California's public research university system and is tasked by the 1960 Master Plan for Higher Education to educate students from the top 12.5 percent of California public high school graduates. The system enrolled 137,000 undergraduates at eight campuses in 1999, with the campuses ranging in selectivity from the highly-selective Berkeley and Los Angeles (UCLA) campuses (which admitted about 35 percent of applicants with an average SAT score 1.5 *sd* above mean) to the less-selective Santa Cruz and Riverside campuses (with an 85 percent admission rate and SAT scores 0.5 *sd* above mean). Ranking campuses by their admissions rates in the period, I refer to the Berkeley, UCLA, and San Diego campuses as "more selective," the Santa Barbara, Irvine, and Davis campuses as "selective," and the Santa Cruz and Riverside campuses as "less selective." In 1999, California also had a 22-campus system of teaching-oriented universities – the California State University (CSU) system – and 114 two-year community colleges.

Race-based affirmative action began at UC in 1964, the first year that the number of eligible applicants to UC's highest-demand Berkeley campus exceeded the number of available seats.[21] UC's affirmative action policies provided admissions advantages to URM applicants that augmented campuses' standard admissions protocol, which required that 50 percent of students be admitted solely based on their "Academic Index" (*AI*), a linear combination of high school GPA and SAT scores.[22]

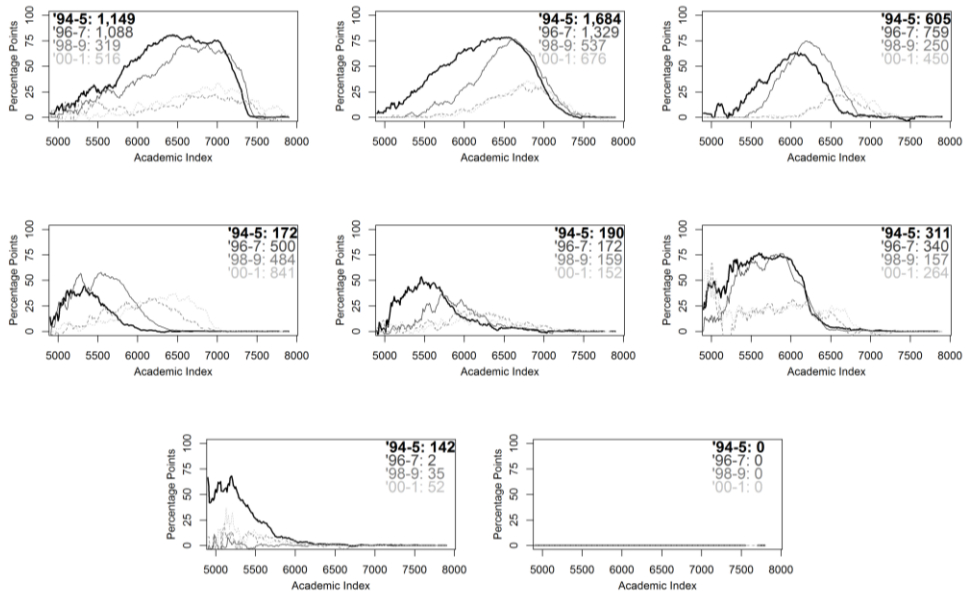
For example, archival documents from UC Berkeley (Figure A-2) show that the university guaranteed admission to all students above a given *AI* threshold (e.g. 7,150), but set a lower *AI* threshold (6,500) for African-American, American Indian, Chicano, and Latino "underrepresented minority" applicants. Students with *AI*s just below their respective threshold had their applications "read" by admissions personnel, giving them a variable likelihood of admission, while those with *AI*s below a second threshold (7,000 for Californian non-URM applicants, 6,000 or lower for URM applicants) were mostly mechanically rejected.

[20] See Online Appendix G.2 on Arcidiacono et al. (2014), Online Appendix G.4 on Arcidiacono, Aucejo, and Hotz (2016), and Online Appendix G.5 on Sander and Taylor (2012). Analysis of the Mismatch Hypothesis outside the UC undergraduate context includes Rothstein and Yoon (2008) and Dillon and Smith (2020).

[21] "The Educational Opportunity Program was established on campus in 1964 and identified ethnicity, socio-economic status, and educational background as the three criteria it would use in targeting students. This was the first time that race emerged as a positive factor in university admissions." Unsigned memo, 1988; Berkeley Bancroft Library CU-558, Cnt. 5.

[22] In particular, $AI = min(HSGPA,4)\times1{,}000 + SATI + SATIIs$. The index included both SAT I components (math and verbal) and three SAT II scores: writing, math, and a third of the student's choosing. All SAT components were scored out of 800, so the maximum *AI* was 8,000. Some campuses employed slight variants of this formula.

Figure 1: 'Normal' URM UC Applicants' Greater Likelihood of Admission by Campus, Year, and AI



Note: The difference between the percent of URM applicants and the percent of non-URM applicants admitted to each campus by academic index (AI), in each of four two-year periods (1994-2001), with darker lines corresponding to earlier periods. The two later periods are after the implementation of Prop 209 ended UC's affirmative action policies. The displayed statistics show the total annual number of additional URM students admitted to each campus in each period based on their higher likelihood of admission, calculated as the sum of the products between the increased admissions likelihood and the number of URM applicants by year and AI. The sample is restricted to freshman fall California-resident applicants who were "normal," in that they (a) were UC-eligible, which means that they satisfactorily completing the required high school coursework, and (b) selected intended majors that did not have special admissions restrictions (e.g. engineering at some campuses). UC Riverside admitted all such applicants. "URM" includes Black, Chicano, Latino, and Native American applicants. Source: UC Corporate Student System.

Figure 1 summarizes the relative admissions likelihood URM and non-URM applicants by *AI* at each campus in two-year increments from 1994 to 2001, restricting the sample to applicants in the "normal" admissions pool.[23] At the most-selective Berkeley campus, for example, 1994-1995 URM applicants with *AI*s between 6,000 to 7,100 were 80 percentage points more likely to be admitted than same-*AI* non-URM applicants. The admissions advantage declines to zero above *AI* = 7,400 because all such applicants were admitted. Seven of the eight UC campuses provided similar admissions advantages to URM applicants under affirmative action, with the advantage shifting to higher-*AI* applicants over time as the campuses became more selective overall.

UC Riverside admitted all "normal" UC applicants. The figure's superscripts show the empirical integrals under each curve by the contemporaneous *AI* distribution of each campus's URM applicants, estimating the excess number of annual URM applicants admitted relative to simulated URM admissions by *AI* under the non-URM admissions rule. It shows that Berkeley and UCLA each annually admitted more than 500 annual additional URM applicants using affirmative action.

The increasing controversy around affirmative action came to a head in the mid-1990s, when it was prohibited first by the UC Regents in July 1995 and then by a voter referendum to the same effect in November 1996, both with 1998 implementation dates (Douglass, 2018). While the original Regents policy (SP-1) was rescinded in 2001, Prop 209 has prohibited UC and other public institutions in California from "discriminat[ing] against, or grant[ing] preferential treatment to, any individual or group on the basis of race, sex, color, ethnicity, or national origin" since the Fall 1998 admission cohort.[24] Figure 1 shows that most campuses

[23] "Normal" applicants exclude those without the minimum high school credentials qualifying them for UC enrollment and those who applied to specially-restricted programs like some campuses' Colleges of Engineering.

[24] Prop 209 also prohibited racial preferences in university outreach and financial aid as well as affirmative action policies at the teaching-oriented California State Universities, though their lesser selectivity entailed those policies' smaller impact. Racial preferences in state hiring (Marion, 2009) and graduate school admissions (Yagan, 2016) were also banned by Prop 209, though high school graduates soon before and after 1998 were similarly-impacted; both entered the labor market after 1998.

continued providing large admissions advantages to URM applicants in 1996 and 1997 (though UCLA, Irvine, and Santa Cruz curtailed their programs), but those advantages shrank considerably in 1998.[25]

Starting in 1998, UC implemented costly school-specific outreach programs to increase enrollment from majority-URM high schools and communities, but those programs wound down after 2001 with little evidence of success in even increasing URM application rates (Atkinson and Pelfrey, 2004; UCOP, 2003). Instead, UC's primary policy response to the end of affirmative action was its Eligibility in the Local Context top percent policy, which did not begin until 2001 (Bleemer, 2019a).

1.2 Data

This study relies on four primary data sources. The first, collected contemporaneously for administrative use by the UC Office of the President, covers all 1994-2002 California-resident freshman applicants to any University of California campus.[26,27] Each record contains an applicant's high school attended, gender, ethnicity, parental education, parental occupations, and family income.[28] Academic preparedness measures include SAT and ACT standardized test scores by component, SAT II scores, high school grade point averages, and the number of 12th-grade honors courses.[29] Application, admission, and enrollment indicators are available for each UC campus, as are degree attainment and major choice for UC enrollees.

The second dataset, an extract from the National Student Clearinghouse's (NSC) StudentTracker database, contains enrollment and graduation records – covering nearly all U.S. two- and four-year colleges and universities – for all students in the UC application dataset, linked by full name and birthdate.[30] Science, Technology, Engineering, and Mathematics majors are categorized by CIP code following the US Department of Homeland Security (2016).[31] NSC data are available starting for the 1995 applicant cohort.[32]

Third, I observe UC applicants' quarterly 2000-17 wages from the California Employment Development Department, linked by SSN.[33] Wage records are unavailable for workers not covered by California unemployment insurance, including out-of-state, federal, and self-employed workers. Annual wages are measured as the sum of quarterly wages in that year, CPI-adjusted to 2018, and winsorized at the top and bottom one percent. About 69 percent of applicants in the sample have positive covered wages in each of years six to 16 after UC application.

The fourth dataset includes comprehensive student transcript records – including course enrollments and grades – for five UC campuses: Berkeley, Davis, Santa Barbara, Santa Cruz, and Riverside. These records were obtained directly from each campus's Registrar's Office by the UC ClioMetric History Project (Bleemer, 2018b) and are linked by name and birthdate. Data remain unavailable for the other three UC campuses.

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[25] Figure A-3 shows that some UC campuses saw relatively-large declines in URM admission and enrollment likelihood between 1995 and 1996 relative to academically-comparable non-URM applicants (particularly at UCLA and the less-selective UCs), but every UC campus saw sharp immediate declines in URM admission between 1997 and 1998, and the more selective UC campuses also saw sharp year-over-year declines in URM enrollment. Another approach to estimating the magnitude of each campus's racial preferences is to consider the annual difference between the R^2 of two linear regressions: admission on applicants' leave-one-out admissions likelihood by *AI* and ethnicity, and admission on their leave-one-out admissions likelihood by just *AI*. Figure A-4 shows, for example, that the difference was about 0.25 at UCLA in 1994-95, 0.15 in 1996-97, and less than 0.05 after 1998. Most campuses saw smaller declines in 1996 and large declines in 1998.

[26] About one-third of UC students transfer from community colleges rather than applying as freshmen. Because affirmative action was likely less-practices for those students and because little is known about those students' academic background (and selection into transfer was likely impacted by Prop 209), transfer applicants are omitted from the present study, though freshman applicants may enroll at a community college and transfer to UC later.

[27] These data are the basis of a highly-censored publicly-available UC admissions data set that has been used in some previous studies; see Online Appendix G.2.

[28] Parental education is observed as an index of maximum parental education for up to two parents, from 1 (no high school) to 7 (graduate degree). Parental occupations are observed as one of 17 occupation codes each for two parents (or 289 total codes), including codes like "Clerical," "Laborer," and "Professional" as well as "Homemaker," "Retired," "Other," or "Deceased." Family income is not reported by about 15 percent of applicants.

[29] Throughout the study period, each UC applicant was required to submit an SAT score and SAT II scores in writing, mathematics (1 or 2), and a third of their choosing. Only 0.9 percent of in-sample applicants submitted ACT instead of SAT scores.

[30] The NSC data include semesterly enrollment (by institution) and graduation (by institution, degrees, and majors) records for all Title-IV postsecondary institutions that had commenced reporting to NSC, excluding students who opted against data disclosure.

[31] STEM includes the 278 "fields involving research, innovation, or development of new technologies using engineering, mathematics, computer science, or natural sciences (including physical, biological, and agricultural sciences)" identified by CIP code. Not all NSC majors have CIP codes; I assign each major to its modal CIP code (in the full observed NSC database) for categorization.

[32] Some 1990s NSC records are incomplete, for which reason I augment them with administrative UC records in the undergraduate degree analysis below. Since UC enrollment declined after Prop 209, this could bias estimates of the impact of Prop 209 on degree attainment toward 0. See Appendix E.

[33] Social security numbers on UC applications are not verified unless the student enrolls at a UC campus. Among enrollees, the verified social security number differs from that reported on their application in fewer than 0.25 percent of cases. All employment results are replicated from institutional research conducted at the UC Office of the President (see Bleemer (2019b)).

Table 1: Descriptive Statistics of 1990s UC Admissions by Ethnicity

	Application			Admission			Enrollment		
	'94-5	'96-7	'98-9	'94-5	'96-7	'98-9	'94-5	'96-7	'98-9
Panel A: Non-URM Applicants									
Average Number or Percent of Applicants									
More Selective UCs	15,581	18,856	22,162	48.3	43.3	37.7	15.2	13.4	13.2
Selective UCs	12,638	14,320	17,275	77.3	72.7	63.2	19.0	19.2	16.7
Less Selective UCs	7,210	7,788	10,051	83.7	85.6	84.6	15.7	18.4	17.5
Total	33,415	37,792	42,066	84.9	83.6	83.9	49.7	49.4	49.6
Average SAT Score									
More Selective UCs	1224	1228	1238	1320	1335	1339	1277	1294	1299
Selective UCs	1156	1160	1171	1193	1203	1222	1140	1156	1173
Less Selective UCs	1136	1135	1138	1157	1154	1158	1124	1121	1124
All UCs	1183	1188	1194	1207	1212	1216	1196	1208	1217
Panel B: URM Applicants									
Average Number or Percent of Applicants									
More Selective UCs	3,922	4,198	4,539	56.3	49.4	27.1	17.7	15.8	10.0
Selective UCs	2,956	3,033	3,438	77.9	74.3	57.3	18.0	16.5	15.8
Less Selective UCs	2,270	2,240	2,802	81.6	79.2	76.3	17.9	16.4	17.9
Total	9,665	9,678	10,124	81.1	79.2	73.4	47.0	44.2	39.8
Average SAT Score									
More Selective UCs	1056	1069	1085	1134	1159	1196	1105	1126	1151
Selective UCs	1020	1031	1047	1058	1074	1105	1020	1042	1072
Less Selective UCs	986	994	1008	1011	1020	1036	979	988	1004
All UCs	1027	1040	1050	1056	1072	1083	1054	1073	1079

Note: Count and mean average descriptive statistics of 1994-1999 California-resident freshman UC applicants who are or are not underrepresented minorities (URM). Statistics are averaged across campuses: Berkeley, UCLA, and San Diego are More Selective; Santa Barbara, Irvine, and Davis are Selective; and Santa Cruz and Riverside are Less Selective. URM includes Black, Hispanic, and Native American applicants. SAT score was on the 1600 scale. Percent admitted and percent enrolled are conditional on applying to that campus. Campus-specific statistics are presented in Table A-1. Descriptive statistics by ethnicity available in Tables A-2 (Black and Hispanic) and A-3 (white and Asian). Source: UC Corporate Student System.

Additional educational administrative data come from several sources. Universities' admissions rate, average SAT scores, and six-year graduation rates are linked to NSC institutions using the Integrated Postsecondary Education Data System.[34] Aggregated data from the California Department of Education provide the annual number of graduates from each public high school by gender and ethnicity. Finally, a comprehensive College Board SAT-taker database covering public California high schools is linked by name and birthdate to the UC applicant pool to compare the application deterrence estimates below with those of Card and Krueger (2005); see Online Appendix G.3.

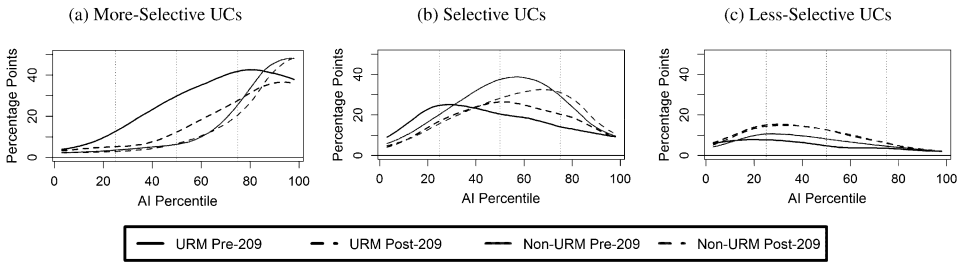
1.3 University of California Descriptive Statistics

Table 1 provides descriptive statistics of 1990s UC applications, admissions, and enrollment for California-resident freshman applicants. Statistics are presented by two-year cohort sets: 1994-95, who applied before Prop 209's passage; 1996-97, who applied after the ban was approved but before its mandatory implementation; and 1998-99, following the ban. The average number of non-URM annual applications received by UC increased by more than 25 percent in the period, with increases of 42 percent at the more-selective campuses. As a result, admissions rates consistently fell at all but the least-selective Riverside campus. Increasing yield rates – the percent of admitted students who enrolled – across most campuses stemmed the decline in the proportion of applicants who enrolled at each campus; for example, while the average percent of admitted Table 1: Descriptive Statistics of 1990s UC Admissions by non-URM applicants to UC's more selective campuses declined 11 percentage points between 1994 and 1999, the fraction who enrolled at those campuses fell only three percentage points over the period.

Meanwhile, the average SAT scores of most campuses' applicants were steadily rising, as were the average scores of students admitted to each campus. At UCLA, for example, average SAT scores rose 17 points among non-URM applicants and 27 points among admits. Taken together, the increasing application and yield rates, lower admissions rate, and stronger academic preparedness of both the applicant and admitted pools indicate a university system steadily increasing in reputation and selectivity throughout the 1990s.

[34] Average SAT scores are measured as the sum of the mean of universities' 25th and 75th Math and Verbal SAT percentiles. Admissions rates (and average SAT scores) are fixed at 2006 (2000), the earliest available year; graduation rates are contemporaneous.

Figure 2: UC Enrollment before and after Prop 209 by Ethnicity and AI Percentile



Note: The percent of all UC applicants who first enroll at each set of UC campuses before ('96-97 cohorts) and after ('98-99 cohorts) the end of affirmative action, by URM status and by percentile of academic index (AI) measured among 1996-1999 URM UC applicants. First enrollment measured in NSC up to six years after high school graduation. Statistics are smoothed with a triangular kernel with bandwidth 15. Source: UC Corporate Student System and National Student Clearinghouse.

Almost 20 percent of UC applicants were URM in 1997, and URM applicants' average SAT scores rose swiftly through the period, potentially reflecting that many less-competitive URM applicants were deterred from UC application in the first place.[35] Most campuses' URM admissions rates slowly declined until 1997 but then sharply declined in 1998, with a simultaneous sharp rise in URM admits' average test scores. URM enrollment rates fell precipitously at UC's more-selective campuses, slightly declined at the selective campuses, and rose slightly at the less-selective campuses. The next section examines this 'cascade effect' from more- to less-selective universities after Prop 209 in greater detail.

1.4 UC Applicants' University Enrollment

After 1998, URM applicants to UC campuses became substantially less likely to earn admission at every campus.[36] Figure 2 shows how these admissions changes affected the UC enrollment behavior of URM UC applicants between the 1996-97 and 1998-99 cohort pairs. Enrollment shares are shown for the full *AI* distribution of URM UC applicants in the period and are smoothed across percentiles. Before Prop 209, about 30 percent of median-*AI* URM applicants enrolled at the three more-selective UC campuses, while only about three percent of similar-*AI* non-URM applicants did so. After Prop 209, this gap largely closed. URM applicants across the full *AI* distribution became less likely to enroll at more-selective UC campuses. Higher-*AI* URM applicants became more likely to enroll at the selective and less-selective campuses – likely as a result of their now being rejected from the more-selective UC campuses – while lower-*AI* URM applicants' selective UC enrollment declined. Meanwhile, the increasing selectivity of UC campuses also led to decreased enrollment likelihoods of all but the highest-*AI* non-URM applicants.

Figure 3 broadens the scope of this analysis, summarizing how Prop 209 reshaped UC applicants' enrollment across the public and private sectors of U.S. higher education. Each panel plots the percentage point *difference* in enrollment likelihood before and after Prop 209 for all URM and non-URM UC applicants at each URM *AI* percentile. URM applicants' relative likelihood of enrollment at Berkeley and UCLA substantially declined across the *AI* spectrum.[37] UC San Diego exhibits a pattern common to California's other public universities: URM enrollment increased relative to non-URM enrollment for higher-*AI* applicants (70-95th percentiles) and decreased for those with somewhat-lower *AI*s (20-60th percentiles).

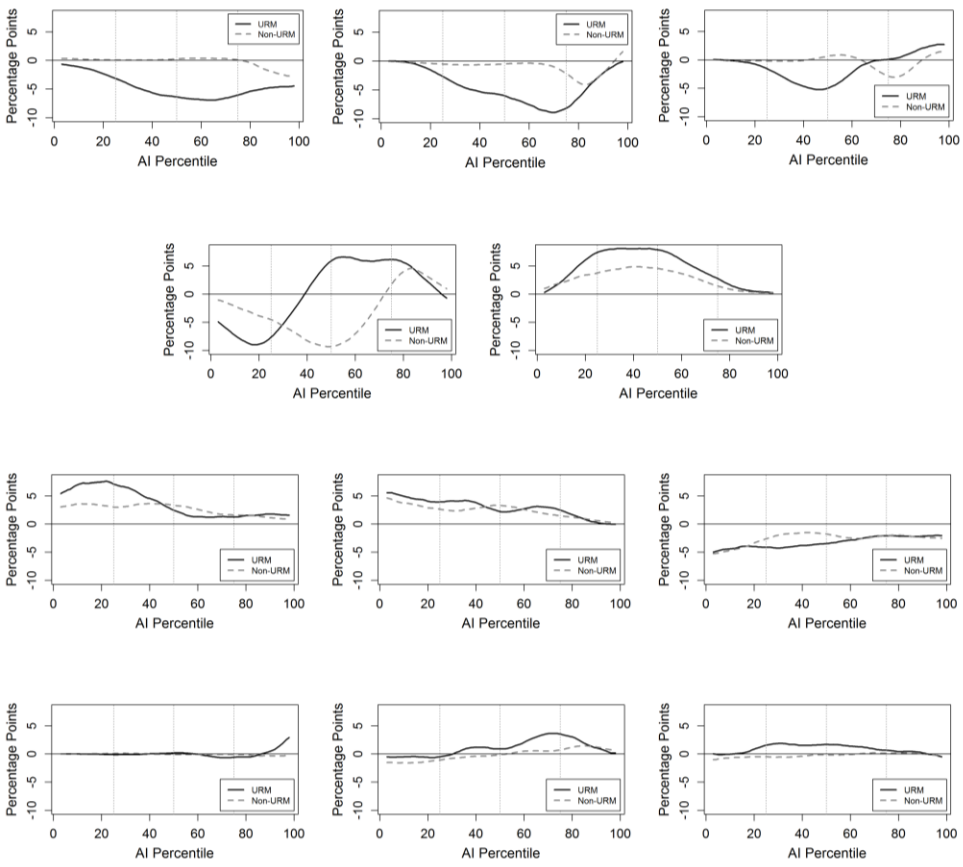
The same pattern holds at lower *AI* bands for the selective and less-selective UC campuses: URM applicants at the 60th *AI* percentile became about 10 percentage points relatively more likely to enroll at the selective campuses, while those at the 25th percentile became less likely to enroll at the selective campuses but more likely to enroll at less-selective campuses. The teaching-oriented CSU university system and California community colleges also absorbed some low-*AI* URM applicants (relative to changes

[35] About 20 percent of URM UC applicants were Black in the period, with nearly all of the rest Hispanic. Only a small share of URM applicants are Native American. Among Hispanic applicants, about 75 percent were Chicano and the rest Latino. See Table A-2 for separate descriptive statistics for Black and Hispanic UC applicants.

[36] Appendix B presents difference-in-difference analysis showing that URM UC applicants became four to 25 percentage points less likely (on average) to be admitted to each UC campus. While URM applicants were 9.3 percentage points more likely than academically-comparable non-URM applicants to be admitted to at least one campus before Prop 209, that gap declined by 7.9 percentage points after 1998. Prop 209 had generally-similar impacts on the admissions likelihood of Black and Hispanic UC applicants: Though Black students received somewhat-larger admissions advantages under affirmative action relative to academically-comparable non-URM applicants, Prop 209 caused slightly larger admissions declines for *Hispanic* applicants to UC's more-selective campuses than for Black UC applicants (see Table A-4).

[37] Figure A-5 shows that the URM students who exited Berkeley and UCLA following Prop 209 also came from much lower-income households than those who replaced them, leading to a substantial net enrollment shift at UC's more-selective campuses from students in the bottom three income quartiles (fixed in 1996-97) to students in the top quartile after 1998.

Figure 3: Changes in University Enrollment after Prop 209 by Ethnicity and AI Percentile



Note: Difference in percent of UC applicants who first enroll at each postsecondary institution(s) between 1998-1999 and 1996-1997, by URM status and by percentile of academic index (AI) measured among 1996-1999 URM UC applicants. First enrollment measured in NSC up to six years after high school graduation; university groups partition possible enrollments. Statistics are smoothed with a triangular kernel with bandwidth 15. "Ivy+" universities include the Ivy League, MIT, Stanford, and U. Chicago; private and non-CA universities exclude those institutions. Source: UC Corporate Student System and National Student Clearinghouse.

among non-URM applicants).[38] A small number of high-*AI* URM applicants were absorbed by the highly-selective Ivy+ universities, and middle-*AI* URM applicants became a few percentage points relatively more likely to enroll at other private and out-of-state universities.[39]

Overall, these patterns are consistent with a substantial cascade of URM students from more- to less-selective universities after 1998, with URM students from more-selective schools taking the less-selective university seats previously held by lower-*AI* URM students rejected in the absence of affirmative action, who themselves take the seats of other URM students who formerly enrolled at even less-selective universities.[40]This cascade explains why the proportion of each campus's URM applicants who enroll at that campus only declines at the three more-selective campuses.[41]

The broad effect of Prop 209 on URM UC applicants' likelihood of enrollment at every California college and university highlights the importance of analyzing student outcomes across the full set of universities where these students enroll before and after 1998. The outcomes of URM students at a given set of universities – for example, the UC system – will observably change for two

[38] The small URM and non-URM increase in community college enrollment and small decrease in the number of students with no observed enrollment in NSC likely largely reflects community colleges' entry into NSC reporting; see Appendix E.

[39] Geiser and Caspary (2005) report similar findings for high-performing URM applicants. These out-of-state enrollment estimates are within the confidence intervals presented by Hinrichs (2020), who argues that affirmative action bans cause minimal cross-state migration.

[40] Figure A-6 shows that this cascade pattern is not reflected in applicants' UC application portfolios, suggesting both that UC's admissions changes were poorly anticipated by URM applicants and that the observed patterns result from admissions decisions rather than cross-campus applicant behavior.

[41] See Table A-5.

reasons: because those students are enrolled at less-selective campuses and because of substantial changes in the composition of students enrolled at those universities, with many lower-*AI* students exiting the system after Prop 209. The following section describes this study's baseline empirical methodology, which exploits longitudinal records for all UC applicants – following students wherever they enroll, before or after Prop 209 – to credibly estimate the effects of affirmative action on short- and long-run outcomes.

2. EMPIRICAL METHODOLOGY

I estimate the impact of Prop 209 on URM UC applicants by comparing the outcomes of URM applicants before and after Prop 209 with those of non-URM students with similar prior academic opportunity and preparedness. A key feature of this research design is that it spans outcomes for all UC applicants whether or not they ever enroll at a UC campus. This helps to avoid concerns of sample selection bias that arise from changes in the UC student composition caused by UC's changed admissions policies following Prop 209.

Comparing the outcomes of URM and non-URM applicants after 1998 accounts for the substantial shifts in UC campuses' reputation and selectivity through the period, which likely shaped the outcomes of both groups of applicants. However, the non-URM UC applicant group are not a traditional "control" group, since they were also partly treated by Prop 209: Some non-URM applicants' likelihood of admission to more-selective universities likely increased in order to maintain class sizes despite the decline in URM enrollment.[42] As a result, the estimates presented below identify the impact of Prop 209 on URM student outcomes *relative* to its impact on non-URM outcomes. There are about four times as many non-URM UC applicants as URM applicants, so if UC campuses' enrollment did not respond to Prop 209, every one percentage point average decrease in URM applicants' enrollment likelihood corresponds to almost a 0.25 percentage point average *increase* in non-URM applicants' enrollment likelihood. If universities' treatment effects for on-the-margin URM and non-URM students are equal, this implies that as much as 20 percent of the relative treatment effect estimates described below could be explained by improved outcomes among non-URM students who benefited from Prop 209. I return to this possibility at the end of the paper, presenting evidence that the benefits of Prop 209 to non-URM students likely explain an even smaller share of the presented estimates.

To implement the proposed research design, I estimate difference-in-difference models of the form:

$$Y_{iy} = \alpha_{h_i} + \delta_y + (\beta_0 + \beta_y) URM_i + \gamma X_{iy} + \epsilon_{iy} \quad (1)$$

Where Y_{iy} is an outcome for California-resident freshman applicant i after they applied in year y. I present results from two model specifications, both estimated by OLS.[43] First, I restrict the sample to 1994-2002 California-resident freshman UC applicants and set β_{1997} to 0, estimating the difference between URM and non-URM applicants' outcomes in the years before and after Prop 209. The β_{1996} coefficient can be interpreted as a placebo test that observed post-1998 effects are driven by Prop 209, while the β_{1994} and β_{1995} coefficients could possibly reflect changes in applicant outcomes as a result of SP-1 and Prop 209's passage (which led some UC campuses to begin phasing out affirmative action in 1996). To estimate the effect of Prop 209 more concisely, I also estimate a specification further restricting the sample to 1996-1999 applicants and estimating a single β_{98-99} term, averaging outcomes two years after 1998 relative to the two years prior. No UC campus implemented any substantial unrelated changes in their admissions processes in this period.

Each model includes high school fixed effects α_{h_i}, which absorb spurious cross-school application and outcome variation, and the components used to construct UC's Academic Index (X_{iy}), which absorb variation in applicants' observed academic preparedness.[44] Standard errors are robust.[45]

I also estimate three variants on this model to better understand Prop 209's effects on student outcomes. First, I separately estimate the model by 1996-97 URM *AI* quartile to observe heterogeneous treatment effects for students with different prior academic opportunities and preparedness. Second, because some UC campuses began phasing out their affirmative action policies in 1996,

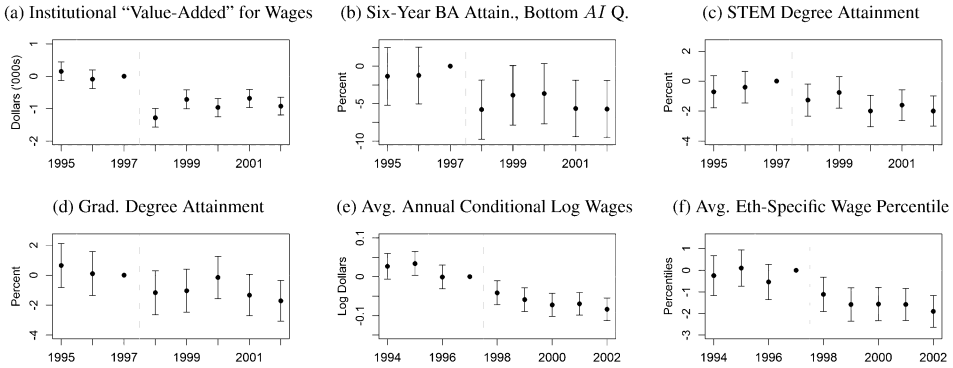
[42] Figure 3 clearly shows that there is no "control" group of URM UC applicants in the period; Prop 209 shifted URM UC applicants' college enrollment across the *AI* spectrum, even among the highest-testing URM applicants.

[43] All OLS estimation is conducted using the *felm* and *summary.felm(,robust)* functions in the *lfe* R package, version 2.8-5.

[44] That is, X_{iy} includes Verbal and Math SAT scores, high school GPA, SAT II Writing score, SAT II Math score (and an indicator for submitting a Math 2 SAT II score), and a third SAT II score (along with indicators for which score was submitted). About 15 percent of the sample is missing at least one test score (mostly the third SAT II); dummies are included for each missing value to preserve the full sample. I test models' sensitivity to covariate inclusion in Section 4. These detailed covariates (and fixed effects) importantly differentiate the presented enrollment effects of Prop 209 from previously-published results (Chang and Rose, 2010; Antonovics and Backes, 2014) by absorbing sample selection and omitted variable biases.

[45] Following Abadie et al. (2017), given that the data comprise the full population of UC applicants and that there is little reason to expect correlated random effects across any particular clusters of applicants, I do not cluster the reported standard errors.

Figure 4: Annual Difference-in-Difference Estimates of URM UC Applicants' Post-1998 Outcomes



Note: OLS difference-in-difference coefficient estimates of Equation 1, the change in URM UC applicant outcomes relative to non-URM applicants, compared to the 1997 baseline. For details on outcomes (a) to (e), see notes to Tables 2 (with institutional value-added estimated following Chetty et al. (2020a)), 3, and 4. Panel (f)'s outcome is defined as the average annual ethnicity-specific wage percentile between 6 and 16 years after UC application, omitting zero-wage years; percentiles are defined relative to the empirical distribution of wages earned in that year by same-ethnicity (URM, Asian, or White/Other) college-educated California ACS respondents born between 1974 and 1978, few of whom were directly impacted in university enrollment by Prop 209. Models include high school fixed effects, ethnicity indicators, and the components of UC's Academic Index (see footnote 44); 1994 NSC data are omitted. Panel (b) restricts the sample to the bottom AI quartile as measured among '96-97 URM UC applicants. Bars show robust 95-percent confidence intervals. Source: UC Corporate Student System, National Student Clearinghouse, California Employment Development Department, and the American Community Survey (Ruggles et al., 2018).

I replace the model's 1996-97 pre-period with 1994-95 and re-estimate post-1998 outcomes relative to those earlier years.[46] Finally, I interact β_0 and β_y with indicators for whether the student is Black or Hispanic, identifying separate coefficients for each group to estimate heterogeneity in Prop 209's impact by URM ethnicity.[47]

It remains possible that the β_y estimates reflect sample selection bias resulting from the impact of Prop 209 on the composition of UC applicants, since a non-random selection of URM applicants may have been discouraged from UC application by their decreased likelihood of admission. I directly quantify the degree of Prop 209's URM application deterrence in Section 4 and present evidence that the magnitude of the remaining bias is very small.

3. THE IMPACT OF AFFIRMATIVE ACTION ON STUDENT OUTCOMES

Figure 4 presents estimates of β_y from Equation 1 for a series of enrollment, educational attainment, and labor market outcomes, all estimated relative to 1997. The subsections below discuss each of the measured outcomes in turn. Given that many URM applicants' undergraduate enrollment remained unchanged by Prop 209, the presented reduced-form coefficients likely underestimate impacted students' treatment effect of enrolling at less-selective universities after UC affirmative action ended.

3.1 Institutional Quality

Prop 209 caused URM UC applicants to be 7.6 percentage points less likely to enroll at the more-selective UC campuses – particularly driven by the second and third URM *AI* quartiles – and led to small corresponding enrollment increases across the spectrum of other public and private higher education institutions.[48] Prop 209 led to larger relative enrollment declines at the more-selective UC campuses for Black applicants – with the top *AI* quartile of Black applicants facing a 15 percentage point enrollment decline – and Black applicants were much more likely to flow into Ivy+ and out-of-state universities than Hispanic applicants.[49]

I summarize these changes in university enrollment quality by characterizing each institution in two ways: (1) using traditional measures of university quality like selectivity and graduation rate, and (2) using a set of novel "value-added" (VA) statistics, which estimate each institution's average treatment effects on their students' degree attainment and average wages between ages 30

[46] All models estimating National Student Clearinghouse outcomes omit 1994 applicants, for whom NSC records are unreliable.
[47] I omit Native American applicants from this final specification due to small sample size.
[48] Table A-6 summarizes URM students' enrollment changes. The empirical integral of URM students' relatively increased and decreased enrollment at each UC campus by *AI* between 1995 and 1998-99 – over the 1998-99 distribution of URM UC applicants – provides a lower-bar estimate (assuming Prop 209's monotonicity) for the number of URM students who enter and exit each campus as a result of Prop 209. Table A-7 shows that at least 1,200 URM UC applicants exited UC campuses – with more than 800 exiting Berkeley and UCLA – and 800 entered UC campuses after Prop 209.
[49] See Table A-8.

Table 2: Difference-in-Difference Estimates of URM UC Applicants' Post-1998 University Quality

	First Four-Year Institution			First Institution			
	Adm. Rate	Avg. SAT	6 Yr. BA Rate	"MH" VA[1] BA 6	"MH" VA[1] Earn 30s	"CFSTY" VA[1] BA 6	"CFSTY" VA[1] Earn 30s
Panel A: Difference-in-Difference Coefficients							
URM (β_0)	-5.5	43.2	3.1	2.0	1,890	2.9	2,853
	(0.2)	(1.6)	(0.1)	(0.1)	(75)	(0.1)	(84)
URM × Prop. 209	2.9	-23.4	-1.9	-0.5	-384	-0.9	-924
($\beta_{\cdot 98-99}$)	(0.2)	(2.0)	(0.2)	(0.2)	(93)	(0.2)	(105)
$\bar{Y}$	48.8	1772	74.6				
Obs.	151,655	149,241	151,899	176,976	173,844	175,624	173,557
Panel B: Freshman Undergraduates by AI Quartile							
Bottom	1.8	-38.2	-3.7	-1.5	-632	-1.7	-785
Quartile	(0.6)	(5.5)	(0.5)	(0.5)	(214)	(0.5)	(246)
Second	4.2	-34.6	-3.0	-0.4	-608	-1.2	-1,535
Quartile	(0.5)	(4.3)	(0.4)	(0.4)	(197)	(0.4)	(238)
Third	4.7	-22.0	-1.3	0.1	-381	-0.4	-1,280
Quartile	(0.5)	(3.9)	(0.3)	(0.3)	(182)	(0.3)	(218)
Top	1.6	-6.4	-0.5	-0.5	-172	-0.6	-499
Quartile	(0.5)	(4.0)	(0.3)	(0.3)	(224)	(0.3)	(234)

Note: Estimates of β_0 and $\beta_{\cdot 98-99}$ from Equation 1, a difference-in-difference model of 1996-1999 URM UC freshman California-resident applicants' outcomes compared to non-URM outcomes after the 1998 end of UC's affirmative action program. Outcomes defined as characteristics of the first four-year university or the first two- or four-year institution at which the applicant enrolled within six years of high school graduation as measured in the NSC. Models include high school fixed effects and the components of UC's Academic Index (see footnote 44). Academic Index (AI) is defined in footnote 22; models by AI quartile are estimated independently, with quartiles defined by the AI distribution of 96-97 URM UC applicants. IPEDS data (first three and last two columns) linked by OPE ID and year to NSC enrollment. Admission rate (average SAT score) is fixed by institution in 2006 (2000), the first observed year in IPEDS; graduation rate is contemporaneous. Robust standard errors in parentheses. [1]Value-added measures are estimated by regressing six-year BA attainment (in NSC) or average 12-to-16 year conditional wages (in EDD), when most applicants are in their early 30s, on college indicators, year FEs, and either indicators for each applicant's set of UC campus applications and admissions (following Mountjoy and Hickman (2020), "MH") or ethnicity indicators and quintics in SAT score and family income (following Chetty et al. (2020a), "CFSTY") using the 1995-1997 UC applicant pool. Source: UC Corporate Student System, National Student Clearinghouse, the California Employment Development Department, and the Integrated Postsecondary Education Data System (IPEDS).

and 34. I estimate the value-added statistics using fixed effect OLS regression over the 1995-97 sample of UC applicants matched to their first enrollment institution, absorbing selection bias across institutions using students' UC application and admission portfolios (following Mountjoy and Hickman (2020); "MH") or using ethnicity indicators and fifth-order polynomials in SAT score and family income (following Chetty et al. (2020a); "CFSTY").[50] Online Appendix G.1 provides methodological details and the estimated value-added statistics.

Table 2 presents difference-in-difference estimates of how Prop 209 impacted URM UC applicants' quality of enrollment institution. Prop 209 caused URM UC applicants to enroll at less-selective universities with lower average SAT scores and graduation rates, with larger declines among lower-*AI* applicants. Those institutions are also estimated to have lower average "value-added": Prop 209 caused URM UC applicants to enroll at institutions that (on average) lead their students to lower likelihoods of Bachelor's degree attainment by 0.5-0.9 percentage points and whose graduates earn $400-$900 lower annual early-30s wages, with smaller value-added declines among high-*AI* URM applicants.[51] Figure 4 shows that the institutions where URM UC applicants enrolled remained relatively steady in terms of their "CFSTY" early-30s annual wage value-added between 1995 and 1997, but sharply and persistently declined by about $1,000 after 1998.

[50] I do not shrink the value-added statistics, and both sets of covariates likely fail to fully absorb selection bias across universities. Given that most URM students enroll at lower-VA institutions following Prop 209, both of these factors likely lead toward over-estimation of the VA decline following Prop 209. Nevertheless, I show below that the wage value-added estimates substantially underestimate the actual observed change in URM applicants' wages, suggesting that both value-added procedures understate selective universities' treatment effects among the URM students impacted by Prop 209.

[51] Table A-9 shows slightly-larger estimates when compared to the 1995 pre-209 baseline, and that Black and Hispanic UC applicants faced similar VA declines following Prop 209.

Table 3: Difference-in-Difference Estimates of URM UC Applicants' Post-1998 Educational Outcomes

	Earn Bach. Degree		Earn STEM Degree		Earn Graduate Degree		
	4 Years	6 Years	Uncondit.	Condit.	All	STEM	JD
Panel A: Difference-in-Difference Coefficients							
URM	-1.90	-2.61	0.46	0.45	4.83	0.60	0.91
	(0.41)	(0.40)	(0.31)	(0.41)	(0.42)	(0.17)	(0.19)
URM ×	-0.85	-0.71	-0.98	-0.65	-1.31	-0.58	-0.21
Prop 209	(0.51)	(0.50)	(0.38)	(0.51)	(0.53)	(0.21)	(0.22)
$\bar{Y}$	47.8	74.6	22.2	27.1	36.0	5.4	4.9
Obs.	199,321	199,321	199,321	148,771	199,321	199,321	199,321
Panel B: Estimates of URM × Prop 209 (β_{98-99}) by AI Quartile							
Bottom	-2.09	-4.25	-1.23	-1.42	-2.77	-0.86	-0.08
Quartile	(1.21)	(1.44)	(0.65)	(1.08)	(1.25)	(0.33)	(0.32)
Second	0.55	-0.52	-1.05	-0.44	-1.11	0.34	-0.65
Quartile	(1.23)	(1.22)	(0.80)	(1.03)	(1.21)	(0.37)	(0.42)
Third	0.98	1.22	-0.76	-0.82	-1.26	-0.53	-0.68
Quartile	(1.19)	(1.05)	(0.89)	(1.07)	(1.16)	(0.42)	(0.48)
Top	-0.71	-0.03	0.81	0.14	-0.14	-0.32	-0.24
Quartile	(1.10)	(0.88)	(0.96)	(1.09)	(1.13)	(0.56)	(0.61)

Note: Estimates of β_0 and β_{98-99} from Equation 1, an OLS difference-in-difference model of 1996-1999 URM UC freshman California-resident applicants' educational outcomes compared to non-URM outcomes after the 1998 end of UC's affirmative action program. Outcomes defined as having earned a Bachelor's degree in five or six years, having earned a Bachelor's degree in a STEM field (unconditional or conditional on six-year degree attainment), or having ever earned a graduate degree (any, JD, or MD), all as measured in the union of UC administrative records and the NSC. Models include high school fixed effects and the components of UC's Academic Index (see footnote 44). Academic Index (AI) is defined in footnote 22; models by AI quartile are estimated independently, with quartiles defined by the AI distribution of 96-97 URM UC applicants. Robust standard errors in parentheses. Source: UC Corporate Student System and National Student Clearinghouse.

3.2 Degree Attainment

Next I turn to three measures of degree attainment: whether the applicant earns a Bachelor's degree, whether they earn an undergraduate STEM degree, and whether they earn a graduate degree. I define Bachelor's and STEM degree attainment using the union of UC administrative records and the National Student Clearinghouse records, while graduate degree attainment is measured only in NSC.[52] Figure 4 presents estimates from Equation 1 for six-year BA attainment among bottom-*AI*-quartile applicants, unconditional STEM degree attainment, and graduate degree attainment, showing that all three abruptly and persistently decline in 1998 following Prop 209.

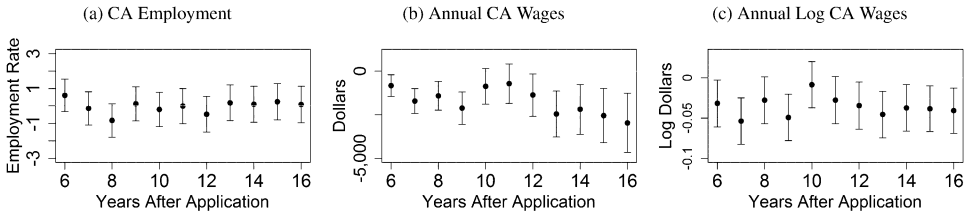
Table 3 provides additional details on the impact of Prop 209 on URM UC applicants' degree attainment. The first two columns show that URM UC applicants were less likely to earn Bachelor's degrees than academically-comparable non-URM applicants under AA, and if anything became even less likely to earn degrees after affirmative action was eliminated, with a 95-percent confidence interval of -1.69 to 0.27 percentage point change in average six-year degree attainment.[53] This effect is wholly driven by the bottom *AI* quartile of URM applicants, whose enrollment was shown above to largely flow from the more-selective and selective UC campuses to less-selective public and private California universities.[54]

[52] Bachelor's attainment and STEM major choice are measured using the union of UC and NSC records to augment imperfect NSC records from UC Santa Cruz; see Appendix E. This may positively bias the resulting estimates, since URM students are less likely to enroll at UC campuses following Prop 209 and thus less likely to have the opportunity that their degrees are measured in UC administrative data. Estimates for each separate data source (restricting UC data to UC enrollees) are presented in Table A-10; estimates are somewhat more-negative in NSC data and less-negative in UC data (among UC enrollees).

[53] These estimates contrast with those presented by Arcidiacono et al. (2014), who present results suggesting that Prop 209 *increased* URM UC graduation rates. Online Appendix G.2 shows that those findings are driven by selection on applicant characteristics unobserved in those data: replacing the highly-censored SAT score and high school GPA covariates available in their data with continuous measures of the same metrics fully attenuates the observed effect, with the remaining difference explained by that paper's sample restriction to UC enrollees.

[54] Applicants' changed degree attainment is less than half of the change in the six-year graduation rates of the institutions where they enroll, a lower ratio than those estimated by Cohodes and Goodman (2014) and Bleemer (2018a) in other contexts. This suggests that the degree attainment of students targeted by affirmative action was relatively less sensitive to enrollment change. The bottom *AI* quartile had an estimated ratio closer to 1 (as in those other studies), while applicants in the other quartiles do not appear to have faced declines in degree attainment despite enrolling at institutions with lower graduation rates.

Figure 5: Annual Difference-in-Difference Estimates of URM UC Applicants' Post-1998 Wage Outcomes



Note: Estimates of β_{98-99} from Equation 1, an OLS difference-in-difference model of 1996-1999 URM UC freshman California-resident applicants' employment outcomes compared to non-URM outcomes after Prop 209. Outcomes defined as non-zero California wages ("CA Employment") and California wages in dollars and log-dollars (omitting 0's) as measured in the California Employment Development Department database, which includes employment covered by California unemployment insurance. Coefficients in each year after high school graduation are estimated independently. Models include high school fixed effects and the components of UC's Academic Index (see footnote 44). Academic Index (AI) is defined in footnote 22. Annual wages CPI-adjusted to 2018 and winsorized at top and bottom 1 percent. Robust 95-percent confidence intervals shown. Figure A-7 presents separate estimates for Black and Hispanic applicants. Source: UC Corporate Student System and the California Employment Development Department.

The third and fourth columns of Table 3 show that URM applicants may have become somewhat less likely to earn STEM degrees conditional on earning a college degree (95-percent c.i. -1.65 to 0.35 percentage points).[55] In combination with the decline in overall degree attainment, this provides strong evidence for Prop 209 causing a decline in *unconditional* STEM degree attainment by 1.0 percentage point (s.e. 0.4). Table A11 presents major-specific estimates of changes in URM UC applicants' fields of study; the fields with largest increases after 1998 are biology (0.62 percentage points) and miscellaneous humanities fields (0.30), while those with the largest decreases are economics (-0.39), history (-0.32), and mathematics (-0.29), suggesting substantial heterogeneity between and within disciplines.

The last three columns of Table 3 show the relative impact of Prop 209 on URM students' likelihood of earning a graduate degree (within 18 years of high school graduation). Graduate degrees tend to offer large labor market returns (Altonji, Arcidiacono, and Maurel, 2016; Altonji and Zhong, 2019) and may represent an important benefit to more-selective university enrollment. URM applicants became 1.3 percentage points (s.e. 0.5) less likely to earn graduate degrees after Prop 209 relative to academically-comparable non-URM applicants, with particularly-large declines among lower-*AI* applicants. Almost half of this decline can be explained by a decline in STEM-oriented masters and doctoral degrees, for which attainment declines 0.58 percentage points (s.e. 0.21).[56] There is only weak evidence of a decline in law degree attainment, and no such evidence for medical degrees.

Table A-12 shows that URM UC applicants' educational declines after Prop 209 are generally somewhat larger when compared to a 1995 baseline, before some campuses began phasing out affirmative action. Educational outcomes after Prop 209 appear broadly similar for Black and Hispanic applicants.

3.3 Employment and Wages

Finally, I turn to applicants' labor market outcomes. Figure 5 shows estimates of β_{98-99} estimated separately by year for each specified outcome, with outcomes CPI-adjusted to 2018 and covering 16 years after graduation (when most applicants were age 34). The first panel shows that Prop 209 had no net effect on URM UC applicants' California labor market participation; 69 percent of applicants annually earned covered California wages before and after Prop 209.[57] Among wage-earning UC applicants, however, Prop 209 caused URM workers' wages to persistently decline by an average of $1,800 (0.05 log points), or $2,400 (0.04 log points) in their early 30s. As late as age 34, there is no evidence that the average wages of URM applicants impacted by Prop 209 recover to their earlier levels. Table A-13 shows that these wage declines are proportionally larger for lower-*AI* URM applicants.

The last two panels of Figure 4 present the dynamics of URM UC applicants' wages in the years before and after Prop 209. Panel (e) shows estimated β_y coefficients for the average of observed log wages 616 years after UC application. URM applicants' wages sharply decline between 1997 and 1998, reflecting the impact of Prop 209, but there is also evidence of a decline after 1996 and continued declines between 1998 and 2000. While the former may partly reflect some UC campuses' early affirmative action phase-

[55] This finding contrasts with a number of previous studies that show that increased university selectivity tends to decrease students' likelihood of earning STEM degrees along different margins (Arcidiacono, Aucejo, and Hotz, 2016; Mountjoy and Hickman, 2020; Bleemer, 2018a). I further analyze Prop 209's effect on UC enrollees' performance and persistence in STEM courses in Section 5.

[56] STEM graduate degrees are defined as masters- or doctoral-level degrees in any STEM field; see footnote 31.

[57] Figure A-8 shows that California labor market participation is unchanged after Prop 209 for all four *AI* quartiles of URM applicants. Prop 209 could have either increased or decreased URM applicants' likelihood of covered California employment: less-selective university enrollment likely decreases applicants' likelihood of seeking employment outside the state (since the credential is more geographically-specific), but increased out-of-state enrollment might have led to out-of-state employment.

Table 4: Difference-in-Difference Estimates of URM UC Applicants' Post-1998 CA Wage Outcomes

	Average 6-16 Years after UC App.				Average 12-16 Years after UC App.			
	# Years Emp.	Total Wages	Log Wages	# > $100K Wages	# Years Emp.	Total Wages	Log Wages	# > $100 Wages
Panel A: Difference-in-Difference Coefficients								
URM	0.09	-163	0.01	-0.06	0.05	-812	-0.00	-0.03
	(0.04)	(359)	(0.01)	(0.02)	(0.02)	(531)	(0.01)	(0.01)
URM × Prop 209	-0.00	-1,821	-0.05	-0.08	0.00	-2,381	-0.04	-0.07
	(0.04)	(438)	(0.01)	(0.03)	(0.02)	(639)	(0.01)	(0.02)
$\bar{Y}$	7.55	60,885	10.69	1.48	3.30	79,057	10.89	1.01
Obs.	199,321	178,156	178,156	199,321	199,321	152,977	152,977	199,321
Panel B: Estimates with Separate Coefficients for Black and Hispanic Applicants								
Black	-0.60	-2,009	-0.078	-0.16	-0.27	-1,908	-0.088	-0.09
	(0.07)	(645)	(0.017)	(0.03)	(0.04)	(948)	(0.022)	(0.02)
Hispanic	0.38	592	0.049	-0.02	0.19	-306	0.034	-0.01
	(0.04)	(403)	(0.010)	(0.02)	(0.02)	(594)	(0.012)	(0.02)
Black × Prop 209	0.03	-478	-0.032	-0.01	0.02	-583	-0.025	-0.02
	(0.09)	(855)	(0.024)	(0.05)	(0.05)	(1,258)	(0.030)	(0.03)
Hispanic × Prop 209	-0.04	-2,298	-0.054	-0.12	-0.01	-2,998	-0.053	-0.09
	(0.05)	(482)	(0.012)	(0.03)	(0.03)	(699)	(0.015)	(0.02)
$\bar{Y}$	7.56	60,936	10.690	1.48	3.30	79,129	10.894	1.01
Obs.	197,804	176,825	176,825	197,804	197,804	151,854	151,854	197,804

Note: Estimates of β_0 and $\beta_{\cdot 98-99}$ from Equation 1, an OLS difference-in-difference model of 1996-1999 URM UC freshman California-resident applicants' wage outcomes compared to non-URM outcomes after the 1998 end of UC's affirmative action program. Panel B interacts the coefficients with Black and Hispanic indicators to separately estimate outcomes for each group; Native American applicants are omitted. Outcomes are defined as number of years of non-zero California wages, average wages and log wages across years with non-zero wages, and number of years with wages above $100,000, among the years 6-16 or 12-16 years after initial UC application. Outcomes measured in the California Employment Development Department database, which includes employment covered by California unemployment insurance. Models include high school fixed effects and the components of UC's Academic Index (see footnote 44). Academic Index (AI) is defined in footnote 22; models by AI quartile are estimated independently, with quartiles defined by the AI distribution of 96-97 URM UC applicants. The years 1996-1997 are omitted in Panel C because some universities preemptively curtailed their affirmative action programs in those years. Annual wages CPI-adjusted to 2018 and winsorized at top and bottom 1 percent. Robust standard errors in parentheses. Source: UC Corporate Student System and the California Employment Development Department.

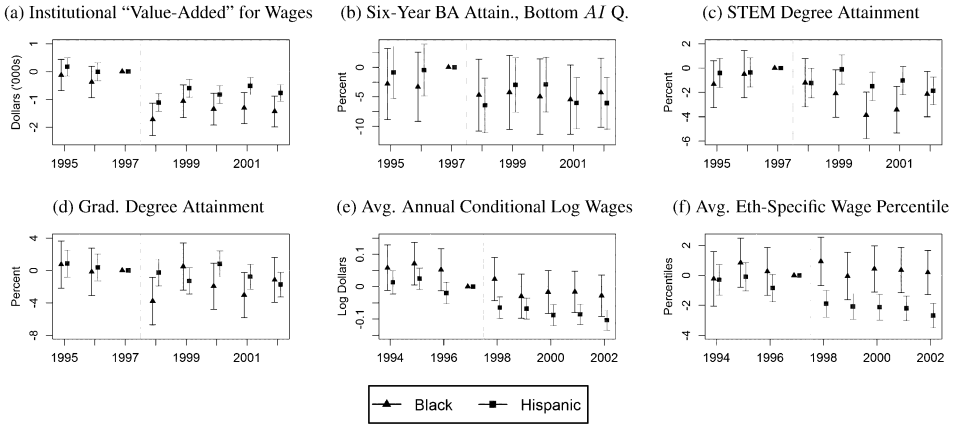
out, this variation is more likely the result of ethnicity-specific wage dynamics in the California labor market. I adjust for those dynamics by replacing individuals' wages with their percentile in the contemporaneous wage distribution of same-ethnicity college-educated California workers born between 1974 and 1978, most of whom were already in college prior to Prop 209's 1998 implementation.[58] Panel (f) shows that the resulting percentiles exhibit minimal trend in the years before and after Prop 209, with an approximately one percentage point decline observed between 1997 and 1998 caused by Prop 209. On average, a one percentile change in the 2001-17 URM wage distributions corresponds to $1,940, closely matching the estimated decline in URM UC applicants' wages after Prop 209.

Table 4 summarizes the changes in URM applicants' wages following Prop 209, showing that academically-comparable URM and non-URM workers earned similar wages before Prop 209 but diverged afterwards. The second panel shows striking evidence of heterogeneity across URM students: While the wages of Hispanic students sharply declined following Prop 209 relative to academically-comparable non-URM applicants, there is little such evidence for Black applicants (though their smaller sample size results in larger standard errors). This compounds a previously-existing gap between the two groups, with Black applicants already earning substantially lower average wages than academically-comparable Hispanic students (who also earn somewhat higher wages than academically-comparable non-URM applicants).

Figure 6 contextualizes this finding: While Black and Hispanic UC applicants faced similar declines in university quality and educational outcomes after Prop 209, and Hispanic UC applicants' wages and wage percentile sharply declined after 1998, there was no observable parallel decline among Black UC applicants. While gap may be partially explained by positively-selected Black students' greater likelihood of exiting California to enroll at Ivy+ and other highly-selective private universities, this suggests that

[58] The wage distributions are observed among employed college-educated 2001-2017 American Community Survey respondents Ruggles et al. (2018).

Figure 6: Annual Difference-in-Difference Estimates of URM UC Applicant Outcomes by Ethnicity



Note: OLS difference-in-difference coefficient estimates of an extension of Equation 1 interacting β_t with Black and Hispanic indicators, estimating the change in Black and Hispanic UC applicant outcomes relative to non-URM applicants compared to the 1997 baseline. For details on outcomes (a) to (e), see notes to Tables 2, 3, and 4; institutional value-added is estimated following Chetty et al. (2020a). Panel (f)'s outcome is defined as applicants' average annual ethnicity-specific wage percentile between 6 and 16 years after UC application, omitting zero-wage years; percentiles are defined relative to the empirical distribution of wages earned in that year by same-ethnicity (URM, Asian, or White/Other) college-educated California ACS respondents born between 1974 and 1978, few of whom were directly impacted in university enrollment by Prop 209. Models include high school fixed effects, ethnicity indicators, and the components of UC's Academic Index (see footnote 44); 1994 NSC data are omitted. Panel (b) restricts the sample to the bottom AI quartile as measured among '96-97 URM UC applicants. Native American applicants are omitted. Bars show robust 95-percent confidence intervals. Source: UC Corporate Student System, National Student Clearinghouse, California Employment Development Department, and the American Community Survey (Ruggles et al., 2018).

while UC's affirmative action provided substantial long-run wage returns to Hispanic students, its labor market benefits to Black Californians may have been small.

4.3.1 Contextualizing Prop 209's Labor Market Impact

While the University of California does not educate enough of the California workforce for its admissions policies to meaningfully shift most moments of the state's aggregate wage distribution, its selectivity and the high wages earned by its graduates imply that its policies may meaningfully impact the composition of California's high-earning workers. UC had 56,300 URM applicants between 1998 and 2002. Compared to a 1996-97 (1994-1995) baseline, the difference-in-difference estimates above imply that each of those applicants became about 1.3 (3.1) percentage points less likely to earn at least $100,000 per year in California in 2014, 12 to 16 years after college application.[59] Assuming that these coefficients reflect a decline in URM labor market outcomes, this implies a decline in the number of high-earning URM Californians by over 700 (1,700). American Community Survey estimates show that there were 27,000 URM Californians earning over $100,000 in 2014, implying that Prop 209 caused a decline in the number of such workers among UC applicants by 3 (6) percent.[60]

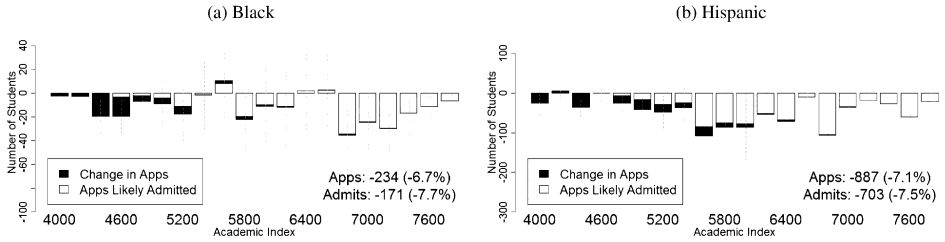
Figure A-10 shows that the fraction of early- and mid-30s URM Californians earning wages above $100,000 indeed disproportionately declined in the years that those cohorts would have lost selective university access as a result of Prop 209.[61] For example, relative to a 2010 baseline, URM Californians between ages 33 and 37 became five to 10 percent less likely to earn over $100,000 between 2012 (when they all would have enrolled at university before Prop 209) and 2017 (when they all would have enrolled after Prop 209). Members of several comparison groups – including slightly older URM Californians, similar-aged URM non-Californians, and similar-aged non-URM Californians – all became slightly *more* likely to earn over $100,000 over the period. This suggests that the baseline estimates' focus on UC applicants may yield an underestimate of the aggregate labor market effect of Prop 209 for high earners, with further declines likely coming from two groups: (1) URM non-UC applicants who could have become less likely to earn admission to the more-selective public CSU universities, which were also bound by Prop

[59] In 2014, $100,000 was approximately the 90th (95th) percentile of wages among California (U.S.) workers aged 30 to 34, though it was earned by more than 20 percent of UC applicants 14 years after application. For annual estimated URM wage threshold declines relative to each baseline, see Figure A-9.

[60] The estimated $130-$150 million decline in 2014 age-30-to-34 URM Californians' aggregate wages represents a 0.4-0.5 percent aggregate decline for that group. All ACS statistics calculated using data from IPUMS (Ruggles et al., 2018).

[61] Here I define Californians as those born in the state (not those reside in the state) to identify those likely impacted by Prop 209 and abstract away from post-education cross-state mobility.

Figure 7: Estimated Declines in 1998-99 Application and Admission by Ethnicity



Note: Estimates of the change in the number of UC applicants (and admits) in 1998-1999 by ethnicity (e) and 200-point AI bin, relative to 1994-1995. The height of each black bar is the product of $\beta_{e,98-99,a}$ (estimated in Equation 2) and $\sum_s UC_{s,98-99,e}$, the average number of UC-eligible California public high school graduates of ethnicity e in 1998-1999. The height of each overlaying blue bar is the product of the black bar and the percent of 1998-1999 UC-eligible e UC applicants in that AI range admitted to at least one UC campus. The statistics in the bottom right sum the bars across all AI and report the sums as a share of all e UC applicants. 95-percent confidence intervals on the black bars from $\beta_{e,98-99,a}$ robust standard errors. Source: UC Corporate Student System and the California Department of Education.

209; and (2) URM high school graduates deterred from UC application by Prop 209. The next section quantifies the magnitude of this latter group.

4. APPLICATION DETERRENCE AND MODEL ROBUSTNESS

The primary potential threat to the presented research design is that Prop 209 may have dissuaded some URM high school graduates from sending an application to any UC campus – the main estimation sample – which could generate sample selection bias in the baseline difference-in-difference estimates (Long, 2004; Dickson, 2006; Yagan, 2016).[62] I quantify the magnitude of this potential bias by first estimating the number and character of 'missing' URM UC applications. I match the applicant data to the annual number of 1994-2001 "UC-eligible" graduates from each public California high school by gender and ethnicity – with UC eligibility indicating that they had satisfactorily completed accredited college-level coursework – and estimate models of the form:

$$\frac{A_{syea}}{UC_{sye}} = \sum_{e' \in \{A,B,H\}} \sum_{y' \in \{96,98,00\}} \beta_{e'y'a} \mathbf{1}_{e=e', y \in \{y', y'+1\}} + \zeta_{sea} + \eta_{sya} + \epsilon_{syea} \quad (2)$$

where A_{syea} is the number of UC-eligible UC applicants from school s in years $\{y, y+1\}$ of ethnicity e in *AI* range a, and UC_{sye} is the number of UC-eligible high school graduates in those years. ζ_{sea} and η_{sya} are school-ethnicity and school-year fixed effects. Years are grouped into four pairs, from 1994-95 to 2000-01; ethnicities are grouped into Asian, Black, Hispanic, and white; and *AI* bins are defined as 200-point bins from 4,000 to 8,000. I estimate Equation 2 by weighted least squares (weighting to the student level using UC_{sye}) separately for each a, and interpret β_{e98a} as the average change in the proportion of UC-eligible e high school graduates who applied to UC following Prop 209, implicitly assuming that the true distribution of *AI* across school-year-ethnicity cohorts remains unchanged over time.[63]

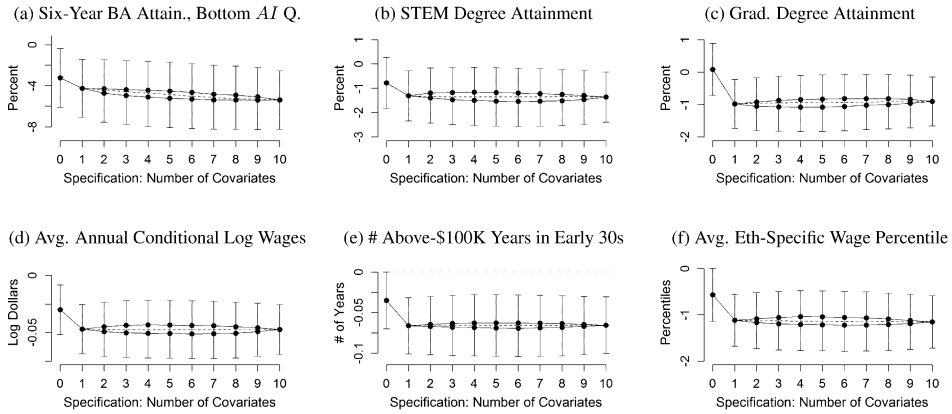
Figure 7 presents estimates of the Black and Hispanic $\beta_{e,98-99,a}$ coefficients from Equation 2 scaled by the average total number of *e* UC-eligible California high school graduates in the 1998-99 cohorts. The figure also shows the proportion of those applicants who would have likely been admitted to some UC campus had they applied, where admission is predicted solely by *e* and *AI*.[64] The figure shows that while some deterred Black and Hispanic high school graduates were unlikely to be admitted to any UC

[62] Card and Krueger (2005) use SAT "sends" (measured by College Board) as a proxy for university applications and present evidence that the decline in UC applications after 1998 was wholly driven by low-testing students unlikely to be qualified for UC admission. Online Appendix G.3 replicates their finding using College Board data and shows that replacing SAT "sends" with actual applications (observed by linking College Board and UC applicant records) reverses the conclusion; in fact, after Prop 209 many highly-qualified URM public high school graduates sent SAT scores to a UC campus but nevertheless did not apply.

[63] Table A-14 presents estimated coefficients for a specification of Equation 2 across all *AI*. It shows that URM application rates following Prop 209 declined by between 4 and 6 percent of all UC-eligible URM public high school graduates.

[64] That is, the blue bar is the product of the black bar and the proportion of 1998-99 URM UC applicants in bin *a* who were admitted to at least one campus. See Figure A-1 for evidence that *e* and *AI* were highly predictive of applicants' admission at most UC campuses, even after 1998. Not every UC-eligible applicant was admitted to a UC campus; many were rejected from each campus to which they applied, and even the least-selective Riverside campus rejected low-*AI* applicants with certain intended majors. Admit estimates implicitly assume that each UC applicant's admission is small relative to the size and composition of the applicant pool.

Figure 8: Alternative Covariate Specifications of URM UC Applicants' Post-1998 Estimated Outcomes



Note: Estimates of $\beta_{\cdot 98-99}$ from Equation 1, an OLS difference-in-difference model of the change in six '96-99 CA-resident freshman URM UC applicant outcomes after Prop 209 relative to non-URM applicants, with different specifications of the covariate matrix X_{iy}. Specification 0 sets X_{iy} to be null, while Specification 1 includes the components of UC's Academic Index (see footnote 44). Specifications 2-10 add additional sets of covariates progressively, presenting the highest and lowest $\beta_{\cdot 98-99}$ estimates from models including 1-9 additional sets of covariates, respectively: gender indicator, log family income, (7) highest parental education indicators, (289) parents' occupation indicators, high school GPA rank, number of 12th-grade honors courses, UC eligibility indicator, and Heckit control functions constructed using two estimates of p: $\frac{A_{s_i yea}}{UC_{s_i ye}}$ (see Equation 2) and the leave-one-out percent of UC-eligible graduates who applied to UC that year in i's school, gender, and ethnicity. For details on outcomes, see notes to Table 3 and 4. Panel (a) restricts the sample to the bottom AI quartile as measured among '96-97 URM UC applicants. Bars show the union of the robust 95 percent confidence intervals of the two presented estimates. Source: UC Corporate Student System, National Student Clearinghouse, and California Employment Development Department.

campus, there were also a large number of applicants certain to be admitted to some campus – indeed, very likely to be admitted to UC's more-selective campuses – who were deterred from UC application after Prop 209.[65] The sum across the scaled statistics suggests that the number of Black and Hispanic UC applicants declined by 12-13 percent (about 1,200 per year), most of whom would have likely been admitted to some UC campus.[66]

I test for the presence of sample selection bias in the baseline difference-in-difference estimates presented above by re-estimating the models with a series of additional covariates that could partially absorb remaining bias. First, I follow Card and Rothstein (2007) and construct a cross-school Heckit control function treating $p = \frac{A_{s_i yea}}{UC_{s_i ye}}$ as applicant *i*'s likelihood of applying to UC. I also construct an alternative Heckit function defining *p* by the leave-one-out percentage of UC-eligible high school graduates who applied to UC by an applicant's school, gender, and ethnicity.[67] In addition to the inverse mills ratios of these *p* statistics, I also accumulate a detailed set of applicant covariates excluded from the main specifications: gender, parental education, log family income, parental occupations, UC eligibility, high school GPA rank, and the number of enrolled 12th-grade honors courses.[68]

I conduct a Monte Carlo exercise randomly selecting sets of these additional covariates for model inclusion (following Card, Fenizia, and Silver (2018)) to test the presented estimates' sensitivity to alternative covariate specifications. In particular, I re-estimate Equation 1 specifying X_{iy} in the following ways: null (no covariates); including only the components of *AI* (as in the main specification); and then adding between one and nine additional sets of covariates, selecting those that lead to the largest and smallest estimates of β_{98-99}. The resulting estimates are shown in Figure 8 for four main outcomes.

[65] Table A-7 links these application declines to the *AI*- and campus-specific enrollment changes presented in Figure 3 to show that application deterrence caused a decline in URM UC enrollment by about 450 students, half from Berkeley and UCLA. Combined with the estimated enrollment decline among UC applicants, this implies that Prop 209 caused an annual decline in URM UC enrollment of about 800 students in 1998-99, or 14 percent. This closely matches the differently-calculated estimates of Bleemer (2019a).

[66] Figure A-11 presents additional specifications of Equation 2. It shows that URM students were particularly discouraged from applying to the Berkeley and UCLA campuses, and that UC-ineligible applicants were only slightly deterred by Prop 209. As a placebo test, it also shows that application rates among Asian students increased by less than two percent relative to white applications.

[67] As expected, including either of these *p* statistics as covariates in Equation 1 yields statistically-significant negative coefficients (implying negative selection out of UC application), while their inverse mills ratios yield significant positive coefficients.

[68] Rank is determined using UC GPA among UC applicants in that school-year. Parental education indicates the applicants' parents' highest education level (with seven codes); parental occupation indicates the parents' occupation set (with 17^2 codes). Covariates with missing values are included with missing value indicators.

While the *AI* components are important covariates for several outcome measures, likely absorbing substantive changes in the composition of UC applicants around 1998, there is no further combination of these highly-detailed control functions and covariates that meaningfully changes any of the β_{98-99} estimates, with the exception of the six-year degree attainment measure growing slightly more negative. These results show that the baseline estimates are highly insensitive to alternative model specifications. There are few remaining unobservables that could contribute to selection bias in this case – while applicants' academic, demographic, and socioeconomic status and cross-school application behavior are observed in detail, orthogonal dimensions of their high school leadership activities remain unobserved – and it appears very likely that the magnitude of remaining bias is small.

5. STEM COURSE PERFORMANCE AND PERSISTENCE

How did Prop 209 impact students' course enrollment and grades? Previous studies have hypothesized that students who attend more-selective universities as a result of affirmative action will earn lower grades and become less likely to persist in demanding courses, especially in STEM fields, than if they'd enrolled at a less-selective university with lower-testing peers.[69] However, no previous study has directly examined the impact of affirmative action on URM students' actual course performance and STEM course progression, instead focusing on overall grade point averages and major choice.[70] Complementing the previous section's finding that Prop 209 failed to increase URM UC applicants' likelihood of earning a STEM degree – indeed, it led to the opposite effect – I further test the "Science Mismatch Hypothesis" by estimating the impact of Prop 209 on URM UC enrollees' performance and persistence along introductory STEM course sequences.[71]

I observe detailed course enrollment records at five UC campuses, ranging from the most-selective Berkeley campus to the less-selective Riverside and Santa Cruz campuses. I employ these records using a difference-in-difference design to analyze how URM students' enrollment at less-selective UC campuses impacts their STEM course outcomes after Prop 209. In particular, I match core introductory STEM course sequences across these campuses – e.g., each campus's two-course introductory Physics sequence – and estimate models of students' performance and persistence along these sequences using an extension of the baseline difference-in-difference models estimated above:[72]

$$Y_{iysm} = \alpha_{h_i} + \delta_y + \left(\beta_0 + \beta_y\right) URM_i + \gamma X_{iy} + \epsilon_{iysm} \tag{3}$$

for student i from high school h_i in cohort y who takes course s in term m. I define three outcomes of interest for each completed course: the student's SAT percentile relative to their peers; the student's grade (GPA); and the student's persistence, defined as an indicator for whether they completed the subsequent course in the sequence (e.g. whether the student completed Chemistry 2 after completing Chemistry 1).[73] The model is stacked over s and estimated across courses, weighted evenly across students. Covariates X_{iy} include the components of *AI* as above. Standard errors are two-way clustered by student and course.

This definition of persistence mirrors the concept employed in the STEM Mismatch Hypothesis. Because the regression is weighted evenly across individuals, persistence can be heuristically understood as ranging from zero to 100 percent. A student whose only completed STEM course is Chemistry 1, without ever completing Chemistry 2, would have persistence of zero percent. A student who takes Chemistry 1, 2, and 3 but not 4 would have persistence 66.6 percent, since they persisted after two courses but not the third. A student who takes only all 3 Computer Science courses would have persistence of 100 percent. Statements of the STEM

[69] For example, Loury and Garman (1993) argue that "with higher required levels of performance and smaller offsetting increases in actual performance, blacks at more selective schools will have poorer grades, be less likely to graduate, and choose less lucrative majors than if they had attended less selective institutions." Recent scholarship has frequently proxied "lucrative majors" with the STEM major designation; Arcidiacono, Aucejo, and Hotz (2016), for example, notes that "STEM majors [earn] substantially more than other college degrees with the exception of perhaps business ... and the STEM premium has increased over time."

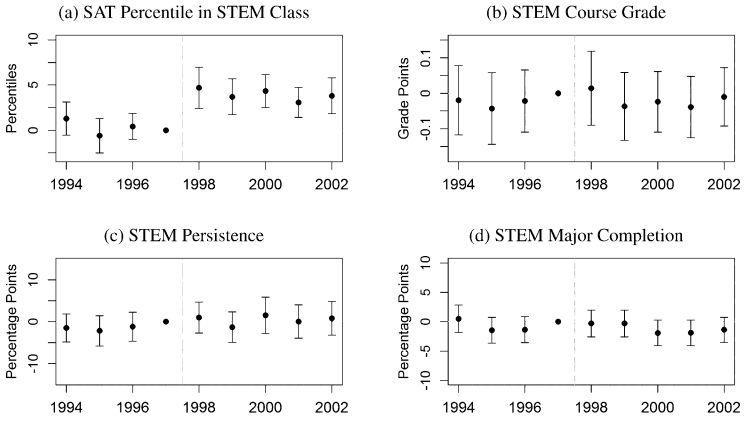
[70] Differences in overall GPAs are at least as likely to reflect differing grading standards across departments and between lower- and upper-division courses as they are to reflect student course performance (Arcidiacono, Aucejo, and Spenner, 2012; Bleemer and Mehta, 2020). Differences in major choice may reflect that students have different preferences across majors at more- or less-selective institutions in a manner unrelated to course performance.

[71] This is the Hypothesis as stated by Griffith (2010) and Arcidiacono, Aucejo, and Hotz (2016). Other studies have tested narrower versions of the Hypothesis, claiming that URM students admitted under affirmative action are lower-performing in STEM courses than their non-URM peers, unconditional (Loury and Garman, 1993; Holzer and Neumark, 2000; Fischer and Massey, 2007) or conditional on prior academic opportunity and preparedness (Rose, 2005). I further analyze these alternative Hypotheses by examining the course performance and persistence of UC Berkeley students before and after Prop 209 in Appendix C, finding little evidence to support either.

[72] Introductory STEM courses include four courses in Chemistry (two introductory, two organic), two in Biology, two in Physics, and three in Computer Science. In nearly all cases, each of these courses requires the previous course as a prerequisite. When universities on the quarter system include three courses along a sequence, I count the first and third course. Specific course details are provided in Appendix F. Estimates are largely insensitive to omitting students in Colleges of Engineering, who may face different incentives around completing STEM course sequences.

[73] Persistence is not defined for the final course in each sequence. Repeated course grades are omitted.

Figure 9: Difference-in-Difference Estimates of URM UC Enrollees' STEM Performance and Persistence



Note: Difference-in-difference WLS regression coefficient estimates of UCB, UCSB, UCD, UCSC, and UCR enrollees' introductory STEM course performance or persistence, differencing across URM status following Equation 3, relative to 1997. In Panels (a)-(c) each observation is a CA-resident freshman student-course pair in an introductory biology, chemistry, physics, or computer science course (see Appendix F) taken within 2.5 years of matriculation, stacking over courses and weighted evenly across observed students. SAT percentile is the fraction of other 1994-2002 freshman CA-resident peers who have lower SAT scores than the student; persistence indicates completing the subsequent course in the introductory STEM course sequence; and course grade is the grade points received in completed courses. In Panel (d) each observation is a student; the outcome indicates completing any UC STEM degree. Models include high school fixed effects, ethnicity indicators, and the components of UC's Academic Index (see footnote 44). UCSC is omitted from the GPA model because it did not mandate letter grades in the period. 95-percent confidence intervals are two-way clustered by student and course sequence level (e.g. second chemistry course). Source: UC Corporate Student System and UC-CHP Database (Bleemer, 2018b).

Mismatch Hypothesis claim that URM students admitted by affirmative action have lower STEM persistence than they would have had at less-selective universities.

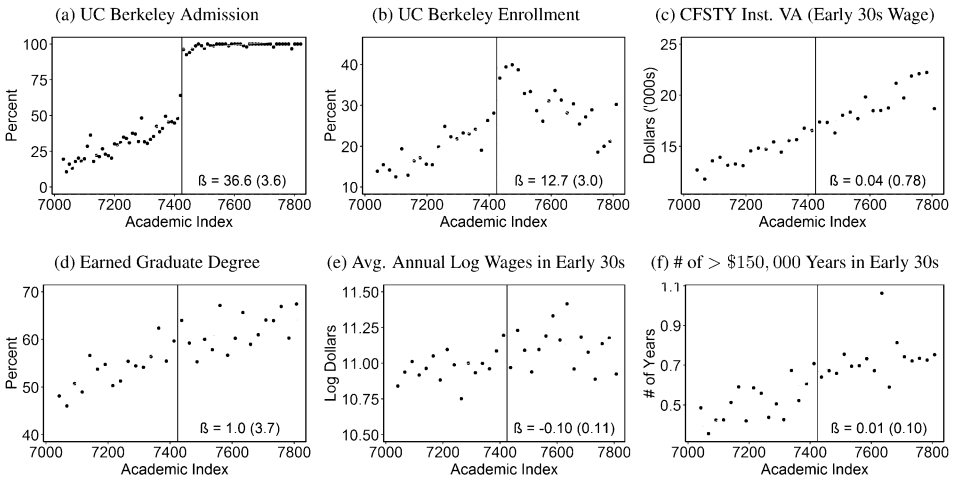
In the two years before Prop 209, URM UC enrollees earned lower average grades in introductory STEM courses by 0.36 GPA points and were less likely to persist along STEM course sequences by 9.3 percentage points.[74] These gaps are fully explained by URM enrollees' poorer prior academic opportunity and preparedness; their performance and persistence was indistinguishable from those of academically-comparable non-URM students across the five UC campuses. Relative to academically-comparable non-URM UC students, however, 1996-97 URM students were 7.3 percentiles lower in their classes' SAT distribution, largely reflecting their enrollment at relatively more-selective UC campuses. The first panel of Figure 9 shows that Prop 209 caused URM students to enroll in STEM courses in which their average SAT percentile was about four percentage points higher, closing that gap by more than half.

However, this increase in class rank did not translate into any observable improvement in those students' likelihood of STEM persistence or course grades. URM enrollees STEM performance and persistence were unchanged when their class rank improved; the 95 percent confidence interval around the estimated change in STEM persistence narrowly bounds 0, from -2.3 to 3.5 percentage points, small effects relative to the raw STEM persistence ethnicity gap of 11.2 percentage points before Prop 209.[75] Figure A-12 shows that Prop 209 similarly impacted Black and Hispanic UC enrollees' STEM persistence and performance outcomes.

I also estimate a difference-in-difference model of UC enrollees' likelihood of completing any STEM major (following Equation 1). URM UC enrollees' STEM major choice is precisely unchanged relative to academically-comparable non-URM enrollees after Prop 209, with a 95 percent confidence interval rejecting increases above 1.5 percentage points.[76] These findings suggest that selectivity differences between public research universities are at best a second-order determinant of URM students' persistence and performance in STEM courses, providing little support for the STEM Mismatch Hypothesis in this context. Instead, students' STEM performance, persistence, and degree attainment appear largely explained by compositional differences in prior academic opportunity and preparedness, which are determined before they arrive at university.

[74] See Table A-15, and Table A-16 for course-specific estimates.
[75] Grades may differ across classes as a result of grade inflation, but I cannot separately identify inflation from actual differences in mean cross-class performance differences. Estimates are similar relative to mean class wages or including class fixed effects.
[76] The overall decline in STEM attainment thus appears driven by students who exit these UC campuses following Prop 209.

Figure 10: Estimated Return to '96-97 UC Berkeley Enrollment for On-the-Margin Non-URM Applicants



Note: Regression discontinuity plots and estimates around the 1996-1997 UC Berkeley guaranteed admission AI threshold among non-URM applicants, estimated by local linear regression following Calonico, Cattaneo, and Titiunik (2014). See the notes to Tables 2, 3, and 4 for a description of the outcome variables; CFSTY Inst. VA measured relative to CSU Long Beach. Reduced form coefficients from local linear regressions (conditional on year), with bias-corrected robust standard errors in parentheses. Running variable defined as $AI + (70 \times \mathbb{1}_{1997})$ to align thresholds over years. Source: UC Corporate Student System, National Student Clearinghouse, and the CA Employment Development Department.

6. IMPACT OF PROP 209 ON NON-URM APPLICANT OUTCOMES

The difference-in-difference research design discussed above cannot separately identify the impact of Prop 209 on non-URM UC applicants, some of whom may have benefited from the policy change as a result of enrolling at more-selective universities. In this section, I employ an alternative research design to directly estimate the admissions return to UC Berkeley – UC's most selective campus, and the campus where URM applicants' relative admissions advantages were largest until Prop 209 – for the non-URM applicants who were on the Berkeley admissions margin in the years before Prop 209. These non-URM students were likely among those who would have most benefited from Prop 209, since many of them could have been admitted in the absence of Berkeley's affirmative action policy.

In 1996 and 1997 Berkeley guaranteed admission to applicants above an annually-determined *AI* threshold.[77] Admissions officers then admitted some lower-*AI* applicants based on other application characteristics. Figure 10(a) shows the admissions likelihood of 1996-97 non-URM Berkeley applicants at every *AI*, adding 70 points to 1996 applicants to align the two years' thresholds (7,360 and 7,430); admission was near-guaranteed above the threshold and provided to only half of slightly below-threshold applicants. Because applicants near Berkeley's admissions threshold are quasi-randomly located on one or the other side of the threshold, differentiated by small test score or grade differences, I interpret outcome differences on either side of the threshold as resulting from the above-threshold applicants' greater access to UC Berkeley.

I estimate the effects of UC Berkeley admission for on-the-margin non-URM 1996-97 applicants using local linear regression discontinuity models following Calonico, Cattaneo, and Titiunik (2014).[78] Figure 10(b) shows that the increased likelihood of Berkeley admission causes about one-third of newly-admitted on-the-margin non-URM students to enroll. However, those students would have otherwise enrolled at similar-value institutions on average; Panel (c) shows that the "CFSTY" wage value-added of

[77] See Figure A-2. Berkeley chose its annual threshold so that 50 percent of its admitted applicants had *AI* above the threshold. As a result, the threshold could not be chosen until after Berkeley observed all applicants' *AI*s, prohibiting applicants from manipulating their *AI* to exceed the threshold (as occurred at UC Davis, another institution with a contemporaneous admissions threshold). Admissions around the threshold was noisier in '94-95; see Figure G-1.

[78] Estimates are produced using the *rdrobust* package, version 0.99.8 (Calonico, Cattaneo, and Titiunik, 2015). Each plot visualizes the 6,086 '96-97 non-URM Berkeley applicants within 400 *AI* points of the threshold; regressions include a 1997 indicator covariate. The distribution of applicants is smooth across the threshold, with the McCrary (2008) test yielding a *p*-value of 0.58 at the threshold. Baseline characteristics are also smooth across the threshold. I predict annual log early-30s wages by gender-ethnicity indicators, log parental income, and parental education among 1996-97 freshman UC-eligible UC applicants – omitting in-sample applicants within 400 *AI* of the threshold – and find that crossing the threshold yields lower "predicted" income by 0.00027 log points, with standard error 0.018.

applicants' enrollment institutions is unimpacted at the threshold.[79] Most of the students would likely have otherwise enrolled at UCLA or UCSD (6.1 percentage points, s.e. 3.5) or out-of-state universities (8.0 percentage points, s.e. 3.4).

Panels (d) to (f) of Figure 10 show that graduate school enrollment, early-30s wages, and the number of years spent by each applicant in their early 30s earning over $150,000 per year are smooth across the Berkeley admissions threshold.[80] While the estimated standard errors cannot reject moderate returns to UC Berkeley admission, the observed effects suggest that on-the-margin non-URM students have access to alternative similar-value universities, and switching enrollment to UC Berkeley provides little measurable long-run economic return. If these estimated returns are externally valid for the non-URM students who crowded into more-selective UC campuses following Prop 209, this implies that non-URM students faced minimal costs from UC's affirmative action policy.

7. DISCUSSION: THE EFFICIENCY OF AFFIRMATIVE ACTION POLICIES

University affirmative action policies may have second-order causal effects on students whose admission was unrelated to those policies, such as through peer effects (Sacerdote, 2011) and the effect of campus diversity (Carrell, Rullerton, and West, 2009). Nevertheless, to a first approximation the efficiency of affirmative action policies is determined by the returns to more-selective university enrollment for two groups of students: the URM students targeted by the policy and the non-URM students who would have been admitted in the absence of affirmative action. At least two sets of efficiency conditions are available. In this context, Pareto efficiency requires that (1) URM student benefit from more-selective university enrollment but (2) on-the-margin non-URM students obtain no benefit from more-selective university enrollment. Kaldor-Hicks efficiency requires only that the economic benefits to URM students exceed the costs faced by non-URM students.

This study's baseline results show that banning affirmative action leads to large relative educational and labor market declines for URM university applicants. While Pareto efficiency is very unlikely in this context – even a single non-URM student benefiting from more-selective enrollment as a result of Prop 209 would prove the policy's inefficiency – three pieces of evidence suggest that the return to more-selective university enrollment is relatively smaller for the non-URM students who enroll at more-selective universities only absent affirmative action.

First, single-difference estimates of the baseline outcomes show that non-URM wage outcomes are notably smooth in the years before and after Prop 209, while URM wage outcomes sharply and persistently decline in 1998 (see Figure A-13). While this provides suggestive evidence of relatively small returns to more-selective UC enrollment for "crowding-in" non-URM students, the absence of a clearly unimpacted comparison group challenges the use of the difference-in-difference research design to distinguish non-URM student effects from ancillary economic trends. Second, the previous section shows little evidence that expanding on-the-margin non-URM students' access to UC Berkeley provides economic benefits to those students.

Third, consider a comparison between the change in URM students' early-30s wages and the change in the wage value-added of their enrollment institutions. While Prop 209 led URM students to enroll at universities with lower early-30s wage value-added by as much as $1,000, those students' actual early-30s annual wages fell by more than $2,000 (see Tables 2 and 4). Assuming that the presented value-added statistics either approximate or relatively overestimate the average difference in treatment effects of enrolling at those universities, this suggests that the wage effect of more-selective university enrollment for the students impacted by affirmative action is significantly larger than universities' average treatment effect.[81] While the local average wage treatment effect for "crowding-in" non-URM students remains unobserved, that effect is very likely to be lower than the sharply above-average effects for the URM students who benefited from affirmative action.[82]

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[79] See Table 2 for value-added definition. The estimated change in institutional six-year graduation rate across the threshold is -0.2 percentage points, with a 2.1 standard error. About nine percent of near-threshold students have no observed four-year enrollment, with only one percent enrolling at a community college but no four-year institution within six years.

[80] As above, "early 30s" is defined as 12-16 years after high school graduation, when most applicants are 30-34. There is no estimated change in likelihood of California employment across the Berkeley access threshold; despite their increased likelihood of out-of-state university enrollment, applicants' number of early-30s years employed in California *increases* by 0.14 years (s.e. 0.17). I use $150,000 as a threshold instead of $100,000 (as above) because of the strongly positively-selected sample, with one-third of in-sample applicants (within 400 *AI* of the threshold) earning over $100,000 in their early 30s. $150,000 is a better indicator of unusually high earnings, achieved in an average 0.60 out of 5 years for in-sample applicants.

[81] As discussed above, there is reason to believe that the presented value-added statistics remain somewhat biased by positive selection into more-selective universities, suggesting that they relatively overestimate differences between universities. Moreover, the VA estimates by quartile show that the VA wage estimates generally poorly match the observed effects of Prop 209, with the true impact more widely distributed across the *AI* distribution than the expected effects based on changes in VA. Figure A-14 visualizes these discrepancies, plotting smoothed (but not covariate-adjusted) difference-in-difference averages for both VA and actual degree attainment and early-30s wages. The two lines poorly mirror each other, suggesting both that VA poorly-explains and substantially underestimates the observed labor market effects of Prop 209.

[82] Table G-4 presents VA and observed degree attainment and early-30s wages for several VA specifications, aligning samples for missing data. In addition to confirming the discussion above, it shows that extending the "MH" approach to indicators for the set of *all* universities to which the

These three sets of evidence provide suggestive support for the Kaldor-Hicks efficiency of California's pre-1998 affirmative action policies.

8. CONCLUSION

The total enrollment of Black and Hispanic students at the University of California declined by about 800 students per year after 1998, when the university's eight undergraduate campuses all ceased implementing race-based affirmative action as a result of Proposition 209. URM UC applicants' university enrollment sharply shifted away from UC's more-selective Berkeley and UCLA campuses, causing a cascade of students to enroll at lower-quality public institutions and some private universities. Ending UC's affirmative action policies did not lead the university's URM applicants to earn higher grades in challenging courses, but it did cause them to become less likely to earn STEM degrees and any graduate degrees, and undergraduate degree attainment declined among lower-testing URM applicants. These poorer educational outcomes in turn contributed to a five percent average annual decline in applicants' wages throughout their 20s and early 30s, which resulted in a decline in the number of early-career URM Californians earning over $100,000 by at least three percent. Prop 209 also discouraged thousands of additional academically-competitive URM students from sending applications to public research universities in the first place. About 80 percent of URM UC applicants were Hispanic, and those applicants received the full observed wage benefits of UC affirmative action policies, Though Black UC applicants faced a decline in degree attainment after Prop 209, their early-career wages were not observably impacted.

Race-based affirmative action decreases non-URM student enrollment for each net additional URM student that it causes to enroll. However, diverse evidence suggest that those impacted non-URM students – whose more-selective university enrollment increased following Prop 209 – already had access to similar-quality universities even without broader UC admissions, and that their more-selective enrollment following Prop 209 had relatively small long-run effects on their economic outcomes. The targeted URM students, on the other hand, received substantially above-average wage returns to more-selective university enrollment under affirmative action, and thus faced disproportionate declines after Prop 209. White and Asian students were proportionally impacted by Prop 209, with no evidence of disparate impacts for one or the other.

These results strikingly differ from several existing estimates of the impact of affirmative action, even those focusing on Prop 209's effect at the University of California, and highlight the importance of high-quality and detailed administrative data and a transparent research design to account for sample selection and omitted variable bias. They also contextualize the impact of university affirmative action policies relative to other policies aiming to close opportunity gaps for low-income and Black and Hispanic youths. Some limitations remain. The presented estimates are reduced-form, averaging over many URM students who were likely unimpacted by the Prop 209 policy change, which means that they likely substantially underestimate the effect of Prop 209 on students whose enrollment was shifted by UC's policy change. They omit the impacts of Prop 209 on URM Californians dissuaded from UC application by Prop 209, who may also have previously benefited from UC affirmative action. The estimates also omit labor market outcomes for (endogenously-selected) non-Californian and self-employed workers. Nevertheless, this study documents the meaningful potential of affirmative action policies to promote economic mobility in the US – though perhaps not to close white-black mobility gaps – and the consequences of the policies' prohibition.

applicant applied (as proxied by SAT score sends) somewhat improves the associated wage VA estimates, while allowing gender- and ethnicity-specific VA coefficients (using the "CFSTY" approach) yields precise 0's for the wage VA estimates across all *AI* quartiles, implying particularly poor performance. Future analysis will evaluate the remaining selection bias in available value-added statistics.

Table 5: Difference-in-Difference Estimates of Post-1998 URM Admissions by UC Campus

Campus:	UCB	UCLA	UCSD	UCSB	UCI	UCD	UCSC	UCR	Total
URM	37.3	26.8	23.8	17.0	10.1	27.5	7.0	4.2	9.3
	(0.6)	(0.5)	(0.5)	(0.5)	(0.6)	(0.5)	(0.6)	(0.6)	(0.3)
URM ×	-24.5	-16.0	-18.7	-6.3	-3.1	-18.6	-5.8	-3.7	-7.9
Prop 209	(0.7)	(0.6)	(0.6)	(0.6)	(0.7)	(0.7)	(0.8)	(0.7)	(0.4)
$\bar{Y}$	32.3	35.1	51.8	65.2	65.8	70.1	81.8	85.0	82.3
Obs.	88,905	108,327	93,238	82,061	70,343	73,834	45,053	45,396	199,321

Note: OLS coefficient estimates of β_0 and $\beta_{\cdot 98-99}$ from Equation 1, a difference-in-difference model of 1996-1999 URM UC freshman California-resident applicants' UC admission compared to non-URM applicants after Prop 209. Models are conditioned on applying to that UC campus. Models include high school fixed effects and the components of UC's Academic Index (see footnote 44), and are estimated independently by campus or "Total" (all applicants to any UC campus). Robust standard errors in parentheses. Source: UC Corporate Student System.

APPENDICES

Appendix A: Public Universities Practicing Affirmative Action in 2020

Many public and private universities are non-transparent about their undergraduate admissions policies. However, most universities publish annual "Common Data Set" reports that provide a response to the question: What is the "relative importance of each of the following academic and nonacademic factors in first-time, first-year, degree-seeking (freshman) admission decisions: ... Racial/ethnic status: Very Important, Important, Considered, and Not Considered?"

The following is a list of states with public universities where race/ethnic status is at least considered in undergraduate admissions – according to their most recent common data set available in July 2020 – naming the university in parentheses if it differs from the state's flagship public university: CO, CT, DE, GA (Georgia Tech), IL, IN, LA (Grambling State), ME (University of Southern Maine), MD, MA, MI, NJ, NY, NC, OH, OR, PA, RI, SC, TN, TX, UT, VT, VI, and WI. The University of New Hampshire reports considering race in admissions but is prohibited by law from providing preference to applicants based on their race. The University of New Mexico does not report whether or not it considers race in admissions.

Appendix B: UC Admissions and Yield after Prop 209

Table 5 presents estimates of Equation 1's β_0 and β_{98-99} for admission to each UC campus, estimated on the 1996-99 sample of applicants to that campus. While URM applicants were 37 and 27 percentage points more likely than comparable non-URM applicants to be admitted to Berkeley and UCLA under AA, these advantages fell to 13 and 11 percentage points after Prop 209.[83] URM applicants faced similar-magnitude declines in their admissions likelihood at San Diego and Davis, and their admissions advantage fell at every campus. Among all applicants to any UC campus, URM applicants' admissions advantage over non-URM applicants (to be admitted to at least one campus) fell from 9.3 to 1.4 percentage points.

Table A-5 shows that *admitted* URM applicants became more likely to enroll at every UC campus after Prop 209, though URM applicants who were admitted to some UC campus became *less* likely to enroll at UC, a case of Simpson's Paradox reflecting the decline in the number of UC campuses to which URM applicants were admitted. Antonovics and Sander (2013) argue that this "warming effect" across UC campuses resulted from an increase in the signaling value of attending UC for URM applicants. As in that study, conditioning on the set of UC campuses to which applicants were admitted flips the sign of the UC-wide coefficient (to 2.8 percentage points); compared to academically-similar students admitted to the same UC campuses, post-1998 URM students are *more* likely to enroll at some UC campus. Admissions and enrollment statistics are slightly larger when estimated relative to the 1994-95 baseline; see Table A-17.

Appendix C: Course Performance and Persistence at Berkeley after Prop 209

Section 5 shows that the STEM performance and persistence of URM students across five UC campuses does not improve following Prop 209, despite those students' enrollment at less-selective campuses. Following previous literature, I also test whether the persistence and performance of URM students at UC Berkeley – the campus where Prop 209 most impacted URM students'

[83] Note that these models do not control for family income or other measures of pre-college opportunity likely correlated with URM status. Since those factors remained part of UC admissions, it is unsurprising that the presented models still identify advantages for URM applicants despite Prop 209.

Table 6: Difference-in-Difference Estimates of **Asian** UC Applicants' Post-1998 Enrollment

	UC Campuses by Selectivity				Comm.		CA	Non-CA	Not in
	Most	Middle	Least	CSU	Coll.	Ivy+	Priv.	Univ.	NSC
Asian	6.5	-1.7	-1.2	-2.0	2.2	0.8	-1.6	-3.6	0.6
	(0.3)	(0.3)	(0.2)	(0.3)	(0.2)	(0.1)	(0.2)	(0.2)	(0.2)
Asian ×	-0.2	0.1	1.5	-0.1	-1.1	0.0	-0.6	0.8	-0.5
Prop 209	(0.4)	(0.4)	(0.2)	(0.3)	(0.3)	(0.2)	(0.3)	(0.3)	(0.2)
$\bar{Y}$	22.6	20.6	6.4	12.7	11.4	2.8	8.8	9.1	5.9
Obs.	150,968	150,968	150,968	150,968	150,968	150,968	150,968	150,968	150,968

Note: Estimates of β_0 and $\beta_{\cdot 98-99}$ from Equation 1, an OLS difference-in-difference model of 1996-1999 Asian UC freshman California-resident applicants' enrollment outcomes compared to non-Asian outcomes after the 1998 end of UC's affirmative action program (restricting the sample to non-URM applicants). Outcomes defined as the first institution of enrollment by college or university type within six years of graduating high school, as measured in the NSC. Models include high school fixed effects and the components of UC's Academic Index (see footnote 44). Academic Index (AI) is defined in footnote 22; models by AI quartile are estimated independently, with quartiles defined by the AI distribution of 96-97 URM UC applicants. "Ivy+" universities include the Ivy League, MIT, Stanford, and the University of Chicago; private and non-CA universities exclude those institutions. Robust standard errors in parentheses. Source: UC Corporate Student System and National Student Clearinghouse.

likelihood of admission – improved after 1998, when Prop 209 caused a decline in the URM share of the student body by more than half. I restrict the sample to 1996-99 Berkeley students and estimate Equation 3 with and without academic covariates (α_{h_i} and X_{iy}). The last column of Table A-18 shows that before Prop 209, Berkeley's URM students earned lower average grades by 0.77 grade points and were 19 percentage points less likely to persist along STEM course sequences. These gaps are broadly present across most introductory STEM courses. If admissions mismatch is a primary cause of these large ethnicity gaps, then Prop 209 would be expected to sharply narrow them. In fact, Prop 209 does lead Berkeley's (higher-testing) URM students to earn slightly higher STEM grades (by 0.14 grade points), but if anything their STEM persistence slightly declined.

Panel B of Table A-18 adds academic covariates and shows that, as was the case across the five UC campuses, cross-high-school and *AI* differences wholly explain URM students' low persistence and performance before Prop 209; in the period when Berkeley was implementing affirmative action, URM students earned similar grades and were (if anything) *more* likely to persist in some of Berkeley's STEM fields than their academically-comparable non-URM peers. Unlike at those other campuses, however, ending affirmative action led to substantial relative *declines* in URM students' persistence and performance across most STEM courses. Why would URM Berkeley students' relative STEM performance and persistence *decline* after Prop 209, instead of remaining steady as it did across the UC system? Table A-19 shows that the effects of Prop 209 on URM persistence were tightly-estimated 0's at the other four other observed UC campuses. One hypothesis is that Berkeley's post-209 "holistic review" admissions policy inefficiently targeted underperforming students as a result of its inability to provide direct race-based admissions advantages (Chan and Eyster, 2003; Fryer, Loury, and Yuret, 2008). Under that hypothesis, the decline would likely be (partly) absorbed by family background covariates like parental income, education, and occupation; however, adding those covariates does not change the estimated coefficient. An alternative hypothesis is that SAT scores are relatively negatively-biased measures of low-testing URM students' academic preparedness, such that Berkeley's selection away from those students causes a decline in URM enrollees' relative overperformance (Vars and Bowen, 1998; Niu and Tienda, 2010). This hypothesis is supported by the finding that the relative decline in URM performance is driven by URM students in the bottom two terciles of SAT scores, with no observed declines among high- or low-GPA high-SAT students (see Table A-19). However, the question remains open for future research.

Appendix D: Differential Impact of Prop 209 on Asian UC Applicants

The baseline difference-in-difference analysis in the main text does not differentiate between groups of non-URM UC applicants, but there is some speculation that affirmative action policies differentially impact Asian applicants relative to white applicants (Arcidiacono, Kinsler, and Ransom, 2020). I test for heterogeneity in Prop 209's effect on non-URM students by restricting the UC applicant sample to non-URM students and re-estimating versions of Equation 1 with Asian students as the treated group (replacing URM).[84] Table 6 presents estimates of Prop 209's effect on Asian students' enrollment institutions. The coefficients on Asian students' enrollment at more-selective and selective UC campuses are precisely-estimated zeroes: Ending UC's affirmative action program did not lead to an increase in Asian UC applicants' enrollment at those campuses. There is a small measurable enrollment shift from community and private California colleges into non-California universities and the less-selective UC campuses, though

[84] Table A-3 presents descriptive statistics for white and Asian UC applicants before and after Prop 209, with both showing similar admissions trends after 1998.

the effects' magnitudes are a small fraction of those observed for URM students. Figure A-15 shows that Prop 209 also caused no estimable change in Asian applicants' longer-run wage outcomes relative to other non-URM applicants. I conclude that there is little reason to treat white and Asian applicants as having been differently-treated by Prop 209, conditional on prior academic opportunities and preparation as measured by the components of *AI*.

Appendix E: Data Quality

E.1 Applicants who Decline to Report Ethnicity

The percent of UC applicants who declined to report ethnicity on their application increased from 4.1 percent in 1996-97 to 10.5 percent in 1998-99, potentially challenging the identification of URM applicants.[85] To identify the ethnicity of missing-ethnicity applicants, I estimate a multinomial logistic regression of ethnicity (Asian, Black, Hispanic, and white) on the leave-one-out ethnicity shares of each known-ethnicity applicant for applicants' first name, middle name, last name, high school, zip code, and Census Block, holding out a randomly-selected 10 percent of applicants. I then predict each missing-ethnicity applicant's likelihood of being each ethnicity, classifying them if their estimated likelihood of being that ethnicity exceeds 75 percent.[86]

In 1996-97, I find that among the 88 percent of missing-ethnicity applicants whose ethnicity can be classified, 68 percent are white, 29 percent are Asian, 2.5 percent are Hispanic, and 0.6 percent are Black. The URM shares are hardly higher in 1998-99; of the 87 percent classified, whites and Asians make up 65 and 29 percent, while Hispanics and Blacks make up 4.2 and 1.3 percent. These results justify the assumption in the baseline analysis that missing-ethnicity applicants are non-URM. No presented result changes statistically or qualitatively if predicted-URM applicants are re-assigned as URM.

E.2 National Student Clearinghouse Coverage

Dynarski, Hemelt, and Hyman (2015) show that national NSC enrollment coverage at four-year institutions was below 50 percent in 1996, rising to over 80 percent by 2000.[87] Coverage at the somewhat-selective institutions at which UC applicants tended to enroll was substantially higher. Appendix A in Bleemer (2018a) shows that while some California community colleges were not reporting enrollment statistics to NSC by the mid-1990s, only a small number of universities may not have been reporting graduation statistics by 1999 (the earliest year that 1996 applicants could plausibly earn a four-year degree), the largest of which was 2,100-student adult-education-oriented Brandman University. The same trend likely holds for other states; Table A-6 shows that only 6.2 percent of the baseline sample did not have observed enrollment in NSC, some of whom likely enrolled at community colleges before the colleges' NSC participation (and others who actually choose against postsecondary enrollment).

A comparison between UC and NSC graduation records suggests that only UC Santa Cruz failed to report a substantial number of earned degrees among the late 1990s graduation cohorts, while a comparison between NSC and UC major reporting (measured by which students earned STEM degrees) shows that NSC routinely captures more than 90 percent of STEM degree attainment at all campuses throughout the period (conditional on degree reporting in both data sets). The six-year graduation and STEM major choice estimates presented in Panel A of Table 3 are robust when restricted to NSC records only or to NSC records augmented by only UCSC degrees (see Table A-10). As a result, differential NSC non-reporting by URM applicants is unlikely to explain the observed degree attainment patterns. Moreover, this concern does not extend to the graduate degree estimates; most such degrees are not earned at the same institutions where applicants earned their undergraduate degrees, and NSC coverage was very wide by the time applicants in the sample were earning graduate degrees.

Appendix F: Introductory STEM Courses at UC Campuses

Section 5 estimates changes in URM UC students' persistence and performance in introductory STEM courses after Prop 209. I identify those introductory courses – four courses in Chemistry (two introductory, two organic), two in Biology, two in Physics, and

[85] Throughout this study, applicants are categorized as "Black" if they self-report their ethnicity as "Black/African American"; as "Hispanic" if they self-report as "Chicano/Mexican-American" or "Latino/Other Spanish-American"; and as "Asian" if they self-report their ethnicity as "Chinese/Chinese-American," "East Indian/Pakistani," "Japanese/Japanese-American," "Korean," "Pilipino/Filipino," "Thai/Other Asian," or "Vietnamese."

[86] Types 1 and 2 error by ethnicity, measured using the 10 percent of hold-outs, are: 13.2 percent and 15.2 percent (white), 3.9 percent and 12.4 percent (Asian), 0.3 percent and 55.5 percent (Black), and 1.2 percent and 27 percent (Hispanic). I replace non-reported ethnicity with predicted ethnicities in Figures 4(f) and 7 to avoid dropping data.

[87] NSC reports that about four percent of records are censored due to student- or institution-requested blocks for privacy concerns, and that the only public university in California with censorship greater than 10 percent is UC Berkeley (National Student Clearinghouse Research Center, 2017).

three in Computer Science – using contemporaneous course catalogs and the student transcript data.[88] I chose these fields because they are uniformly available across campuses, offer similarly-structured introductory course sequences, and are not generally required for non-STEM majors (like Mathematics and Statistics, in which many non-STEM fields often require partial course sequence completion). Some schools had multiple versions of a given introductory course, all of which are included in the analysis. Where schools on quarter systems required three courses in a sequence instead of two, I define the sequence by its first and third courses. Here is the full list:

- Intro. Chem.: UCB CHEM 1A/B, UCD CHEM 2A/C, UCR CHEM 1A/B, UCSC CHEM 1B/C, UCSB CHEM 1A/B
- Organic Chem.: UCB CHEM 3A/B or 112A/B, UCD CHEM 8A/B or 118A/B, UCR CHEM 112A/B, UCSC CHEM 108A/B or 112A/B, UCSB CHEM 6A/B or 107A/B
- Biology: UCB BIO 1B/A, UCD BIO 1A/C, UCR BIO 5A/C, UCSC BIOL 10-12 or 20A/C, UCSB MCDB/EECB/BIOL 1A/4A/5A and 1C/4C/5C/2
- Physics: UCB PHYSICS 8A/B, UCD PHYSICS 1A/B or 5A/C or 7A/C or 9A/C, PHYSICS PHYS 2A/C, UCSC PHYS 5A/C or 6A/C or 7A/B, UCSB PHYS 6A/C
- Computer Science: UCB COMPSCI 61A/B/C, UCD ECOMPSCI 20-or-30/40/50, UCR EEC 10/12/14, UCSC CMPS 12A/B/C-or-101, UCSB CMPSC 10/20/30

Berkeley allowed students to take BIO 1A before BIO 1B, but only 25 percent of students did so. Berkeley also allowed many students to skip CHEM 1B; persistence to CHEM 1B is defined to include students who complete CHEM 3A or 12A.

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