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Peter Arcidiacono
Esteban Aucejo
Patrick Coate
V. Joseph Hotz

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ABSTRACT

Proposition 209 banned the use of racial preferences in admissions at public colleges in California. We analyze unique data for all applicants and enrollees within the University of California (UC) system before and after Prop 209. After Prop 209, graduation rates increased by 4.4%. We present evidence that certain institutions are better at graduating more-prepared students while other institutions are better at graduating less-prepared students and that these matching effects are particularly important for the bottom tail of the qualification distribution. We find that Prop 209 led to a more efficient sorting of minority students, explaining 18% of the graduation rate increase in our preferred specification. Further, universities appear to have responded to Prop 209 by investing more in their students, explaining between 23-64% of the graduation rate increase.

Peter Arcidiacono
Department of Economics
201A Social Sciences Building
Duke University
Durham, NC 27708
and NBER
psarcidi@econ.duke.edu

Esteban Aucejo
Department of Economics
London School of Economics and Political Science
Houghton Street, London, WC2A 2AE
CEP, Office 2.29
United Kingdom
E.M.Aucejo@lse.ac.uk

Patrick Coate
Box 90097
Duke University
Durham, NC 27708
patrick.coate@duke.edu

V. Joseph Hotz
Department of Economics
Box 90097
Duke University
Durham, NC 27708-0097
and NBER
hotz@econ.duke.edu

1 Introduction

The U.S. Supreme Court is set to yet again rule on the constitutionality of race-based preferences (affirmative action) in university admissions in *Shuette v. Coalition.*[1] One of the arguments opponents of affirmative action have advanced is that affirmative action actually hurts the individuals it is supposed to help – the *mismatch hypothesis*. According to the mismatch hypothesis, affirmative action in admissions actually results in worse outcomes for minority students as students admitted under affirmative action are attending schools where the curriculum is designed for students with significantly stronger credentials.[2]

In this paper we examine the mismatch hypothesis in the context of college graduation rates. As documented in Turner (2004), Bound and Turner (2007, 2011), and Bound, Lovenheim and Turner (2010), while the number of students attending college has increased over the past three decades in the U.S., college graduation rates (i.e., the fraction of college enrollees that graduate) and college attainment rates (i.e., the fraction of the population with a college degree) have hardly changed since 1970 and the time it takes college students to complete a baccalaureate (BA) degree has increased (Bound, Lovenheim and Turner, 2012). The disparities between the trends in college attendance and completion or time-to-completion of college degrees is all the more stark given that the earnings premium for a college degree relative to a high school degree nearly doubled over this same period (Goldin and Katz, 2008).

We examine differences in graduation rates and the academic preparation of minority and non-minority students attending the various UC campuses between the years 1995-2000, using a unique source of student-level data that covers the universe of students who applied to one or more of the UC campuses. We obtained these data from the University of California Office of the President, the administrative offices of the entire UC system and refer to them as the "UCOP" data. The UCOP data cover a period where race-based preferences were banned in California. In 1996, the voters of California approved Proposition 209 – Prop 209 hereafter – which stipulates that: "The state shall not discriminate against, or grant preferential treatment to, any individual or group on the basis of race, sex, color, ethnicity, or national origin in the

[1] This case follows the recent Supreme Court ruling in *Fisher v. University of Texas* which made clear that the use of race in college admissions is restricted in remitting the case back to the appellate court.

[2] See the debate over mismatch effects in law schools in Sander (2004, 2005a, 2005b), Ayres and Brooks (2005), Ho (2005), Chambers et. al. (2005), Barnes (2007) and Rothstein and Yoon (2008).

operation of public employment, public education, or public contracting." The Proposition took effect in 1998.

Using these student-level data, we find evidence that the graduation rates of minorities increased after Prop 209 was implemented. Indeed, the data reveal that under-represented minorities were 4.4 percentage points more likely to graduate in the period after Prop 209 that the period before.[3] We also find that the distribution of minorities entering the UC system shifted from its more selective campuses (e.g., UC Berkeley and UCLA) towards its less selective ones. Moreover, while there was an overall improvement in the academic preparation of minorities enrolling at UC campuses after Prop 209 went into effect, the greatest improvements occurred at the less-selective campuses. Taken together, this evidence may be consistent with the mismatch hypothesis noted above.

As we argue below, the scope for the mismatch of students to campuses with affirmative action and its alleviation with bans on its use hinges on whether some campuses, presumably less-selective ones, are better-suited to produce positive outcomes, e.g., graduation rates, for less-prepared students while other universities, typically more-selective ones, are better-suited for more-prepared students. In contrast, if more-selective universities were able to produce better outcomes, such as graduation rates, for students of all levels of preparation than less-selective ones, then there is no scope for student-university mismatch. Bans on affirmative action would not be expected to improve the graduation rates of minority students, especially those with weaker backgrounds. We formalize these arguments below, characterizing and estimating graduation production functions for each of the UC campuses and examining whether and how they differ across campuses.

The student-level UCOP data we examine also reveal that after Prop 209 there was a decline in the number of under-represented minorities enrolled at one of the UC campus. And, if the minority students who did not attend a UC campus after Prop 209 were the least prepared, then graduation rates would have likely risen, regardless of the campus they would have attended. That is, Prop 209 may have induced a significant *selection effect* on minority enrollments within the UC system that would provide an alternative explanation to mismatch for why minority graduation rates improved.

[3]Based on five-year graduation rates. We use five-year graduation rates throughout our analysis.

To separate mismatch and selection explanations for the post-Prop 209 minority graduation rate increases, we exploit the richness of the UCOP data on cohorts of students that entered the UC system before and after Prop 209. These data contain measures of high school GPAs and SAT scores and of parental income and education, which allow us to both control for these factors in evaluating the effects of Prop 209 and assess how they influence minority (and non-minority) graduation probabilities at the various UC campuses. The UCOP data provide information not only on which UC campus a student enrolled (as well as whether they graduated from that campus), but also on the other UC campuses to which they applied and the ones to which they were admitted. We use the information on the UC campuses to which students were admitted, and the quality of those UC campuses, to implement a modified version of the method used in Dale and Krueger (2002) to control for student qualifications beyond those measured by high school GPA and test scores.

We decompose the post-Prop 209 change in minority graduation rates into three components: better matching, better students, and a third, residual, category of post-Prop 209 change in graduation rates not accounted for by the matching or selection. We refer to the latter (residual) component as the *university response* to the Prop 209 affirmative action ban.

We find that better matching explains around 18% of the improvement in minority graduation rates within the UC system. However, this small overall effect masks two notable phenomena with respect to the potential role of matching. First, we find that matching is much more important in accounting for the graduation gains of students in the bottom of the academic preparedness distribution; moreover, it would have been even larger had minorities been allocated to universities in the same way whites were allocated conditional on academic preparation. Second, as we discuss in the Conclusion, Arcidiacono, Aucejo and Hotz (2012) find that improved matching played a much more prominent role in improved graduation rates of minorities who initially enrolled at UC campuses in STEM (Science, Technology and Engineering) majors, especially in the higher rates that minorities who started in STEM majors actually graduated with a STEM degree.

We attribute 23-64% of the minority graduation gains to universities responding by either investing more in their students or easing requirements. These graduation gains cannot be explained either by selection or by matching. We present anecdotal evidence that suggest that universities did indeed respond to Prop 209 by focusing more resources on the retention of their enrolled students, increasing their graduation rates. That such a large share of the gains in graduation result from responses to UC campuses suggests that potential negative effects on minorities from the removal of affirmative action may be over-stated in one important respect: universities may respond to decreased diversity by investing more in the minorities and other students from disadvantaged backgrounds who do enroll.

Finally, the remaining 18-59% of the minority graduation rate increase is due to changes in student characteristics, both observed and unobserved, of those enrolled in the UC system after Prop 209. But the changes in the characteristics of minority enrollees post-209 are not all in the same direction. While some measures of preparation were higher in the post Prop 209 period (high school grades and SAT scores) other measures actually fell (parental income and parental education). Hence, the pool of minority enrollees actually became more diverse from a socioeconomic perspective.[4]

The remainder of the paper is organized as follows. In Section 2 we describe the UCOP data and present the unadjusted levels and post-Prop 209 changes in minority and white student enrollments, measures of their academic preparation and their graduation rates. In Section 3 we examine how much of the increased graduation rates for the UC system as a whole remain after accounting for changes in observables. After showing that a substantial portion of the graduation gap is unexplained, in Section 4 we characterize the mismatch hypothesis and establish the conditions it requires in terms of the differences across colleges in their capacity to produce graduates with disparate academic preparation. In Section 5 we develop and estimate a model of college graduation that embeds campus-specific graduation production functions that depend on student preparation using only data in the pre-Prop 209 period. The estimates in Section 5 serve as one of the inputs of the decomposition of the changes in graduation rates after Proposition 209. Section 6 decomposes the increased graduation rates following Prop 209, focusing in particular on the roles of better matching, university responses to Proposition 209, and changes in the selection of students who enrolled in the UC system. Section 7 concludes.

[4]This may be a result of the UC system placing more weight on characteristics correlated with race after Prop 209 since they could not explicitly take race into account. See Antonovics and Backes (2013b) for a discussion.

2 Graduation Patterns in the UC System Before and After Prop 209

The data we use were obtained from the University of California Office of the President (UCOP) under a California Public Records Act request. These data contain information on applicants, enrollees and graduates of the UC system. Due to confidentiality concerns, some individual-level information was suppressed. In particular, the UCOP data we were provided have the following limitations:[5]

1. The data are aggregated into three year intervals from 1992-2006.
2. The data provide no information on gender, and race is aggregated into four categories: white, Asian, minority, and other
3. Academic data, such as SAT scores and high school grade point average (GPA), were only provided as categorical variables, rather than the actual scores and GPAs.

Weighed against these limitations is having access to two important pieces of information about the individuals who applied to and possibly enrolled at a UC campus. First, we have information on every individual who applied to any of the schools in the UC system over the period, including to which campuses they applied and were admitted. As described below, we use the latter information to adapt a strategy used in Dale and Krueger (2002) in order to account for unmeasured student qualifications. Second, we were provided with access to an index of each student's preparation for college, given by the sum of a student's SAT I score, rescaled to be between 0 to 600, and his or her high school GPA, rescaled to be between 0 to 400. Below, we refer to this as a student's high school *Academic Index*. We have data for the entering cohorts in the three years prior to the implementation of Prop 209 (1995, 1996, 1997), and for three years after its passage (1998, 1999, 2000).

In Table 1, we present summary statistics for the individual-level UCOP data and its measures of student qualifications by race and for applicants, admits, enrollees and graduates for campuses in the UC system, pre- and post-Prop 209.[6] The first panel gives the descriptive statistics for under-represented minorities (URMs). As a fraction of the number of minority graduates

[5]See Antonovics and Sander (2013) for a more detailed discussion of this data set.

[6]The corresponding data for Asian American and Other Races (including un-reported) are given in Table 10 in the appendix.

from California's public high schools,[7] enrollment rates fell from 4.6% to 3.6%. Conditional on enrolling, minority graduation rates increased by 4.4% off a base rate of 62.4% post-Prop 209.[8] While the share of white high school graduates who applied, attended, and graduated in the UC system all did not significantly change post-Prop 209 (second panel), graduation rates conditional on enrolling also showed a significant increase at 2.5%.

With respect to applications at UC campuses before and after Prop 209, while applications by URMs increased, as a share of California public high school graduates, they declined 1.1%. The latter decline suggests the possibility of a chilling effect of Prop 209, where minorities are less likely to apply under the new admissions rules. However, other evidence suggests otherwise. For example, using the same UCOP data as used in this paper, Antonovics and Sander (2013) argue that affirmative resulted in a warming, rather than a chilling, effect, in that minorities, as a group, were more likely to enroll in the UC school conditional on being admitted and Antonovics and Backes (2013a) show that the sending of SAT scores by minority applicants to UC campuses did not change post-Prop 209.

With respect to academic preparation as measured by the student's academic index, minorities had much lower scores at each stage of the college process than whites both prior to and after Prop 209 was implemented (Table 1). This difference in academic preparation accounts, in part, for the lower proportion of minority high school students being admitted to a UC campus ("Share of Calif. HS Grads") compared to whites. However, after Prop 209 is implemented, the academic preparation of minority applicants, admits, enrollees, and graduates improved, both absolutely and relative to whites. This improvement in academic preparation of the minority students that enrolled at a UC campus after Prop 209 suggests that changes in minority student *selectivity* with respect to academic preparation noted in the Introduction may have accounted for some, if not all, of the improved graduation rates of minorities after the implementation of Prop 209.

[7]The number of California public high school graduates by race and year is given at http://www.cpec.ca.gov/StudentData/StudentSnapshot.ASP?DataReport=KGrads. The number of California applicants by race and year can be found at http://statfinder.ucop.edu. While not all of the minorities applying, enrolling, or graduating from UC campuses are from California's public high schools, a large fraction are and we use this benchmark to account for the trends in the numbers of minorities at risk to go to college.

[8]Graduation rates are measured as graduating in 5 years or less. There are a small number of individuals that are listed as graduating but do not have a graduation time. In the period we analyze, these individuals are almost exclusively listed as having a major classified as 'Other'. We drop these individuals from our sample though our qualitative results are unaffected by the treatment of these individuals.

Table 1: Characteristics of UC Applicants, Admits, and Enrollees by Race, Pre-Prop 209 and Change Post Prop 209[†]

	Applied		Admitted		Enrolled		Graduated	
	Pre-Prop 209	Change	Pre-Prop 209	Change	Pre-Prop 209	Change	Pre-Prop 209	Change
Under-represented Minorities:								
No. of Minorities	31,002	2,493	24,352	-472	13,291	-714	8,205	91
High School Acad. Index	619.7	14.7***	645.7	17.2***	641.5	15.6***	653.7	12.4***
Parents have BA	0.369	0.004	0.381	-0.014***	0.385	-0.039***	0.417	-0.046***
Parents' Income $\leq$ $30K	0.379	-0.019***	0.364	-0.008*	0.364	0.008	0.334	0.012
Parents' Income $\geq$ $80K	0.195	0.015***	0.203	0.009**	0.211	-0.010*	0.238	-0.018***
Graduation Rate							0.624	0.044***
Share of Calif. Public HS Grads	0.107	-0.011***	0.084	-0.016***	0.046	-0.010***	0.028	-0.005*
Whites:								
No. of Whites	67,986	8,217	54,571	4,398	27,652	1,937	20,791	2,210
High School Acad. Index	710.4	11.1***	729.8	8.8***	722.6	13.3***	730.7	12.4***
Parents have BA	0.801	-0.002	0.813	-0.010***	0.805	-0.008**	0.822	-0.008**
Parents' Income $\leq$ $30K	0.103	-0.008***	0.101	-0.006***	0.109	-0.006***	0.100	-0.006*
Parents' Income $\geq$ $80K	0.528	0.019***	0.533	0.013***	0.525	0.015***	0.540	0.016***
Graduation Rate							0.769	0.025***
Share of Calif. Public HS Grads	0.187	0.003	0.150	-0.003	0.076	-0.002	0.057	0.000

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

Data Source: UCOP individual data, Pre-Prop 209 (1995-97); Post-Prop 209 (1998-2000).

Variables: *No. of Observations* is the total number of students who engaged in activity indicated in column heading; *No. of Obs./No. of HS Grads* is ratio of a column's No. of Observations to the number of public high school graduates per year in California; *Graduation Rate* is share of enrolled students that graduated in 5 years or less; *High School Acad. Index* is sum of re-scaled student's SAT I score (0 to 600 scale) plus re-scaled student's UC-adjusted high school GPA (0 to 400 scale); *Parents have BA* is indicator variable of whether student has at least one parent with Bachelor Degree or more; *Parents' Income $\leq$ $30K* is indicator variable for whether parents' annual income is $\leq$ $30,000, where Pre-Prop 209 income are inflation-adjusted to Post-Prop 209 levels; *Parents' Income $\geq$ $80K* is corresponding variable whether parents' annual income is $\geq$ $80,000; and where *Graduated* denotes those who graduated in 5 years or less.

Totals in each category include occasional cases with missing data; when calculating average sample characteristics, individuals missing that data are dropped. This includes enrollees with missing graduation information, so Graduation Rate is not identical to graduates/enrollees

[†] Descriptive statistics for Asian Americans and Others (including Unknowns) are omitted from table, but are available in the appendix.

But, the change in the selectivity of enrolled minority students with Prop 209 may not have improved uniformly. As shown in Table 1, there was a significant and sizable decline in the proportion of minority enrollees and graduates from more "advantaged" family backgrounds after Prop 209 went into effect. Among admitted minorities who actually enrolled at a UC campus, there was an 0.039 reduction (a 10% decline) in the proportion with parents who had a BA degree and a corresponding 0.046 reduction (an 11% decline) among those minorities that graduated from a UC campus after Prop 209 was implemented. Similarly, post-Prop 209 a greater share of applicants and admits had parents with incomes above $80,000. Yet, the share of enrollees whose parental income was greater that $80,000 *fell*. That is, while minorities from more advantaged family backgrounds continued to apply and be admitted to UC campuses after Prop 209 (though the set of UC campuses where they were admitted may have changed), they were less likely to enroll at one of the campuses and less likely to graduate from one of them.[9] This decline in minority students from more advantaged backgrounds that enrolled at UC campuses after Prop 209 would seem to work against improved graduation rates, given previous findings that students from wealthier and better educated parents do better in college.[10]

We next consider how graduation rates and academic preparation varied across UC campuses before and after Prop 209. Table 2 gives the distribution of both for minorities and whites, respectively. The campuses are listed in order of their overall academic index which roughly corresponds to their *U.S. News & World Report* ranking as of the fall of 1997.[11] We use this ranking throughout our study as our measure of the selectivity and/or quality of the UC campuses. Focusing initially on the pre-Prop 209 tabulations, one sees that the academic index and graduation rates are systematically related to the rankings of UC campuses, with more-selective campuses having students that are better prepared and more likely to graduate. This is true for minorities and for whites. And, consistent with the tabulations in Table 1, whites have higher academic indices and graduation rates than do minorities, a pattern that

[9] We are unable to determine whether, after Prop 209, these more advantaged minorities who applied and were accepted to a UC campus went to colleges not subject to Prop 209, i.e., private colleges in California or public or private colleges outside of the state. But we doubt that they disproportionately ended up at less-selective public colleges in the state, i.e., at CSU campuses or one of California's community colleges, or not attending college.

[10] For example, Turner (2005) finds that students of mothers with a college degree have a 14 percentage point higher probability of attaining a BA degree than do students whose mothers do not.

[11] The 1997 *U.S. News & World Report* rankings of National Universities are based on 1996-97 data, the academic year before Prop 209 went into effect. The rankings of the various campuses were: UC Berkeley (27); UCLA (31); UC San Diego (34); UC Irvine (37); UC Davis (40); UC Santa Barbara (47); UC Santa Cruz (NR); and UC Riverside (NR). The one exception is that we rank UC Davis ahead of UC Irvine. The academic index is significantly higher for UC Davis and students who are admitted to both schools and attend one of them are more likely to choose UC Davis. See Table 4.

holds campus-by-campus.

The *changes* in student preparedness and graduation rates post-Prop 209 are not ordered according to the selectivity of the various campuses (Table 2). For example, UC Santa Barbara had the largest post-Prop 209 improvements in student academic preparedness and graduation rates, even though it ranked sixth out of the eight UC campuses in the *U.S. News & World Report* rankings. Furthermore, UC Berkeley and UC Riverside, which were the top and bottom ranked UC campuses, were both in the bottom third of post-Prop 209 gains in minority academic preparedness and graduation rates.

Taken together, the across-campus changes that occur in minority graduation rates and the academic preparation of those minorities that do enroll is potentially consistent with the view that the Prop 209 ban of affirmative action resulted in minority students being *better matched* to campuses based on their academic preparation. But as noted earlier, this improvement also may be consistent with greater selectivity in UC minority enrollments post-Prop 209.

3 Adjusting Graduation Gains for Changes in Observables

In the period after Proposition 209 graduation rates increased for under-represented minorities by 4.4 percentage points and increased for whites by 2.5 percentage points. But characteristics of the entering students changed as well, with both under-represented minorities and whites coming in with higher academic indexes but lower parental education. Here we examine how much of the increase in graduation rates can be accounted for after controlling for changes in observables. We also investigate how the changes in graduation rates differ across different levels of the academic index.

Letting G_{it} denote whether individual i in time t graduated within five years, we first specify G_{it} as depending on whether the individual was in the period post-Proposition 209, $POST_{it}$, a flexible function of observable characteristics X_{it}, and an error term, ϵ_{it}:

$$G_{it} = \alpha_0 POST_{it} + f(X_{it}) + \epsilon_{it} \tag{1}$$

We estimate several versions of (1) where we control for academic index, add controls for parental

Table 2: High School Academic Index and College Graduation Rates by UC campus for Minorities & Whites, Pre Post Prop 209 & Change Post Prop 209

	Under-represented Minorities					Whites				
	Academic Index			Grad. Rate		Academic Index			Grad. Rate	
	Pre Prop 209			Pre		Pre Prop 209			Pre	
Campus[‡]	Mean	S.D.	Change	Prop 209	Change	Mean	S.D.	Change	Prop 209	Change
UC Berkeley	679	91	15	0.675	0.030	794	82	5	0.847	0.026
UC UCLA	674	78	29	0.656	0.057	766	76	19	0.839	0.036
UC San Diego	681	69	40	0.661	0.061	760	55	13	0.826	-0.005
UC Davis	637	88	12	0.540	0.091	721	69	3	0.776	0.009
UC Irvine	621	78	34	0.626	0.039	693	83	8	0.685	0.047
UC Santa Barbara	605	78	44	0.599	0.104	682	67	34	0.743	0.054
UC Santa Cruz	590	101	29	0.598	0.044	683	73	5	0.688	0.033
UC Riverside	582	87	15	0.583	0.005	669	86	0	0.636	-0.014

Data Source: UCOP.

[‡] Campuses are listed in order of their ranking in the 1997 *U.S. News & World Report* Top 50 National Universities.

education, income, and initial major, and then add interactions between the academic index and the other variables. We estimate (1) separately for under-represented minorities and whites.

To assess how the graduation gains vary with a student's academic index, we interact whether the individual was in the post-Proposition 209 period with their quartile in the academic index distribution. We specify the academic index quartiles separately for minorities and whites, using the pre-Proposition 209 distribution of the academic index for enrollees. Denoting Q_{it} as the quartile of the academic index distribution for student i at time t, $Q_{it} \in \{1, 2, 3, 4\}$, we specify G_{it} as:

$$G_{it} = \alpha_0 POST_{it} + \sum_{q=1}^{3} I(Q_{it} = q)\alpha_q POST_{it} + f(X_{it}) + \epsilon_{it} \tag{2}$$

where the graduation gains are then relative to those in the top quartile.

Results are presented in Table 3. Estimates of (1) show that controlling for the academic index reduces the overall graduation gains for under-represented minorities and whites by 1.4 and 1.2 percentage points, respectively. These reductions correspond to 32% of the graduation gains for under-represented minorities and 48% of the graduation gains for whites. Adding additional controls–parental education, income, and initial major–has little effect on these baseline results, if anything slightly raising the estimated graduation gains.

Table 3 also shows how the graduation gains vary across the academic index distribution. For under-represented minorities, the gains are concentrated in the bottom quartiles, with all specifications showing significantly higher gains for those in the bottom three quartiles relative to the top quartile. This is consistent with mismatch in that removing affirmative action means students in the lower quartiles are attending schools that better match their levels of preparation. In contrast, the gains for whites are fairly uniform across the quartiles of the academic index distribution. The results for whites suggests the possibility of schools responding to Proposition 209, particularly since Proposition 209 had little to no effect on the share of white students at each of the campuses, implying matching effects for whites are likely to be small.

The differences in the graduation gains between under-represented minorities and whites then motivates the possibility that the match between the school and the student is important in determining graduation outcomes. But the evidence for whites also suggests something happened with the implementation of Proposition 209 such that graduation rates improved for all levels of

Table 3: Baseline Graduation Regressions Pre/Post Prop-209 - No School Effects

	$POST$	$POST\times$ $Q1(AI)$	$POST\times$ $Q2(AI)$	$POST\times$ $Q3(AI)$
Under-represented Minorities				
Specification:				
Baseline Gain	0.044***			
Controlling for Academic Index	0.030***			
Extended Controls 1	0.031***			
Extended Controls 2	0.030***			
Controlling for Academic Index	0.005	0.041***	0.035***	0.028**
Extended Controls 1	0.008	0.037**	0.031**	0.028**
Extended Controls 2	0.005	0.035**	0.037***	0.035***
Whites				
Specification:				
Baseline Gain	0.025***			
Controlling for Academic Index	0.013***			
Extended Controls 1	0.014***			
Extended Controls 2	0.014***			
Controlling for Academic Index	0.013**	-0.006	0.008	0.000
Extended Controls 1	0.012**	-0.003	0.009	0.001
Extended Controls 2	0.011*	-0.002	0.011	0.002

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.
Extended controls 1 include parents' education & income, initial major and AI.
Extended controls 2 include parents' education & income, initial major, alone and crossed with AI (and AI alone).
Academic index quartiles are based on pre-Proposition 209 enrollees and are group specific: breakpoints for the quartiles vary by minority/white status.

academic preparation. In the next section we develop a model that is flexible enough to capture these matching effects and return to the possibility of campuses responding to the passage of Proposition 209 in Section 6.

4 The Mismatch Hypothesis and University Graduation Production Functions

In this section, we characterize the mismatch hypothesis as it applies to minority graduation rates. To fix ideas, consider the following characterization of the *graduation production function* for one of the UC campuses. Let $Pr(g = 1|AI, j)$ denote the graduation rate that campus j can produce for a minority student with an academic preparation index of AI. For simplicity, assume that this production function is linear and increasing in AI, i.e.,

$$Pr(g = 1|AI, j) = \phi_{0j} + \phi_{1j} AI \tag{3}$$

for UC campus $j \in \{1, ..., J\}$, where $\phi_{1j} > 0$.

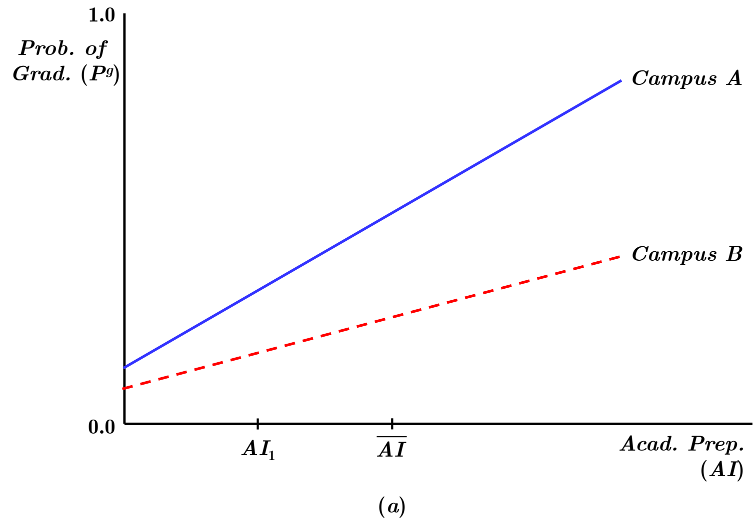
One could proceed by specifying the admission criteria of campuses in the presence and absence of affirmative action, characterizing the criteria students have for the campuses to which they apply and to which they enroll if admitted and that campuses use in its admission decisions and, thus, the matching of students to colleges (or alternative activities).[12] For the purposes of assessing the mismatch hypothesis, it is sufficient to assume that relative to an affirmative action regime, a college under an affirmative action ban will place less (or no) weight on the diversity of an incoming student body and more weight on selecting students based on their academic preparation or AI. The mismatch hypothesis asserts that, under affirmative action, minority students are more likely to be matched to higher quality colleges for which they are less well-prepared than their non-minority counterparts. By banning affirmative action, this form of mismatch of minority students will be reduced, i.e., minority students will be "better matched" to colleges on the basis of their academic preparation (AI), and the outcomes of minorities, such as their graduation rates, will improve.[13]

The validity of this mismatch explanation hinges on whether colleges differ in their graduation production functions and how they differ between high-quality (more selective) and lower quality (less selective) colleges. To see this, consider Figure 1, which illustrates two possibilities for the relationship between the production functions of a more-selective college, *Campus A*, and a less-selective one, *Campus B*. Panel (a) illustrates the case where Campus A has an *absolute advantage* over Campus B in producing higher graduation rates for students of *all* levels of academic preparation (AI). At the same time, the way Panel (a) is drawn, the higher quality campus, A, has a comparative advantage at producing higher graduation rates among better prepared students than Campus B. This latter assumption provides a motivation for why better prepared students tend to attend higher quality colleges.

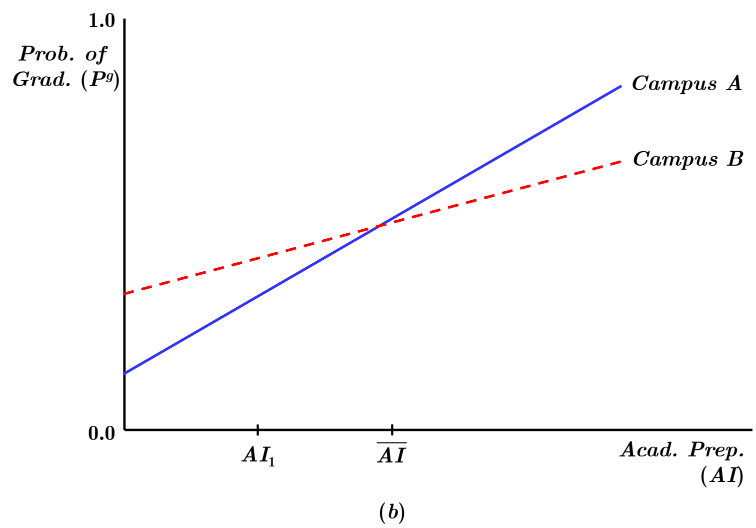
For the predictions of the mismatch hypothesis to hold, one requires a stronger set of dif-

[12]See Epple, Romano and Sieg (2008) for such an equilibrium model of college admissions under affirmative action and when it is banned.

[13]See Dillon and Smith (2009) for reasons why students end up over-matched or under-matched.



(a) Campus A has ***absolute advantage*** in graduations over Campus B for ***all*** levels of AI



(b) Campus A ***better*** than Campus B at graduating ***better prepared*** students ($AI > \overline{AI}$) but B ***better*** than A for ***less prepared*** ones ($AI < \overline{AI}$)

Figure 1: Alternative Relationships between Graduation Production Functions of Higher Quality and Lower Quality Campuses

ferences between the production functions of higher- and lower-quality campuses. To see this, consider Panel (b) of Figure 1. As before, Campus A has a comparative advantage in graduating better prepared students. Now, however, Campus A only has an absolute advantage in the production of graduations for better prepared students, i.e., only for $AI > \overline{AI}$. And, Campus B now has an absolute advantage in the production of graduations for less-prepared students

($AI < \overline{AI}$). Now consider what happens to a minority student with academic preparation AI_1 who was admitted and attended Campus A under affirmative action but is no longer able to get into Campus A once affirmative action is banned.[14] Because Campus B has an absolute advantage in graduating less prepared students, this student's likelihood of graduating from college increases by enrolling in Campus B, as the mismatch hypothesis predicts.[15]

As the above discussion makes clear, the mismatch hypothesis requires lower-quality (less selective) universities to have an absolute advantage, and not just a comparative advantage, in graduating less academically prepared minority students. In the next section, we estimate campus-specific graduation production functions for each of the UC campuses and assess whether this condition holds across the UC system's higher and lower ranked campuses.

5 Estimates of Matching Effects Before Proposition 209

The previous section outlined the flexibility needed in the graduation production function in order to operationalize the mismatch hypothesis. In this section, we present the basic model we estimate to gauge the importance of the match between the school and the student to graduation outcomes. The specification relies only on data before Proposition 209, essentially comparing graduation outcomes of students from different schools but who had otherwise similar observed characteristics.

While Section 3 could be criticized for failing to account for post-Proposition 209 minority enrollees being stronger in unobservable dimensions than pre-Proposition 209 minority enrollees and hence biasing the estimated effects of Proposition 209 on minority graduation rates upward, the concern is the opposite when examining match effects using only the pre-Proposition 209 data. Namely, minority students at highly ranked schools are likely stronger on unobserved dimensions than minority students at lower ranked schools. To address this issue, we take the

[14] If students know their academic preparation then they would presumably internalize the fact that their graduation rates are lower at the more selective campus. However, as discussed in Arcidiacono, Aucejo, Fang, and Spenner (2011), when schools have private information on the probability of success, it is possible for minority students to be made worse off under affirmative action.

[15] Campus B having a comparative, but not absolute, advantage over A with respect to graduations among less prepared students, as in Panel (a) of Figure 1, is not enough to generate the implications of the mismatch hypothesis. To see this, note that if higher quality colleges have an absolute advantage in graduating all students as in Panel (a), then a less prepared minority student with AI_1 ($AI_1 < \overline{AI}$) that was admitted to Campus A under affirmative action will experience a *lower*, rather than *higher*, graduation rate after affirmative action is banned and she can no longer attend Campus A.

approach used by Dale and Krueger (2002) and add to the baseline specification characteristics of the schools where minority students submitted applications as well as characteristics of the schools where minority students were admitted.

As we will show, results from both the baseline specification and from the Dale and Krueger approach show that the more highly ranked schools have a comparative advantage in graduating more prepared students. Further, lower ranked schools appear to have an absolute advantage in graduating students at the bottom of the distribution, suggesting the possibility that one of the reasons for the increased in graduation rates after Proposition 209 was due to minority students being better matched.

5.1 Baseline Model

Our baseline model simply extends the model from the previous section to also allow the probability of graduating to depend on her family background characteristics, X_{it}, to capture the influence of financial constraints and preferences and allowing the production function parameters to vary with the time period (allowing for a university response). Let G_{ijt} denote the 0/1 indicator of whether minority student i who enrolled at UC campus j in cohort t graduated. We then specify G_{ijt} as:[16]

$$G_{ijt} = \phi_{0jt} + \phi_{1jt} AI_{it} + X_{it}\phi_{2t} + \zeta_{it} \tag{4}$$

where ϕ_{0jt} and ϕ_{1jt} are the parameters of the campus-specific production function in (3) and where ζ_{it} is an error term that captures unobserved (to the econometrician) student preferences and characteristics. Our baseline estimates are found by simply regressing the graduation outcomes of the students on their observed characteristics, allowing the intercept and slope to vary by the school attended.

5.2 Dale and Kruger Controls

Ideally, a student's unobserved preferences and characteristics captured by ζ_{it} would be independent from which campus they attended, their AI_{it} and their family background, X_{it}.

[16]We maintain the linear probability model specification in (4) to model graduation rates throughout.

If so, the parameters in linear probability model in (4) would be consistently estimated using standard regression methods. But some of a student's unobserved characteristics are likely to correlated with the quality/selectivity of the campus they attend. As has been noted in the literature,[17] failure to control for the full set of factors will likely to result in biased estimates of the effects of attending more-selective colleges on the outcomes of interest. To help mitigate this source of selection bias, we implement an approach similar to Dale and Krueger (2002), by controlling for characteristics of the schools to which the student applied as well as characteristics of the school to which the student was admitted.

We use various sets of school characteristics to ensure our findings are robust, employing the following specifications:

- **Specification 1** Adds a set of indicator variables for whether the individual applied and was admitted to each of the eight schools (sixteen indicator variables in all) to the baseline specification.
- **Specification 2** Adds the number of schools where the individual submitted applications and was admitted in each of the three tiers of UC campuses to Specification 1.
- **Specification 3** Adds indicator variables for the highest ranked campus where the individual was admitted to the baseline specification.
- **Specification 4** Adds the average academic index of the schools where the individual submitted applications and was admitted to Specification 2.

Denoting $DK_i^{(k)}$ as the kth set of school characteristics, our estimation equation for specification $k \in \{1, 2, 3, 4\}$ becomes:

$$G_{ijt} = \phi_{0jt}^{(k)} + \phi_{1jt}^{(k)} AI_{it} + X_i \phi_{2t}^{(k)} + DK_{it}^{(k)} \psi_t^{(k)} + \zeta_{it}^{(k)} \quad (5)$$

For the Dale and Krueger strategy to be successful in accounting for selection, it must be the case that students do not always attend the best school to which they were admitted. In Table 4 we look at students who were admitted to different pairs of schools and examine the probability

[17] See, for example, Black, Daniel, and Smith (2001), Dale and Krueger (2002), Black and Smith (2004), and Hoxby (2009).

of attending each school in the pair. Conditional on attending one of the schools in the pair, the entries above the diagonal give the share that attend the school along the row while the entries below the diagonal give the number of students that were admitted to the pair and attended one of the two schools. Hence, 1763 minority students were admitted to both UC Berkeley and UCLA in the pre-Proposition 209 period and chose to attend one of these two schools. Of the 1763, 53.3% chose to attend Berkeley.

With only a few exceptions, the numbers above the diagonal are above fifty percent. This suggests that our ordering of colleges is reasonable as, conditional on being admitted to both schools and enrolling in one of them, students are more likely to attend the higher-ranked school. However, Table 4 also reveals that a non-trivial share of students attend the lower ranked school. This is particularly true for minorities in the pre-Proposition 209 period where in all cases at least 10 percent of students chose the lower ranked school conditional on being admitted to both schools and attending one of the schools in the pair.

5.3 Results

Results are presented in Table 5. The models are estimated so that the academic index is normalized to have zero mean and a standard deviation of one for minority enrollees in the pre-Proposition 209 period. Both the campus-specific intercepts and slopes are measured relative to the intercept and slope for UC Riverside. The campus-specific intercepts then reflect the difference in graduation rates for a minority enrollee at the average AI score, and the slopes are now normalized to be the percentage point gain in expected graduation resulting from a one standard deviation increase in the academic index.

The general pattern across the specifications suggest that the more highly-ranked campuses reward (penalize) students with high (low) academic indexes. Exceptions are UC Davis' slope coefficient, which is higher than its rank, and UC Berkeley's slope coefficient, which is lower than its rank. With the exception of the baseline specification, the average minority enrollee would see a higher probability of graduating from any of the four bottom-ranked campuses than at any of the four top-ranked campuses, between 2 and 6.5 percentage points higher for Specification 4 depending on the campuses. With 60% of minority enrollees at the top four campuses in the pre-Proposition 209 period, there would appear to be scope for increasing graduation rates

Table 4: Attendance Decision Tables

	Berkeley	UCLA	San Diego	Davis	Irvine	Santa Barbara	Santa Cruz	Riverside
Under-represented minorities								
Pre-Proposition 209								
Berkeley	–	53.3%	76.6%	81.1%	81.7%	85.9%	87.9%	83.1%
UCLA	1,763	–	75.3%	80.5%	81.5%	87.3%	88.5%	83.0%
San Diego	834	1,194	–	53.9%	66.0%	62.8%	70.6%	66.8%
Davis	958	713	473	–	54.1%	55.6%	65.6%	64.3%
Irvine	416	1,160	438	364	–	49.9%	57.9%	64.3%
Santa Barbara	737	1,073	637	666	577	–	63.8%	62.0%
Santa Cruz	602	400	296	489	214	776	–	43.7%
Riverside	237	587	250	252	563	471	247	–
Post-Proposition 209								
Berkeley	–	53.1%	77.6%	89.6%	88.5%	91.4%	93.6%	90.4%
UCLA	855	–	80.8%	87.9%	91.9%	92.3%	93.2%	91.5%
San Diego	491	854	–	71.9%	73.5%	70.2%	82.3%	74.7%
Davis	548	488	385	–	53.1%	48.1%	77.0%	66.8%
Irvine	269	692	438	390	–	45.8%	65.4%	67.3%
Santa Barbara	451	755	541	572	592	–	75.5%	72.1%
Santa Cruz	264	265	192	473	272	691	–	45.2%
Riverside	208	492	253	374	756	628	504	–
White								
Pre-Proposition 209								
Berkeley	–	65.7%	77.9%	79.9%	81.8%	84.3%	85.2%	83.3%
UCLA	1,923	–	72.9%	77.5%	85.0%	83.8%	84.9%	79.5%
San Diego	1,606	2,275	–	63.6%	79.1%	69.1%	73.4%	79.2%
Davis	1,337	1,170	2,274	–	72.7%	55.9%	64.1%	80.3%
Irvine	373	919	1,105	802	–	35.3%	51.7%	68.5%
Santa Barbara	924	1,411	2,410	2,833	1,517	–	61.7%	81.3%
Santa Cruz	710	392	997	1,568	412	2,947	–	66.6%
Riverside	108	273	437	351	537	672	308	–
Post-Proposition 209								
Berkeley	–	59.5%	79.5%	82.4%	90.8%	88.8%	88.9%	88.9%
UCLA	2,270	–	78.0%	84.2%	90.2%	88.2%	91.8%	84.5%
San Diego	1,867	2,722	–	69.8%	82.7%	67.3%	79.6%	81.2%
Davis	1,411	1,304	2,051	–	71.0%	44.9%	71.5%	83.2%
Irvine	414	1,006	1,073	910	–	26.6%	55.0%	73.6%
Santa Barbara	1,211	2,014	2,617	2,682	1,374	–	76.7%	85.4%
Santa Cruz	606	464	805	1669	567	2,335	–	69.1%
Riverside	135	343	436	601	762	809	637	–

For Row A, Column B, value of cell is:
Above diagonal: if admitted to Campus A and B, P(attends A | attends A or B)
Below diagonal: number in race-period group admitted to A and B and attended A or B
A student admitted to more than two campuses will appear in this count multiple times

through less aggressive affirmative action policies. While the differences in intercepts are often not statistically different, the point estimates are large. For example, Specification 4 shows that the average minority enrollee would be 4.6 percentage points less likely to graduate at UCLA than at UC Riverside. Highlighting the importance of match effects, if the student was one-standard deviation below the minority mean, the difference would increase to 11.7 percentage points. But if the student was one-standard deviation above the minority mean, her graduation probability would be 2.5 percentage points higher at UCLA than at UC Riverside.

To get a sense of the potential importance of match effects, we predict graduation probabilities at each campus for different percentiles of the minority academic index using Specification 4.[18] Table 6 ranks the campuses from highest to lowest predicted graduation probabilities for different percentiles of the academic index holding fixed the remaining characteristics (family income, the Dale and Krueger measures, etc.) at the minority sample average.[19] The rankings vary substantially across the academic index distribution. UC Santa Cruz and UC Riverside are the top two campuses for those at the 10th percentile or the 25th percentile of the academic index distribution yet are the bottom two campuses at the 90th percentile. At the other extreme, UCLA ranks second to last for the 10th and 25th percentiles yet is the top campus for those at the 90th percentile.

Table 6 also makes clear that the heterogeneity in graduation rates across universities is particularly large for those at the bottom of the distribution. The gap between the highest and lowest graduation rates across schools for students at the 10th percentile of the academic index was 15.8 percentage points. For students at the 75th percentile of the academic index, the gap between the highest and lowest graduation rates was a third of the size at 5.2 percentage points.

[18]Relative rankings of the campuses in terms of predicted graduation rates are fairly similar across the different specifications.

[19]Those with lower academic indexes are likely worse off on the other characteristics as well but since the estimated match effects vary only across the academic index, varying these other observed characteristics neither changes the ranking of the campuses nor does it change the differences in graduation probabilities across campuses conditional on the percentile of the academic index.

Table 5: Intercept and Slope for Graduation Rates for Pre Prop-209 Period

Specification	Baseline	(1)	(2)	(3)	(4)
Campus-Specific Intercepts:					
Berkeley	0.018	-0.016	-0.020	-0.074***	-0.025
UCLA	-0.007	-0.037	-0.042	-0.078***	-0.046*
San Diego	0.010	-0.029	-0.035	-0.058**	-0.038
Davis	-0.069***	-0.068***	-0.065**	-0.135***	-0.069**
Irvine	0.036*	0.009	0.010	-0.023	0.006
UCSB	0.006	-0.005	-0.004	-0.014	-0.005
Santa Cruz	0.001	0.006	0.002	-0.016	0.003
Campus-Specific Slopes:					
AI	0.053***	0.034**	0.036**	0.034**	0.031**
Berkeley	0.023	0.030*	0.025	0.042**	0.033*
UCLA	0.063***	0.068***	0.064***	0.078***	0.071***
San Diego	0.047**	0.059**	0.054**	0.063**	0.060**
Davis	0.055***	0.060***	0.056***	0.071***	0.063***
Irvine	0.022	0.027	0.024	0.035	0.029
UCSB	0.021	0.024	0.020	0.019	0.024
Santa Cruz	-0.008	-0.007	-0.007	-0.004	-0.005

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

Campus-specific intercepts are evaluated at mean academic index for pre-209 Minority students and are measured relative to UC-Riverside.

Campus-specific slope coefficients on standardized academic index variable, $AI_{std,r,t}$ for $r = Minority$ and $t = Pre-209$. Each coefficient measures the effect of a one S.D. increase in academic index on probability of graduation and these effects are measured relative of that for UC-Riverside.

All specifications include the following control variables: parents' income and education and initial major.

Specification 1 adds a full set of dummy variables indicating whether the student applied to and/or admitted to each of the eight UC campuses.

Specification 2 adds to Specification 1 the number of campuses applied to and admitted to for each of three tiers of UC campuses, with Tier 1 which includes UC-Berkeley, UCLA and UC-San Diego, Tier 2 which includes UC Davis, UC Irvine and UC Santa Barbara, and Tier 3 which includes UC Santa Cruz and UC Riverside, and also dummy variables that indicate whether a student applied to campuses in the Tier above or in the Tier below the Tier to which they were admitted.

Specification 3 includes the base specification plus a set of dummies for the highest ranked campus a student was admitted to.

Specification 4 includes the controls in Specification 2, plus a student's total number of applications and admissions, respectively, as well as an average of average academic index of the applicants/admits for campuses the student applied/was admitted.

Table 6: Rankings of UC Schools by Predicted Graduation Rates at Various Percentiles of the High School Academic Index Percentiles based on Minority Coefficients Estimates†

Percentile of the Minority Academic Index									
10th		25th		50th		75th		90th	
Santa Cruz	0.611	Santa Cruz	0.627	Irvine	0.648	Irvine	0.689	UCLA	0.726
Riverside	0.602	Riverside	0.621	Santa Cruz	0.645	Santa Barbara	0.674	Irvine	0.725
Irvine	0.571	Irvine	0.607	Riverside	0.642	San Diego	0.666	San Diego	0.721
Santa Barbara	0.567	Santa Barbara	0.600	Santa Barbara	0.637	UCLA	0.664	Santa Barbara	0.707
Berkeley	0.535	Berkeley	0.574	Berkeley	0.617	Riverside	0.663	Berkeley	0.699
San Diego	0.488	San Diego	0.543	San Diego	0.604	Santa Cruz	0.663	Davis	0.694
UCLA	0.465	UCLA	0.527	UCLA	0.596	Berkeley	0.661	Riverside	0.682
Davis	0.453	Davis	0.510	Davis	0.573	Davis	0.637	Santa Cruz	0.679

Data Source: UCOP.

† Average predicted graduation probabilities in parentheses. The predicted probabilities were formed using the estimated coefficients for specification (**??**) for minorities and were predicted using the characteristics of minority students that enrolled at one of the UC campuses in the years 1995-1997.

6 Decomposition of Post-Proposition 209 Graduation Gains

The previous section illustrated that the match between the student and the university is important for graduation rates. Relatively less-prepared minority students see higher graduation rates at lower-ranked campuses while the reverse is true for the more-prepared students. Coupled with the gains in graduation rates post-Proposition 209, this suggests the possibility Proposition 209 improved graduation rates in part due to improving the match between the student and the school.

But there are at least two other reasons Proposition 209 may have improved graduation rates. First is selection as affirmative action bans may result in students who had the lowest probability of graduating no longer being admitted to any school in the system. While Section 3 accounted for selection on observables, minority students in the post-Proposition 209 period may have also been stronger on unobservables.

It is also possible that affirmative action bans resulted in universities reallocating resources to ensure that the smaller number of minorities now enrolled would be more likely to graduate. For example, colleges subject to affirmative action bans may try to improve their tutoring and counseling programs especially at freshman in order to help them get through their first year of collegiate studies in order to reduce the rates of drop-out and improve graduation rates.

There is anecdotal evidence that UC campuses did take actions after Prop 209 to improve student retention rates. For example, UCLA changed the way its introductory courses for first year students were organized in the wake of Prop 209 in an attempt to improve the retention of "disadvantaged students."[20] While some of these efforts were direct responses to the passage of Prop 209, others appear to have been in response to the rising (and continuing) attention to retaining college enrollees, especially those from disadvantaged groups.[21] We note that the efforts by UC campuses to improve outreach and retention of minority students after Prop 209 could not directly target racial and ethnic groups, which was deemed a violation of ban on the use of race and ethnicity "in the operation of ... public education" (Text of Proposition 209).[22]

[20]See "Intercollegiate Forums at UCLA discuss Retention of Minorities," *Daily Bruin*, March 2, 1998.

[21]See "Scholars urge Early Help for Minorities," *UCLA Today*, March 16, 1998.

[22]See "Prop. 209 Mandates Changes on Campus," *UCLA Today*, October 10, 1997. As noted in Horn and Flores (2003), some of the post-Prop 209 efforts to improve the retention of minority enrollees at UC Berkeley were handled by student-run organizations who were not directly subject this provision of Prop 209.

This led to a restructuring of official campus programs to target disadvantaged, rather than only minority, students based on "academic profiles, personal backgrounds and social and environmental barriers that may affect [a student's] university experience, retention and graduation."[23] As a result, some of these retention efforts in response to, or coincident with, Prop 209 may have affected the graduation rates of both minority and non-minority students.

In this section we seek to separate out the gains in graduation rates after Proposition 209 was implemented into three components: matching, university response, and selection. We begin by showing our decomposition strategy and then discuss how Proposition 209 affected the allocation of minorities across schools. Next, we discuss how to separate out the university response from selection. Finally, we show the decomposition results.

6.1 Overview

Here we provide an overview of how our decomposition is conducted. Denote the policy regime as $r \in \{PRE, POST\}$. Denote x as the set of observed characteristics that affect graduation probabilities or college assignment. Using Bayes' rule, we can express the unconditional probability of a minority student in regime r graduating, $Pr(g = 1|r)$, as:

$$Pr(g = 1|r) = \sum_x \sum_j Pr(g = 1|j, x, r)Pr(j|x, r)Pr(x|r) \tag{6}$$

where the inner sum is over the possible colleges and the outer sum is over the possible observed characteristics. $Pr(j|x, r)$ and $Pr(x|r)$ then refer to the probability of attending school j given characteristics x and regime r and the probability of observed characteristics x conditional on regime r respectively.

The difference in graduation rates across the two periods can then be expressed as:

$$\begin{aligned}\Delta_T &= Pr(g = 1|POST) - Pr(g = 1|PRE) \\ &= \sum_x \sum_j Pr(g = 1|j, x, POST)Pr(j|x, POST)Pr(x|POST) \\ &\quad - \sum_x \sum_j Pr(g = 1|j, x, PRE)Pr(j|x, PRE)Pr(x|PRE)\end{aligned} \tag{7}$$

[23] "Prop. 209 Mandates Changes on Campus," *UCLA Today*, October 10, 1997.

Equation (7) presents a natural way of considering the three channels through which Proposition 209 changed graduation rates: affecting college assignment ($Pr(j|x,r)$) which in turn affects matching, affecting the graduation production function directly ($Pr(g=1|j,x,r)$), and affecting the distribution of the observed characteristics of minority enrollees ($Pr(x|r)$).[24]

To isolate how Proposition 209 affected graduation rates through match effects, we use the graduation production functions and distribution of observed characteristics from the pre-Proposition 209 period and then look at differences in graduation rates to changes in how minorities were allocated across schools:

$$\begin{aligned} \Delta_M &= \sum_x \sum_j Pr(g=1|j,x,PRE)Pr(j|x,POST)Pr(x|PRE) \\ &\quad - \sum_x \sum_j Pr(g=1|j,x,PRE)Pr(j|x,PRE)Pr(x|PRE) \end{aligned} \tag{8}$$

Given the post-Proposition 209 assignment rules, we can examine how changes in university production functions, which is what we mean by university response, affected graduation rates using:

$$\begin{aligned} \Delta_{UR} &= \sum_x \sum_j Pr(g=1|j,x,POST)Pr(j|x,POST)Pr(x|PRE) \\ &\quad - \sum_x \sum_j Pr(g=1|j,x,PRE)Pr(j|x,POST)Pr(x|PRE) \end{aligned} \tag{9}$$

Finally, we can examine selection into the sample by examining how the distribution of observed characteristics changed after Proposition 209.

$$\begin{aligned} \Delta_S &= \sum_x \sum_j Pr(g=1|j,x,POST)Pr(j|x,POST)Pr(x|POST) \\ &\quad - \sum_x \sum_j Pr(g=1|j,x,POST)Pr(j|x,POST)Pr(x|PRE) \end{aligned} \tag{10}$$

The sum of the three changes then gives the total change in graduation rates.

$$\Delta_T = \Delta_M + \Delta_{UR} + \Delta_S \tag{11}$$

[24] Note that here we are effectively assuming that universities change their graduation production functions in response to the changes in the assignment rules as the primary effect of Proposition 209 was to change how minorities were allocated to colleges.

In Section 5 we specified and estimated the pre-Proposition 209 graduation production functions, $Pr(g=1|j,x,PRE)$. We can perform a similar exercise to obtain the graduation production functions in the post-Proposition 209 period, $Pr(g=1|j,x,POST)$. Note that the Dale and Krueger adjustments will be substantially different in the post-Proposition 209 period implying that some care will need to be taken to separate out the university response from selection. The rest of this section outlines how the remaining components of the decomposition are calculated as well as performing the decomposition.

6.2 Graduation Gains Due to Matching

We first consider how Proposition 209 affected the allocation of minority students across the different UC campuses. Letting x denote the regressors used in our baseline specification, Equation (4), we estimate multinomial logits of the probability of being assigned to each of the eight schools conditional on having enrolled in one of the schools, allowing the coefficients to differ across the two regimes.[25] The probability of being assigned to school j in regime r given characteristics x is then:

$$Pr(j|x,r) = \frac{\exp(x\alpha_{jr})}{\sum_j \exp(x\alpha_{jr})} \tag{12}$$

Note that we do not include the Dale and Krueger controls when examining school assignment. Clearly these controls have different interpretations in the two regimes and implicitly include the dependent variable: if the student did not apply to a particular school or was not admitted then that student could not be assigned to the school. Estimates of our allocation mechanism will under-predict unobserved ability at the top schools and over-predict unobserved ability at the bottom schools. However this will not affect the results of our decomposition because we have specified unobserved ability to have the same effect on graduation probabilities at all schools. Indeed, if matching on unobservables is important we are likely to underestimate the importance of match effects.

Estimates of the minority assignment rules for the two regimes are given in the appendix. Table 7 gives the predicted probability of pre-Proposition 209 students being assigned to each of the schools using both the pre and post assignment rules. Assigning pre-Proposition 209 students

[25] Here we ignore the fact that some of these students would not be admitted to any of the campuses post-Proposition 209. The selection into the sample comes in the last part of the decomposition. $Pr(x|r)$.

Table 7: Distribution of Minority Enrollees across UC Campuses, Pre-Prop 209 & Predicted under Post-Prop 209 Assignment Rules†

	Assignment Rule		
	Pre Prop 209 Predicted	Post Prop 209 Predicted	Difference
UC Berkeley	0.178	0.100	-0.078
UCLA	0.217	0.140	-0.077
UC San Diego	0.084	0.072	-0.012
UC Davis	0.118	0.127	0.009
UC Irvine	0.087	0.113	0.026
UC Santa Barbara	0.144	0.152	0.008
UC Santa Cruz	0.077	0.107	0.030
UC Riverside	0.095	0.190	0.095

Data Source: UCOP.

to UC campuses according to the post-Proposition 209 rules shifts minority students out of the top three schools and into the bottom five, with particularly large shifts to UC Riverside. As noted above, some of the students assigned to UC Riverside likely would not have been admitted to any school in the system. It remains an outstanding question whether these students would then be better matched at lower ranked schools, such as those in the California State system, and therefore would graduate at an even higher rate or whether schools lower down in the system produce lower graduation rates that UC Riverside at all levels of academic preparation.

We then predict graduation probabilities using the two different assignment rules to calculate minority graduation gains from Proposition 209 due to matching. Table 8 gives the results for each of our five specifications, both overall and for each quartile of the academic index.[26] Absent the Dale and Krueger controls (baseline specification), the gains from matching are positive but very small. Including the Dale and Krueger controls shows increases the overall minority graduation rate between 0.64 percentage points and 1.2 percentage points.

These numbers may seem small given the substantial heterogeneity in graduation rates shown in Table 6. But this is more indicative of the scope for reallocating students. For example, students at the very bottom of the distribution will be allocated to UC Riverside regardless of whether we use the pre or post assignment rules. And those at the top of the distribution may be hurt by shifting to the new rules. The last four rows of Table 8 illustrate the distributional effects by showing the graduation gains from matching for different quartiles of the academic

[26] As before, the quartiles are assigned based on the academic indexes for minority enrollees in the pre-Proposition 209 period.

Table 8: Gains in Graduation Rates from Proposition 209 Due to Matching

		Specification			
	Baseline	(1)	(2)	(3)	(4)
Average Gain	0.13%	0.64%	0.69%	1.20%	0.77%
AI Quartile 1	0.81%	1.51%	1.45%	2.20%	1.66%
AI Quartile 2	0.18%	0.80%	0.85%	1.45%	0.96%
AI Quartile 3	-0.22%	0.26%	0.36%	0.80%	0.40%
AI Quartile 4	-0.26%	-0.01%	0.09%	0.36%	0.06%

Specifications as listed in Table 5
Final part of the table calculates matching effects for only those in each quartile of the pre-209 URM AI distribution.

index. Here we see that the gains are largest for those in the bottom quartile followed by those in the next-lowest quartile. These students benefit from being shifted down to schools where they are more competitive. Smaller, or negative, gains are seen for those in the top two quartiles, both because these students are better matches for the top schools and because there is less across-campus heterogeneity in graduation rates for top students.

6.3 Bounding University Response and Selection Effects

Given estimates of the pre-Proposition 209 and post-Proposition 209 production functions, we would like to predict changes in graduation rates due to changes in the production functions. The issue is how to adjust the Dale and Krueger effects across the two regimes. We can obtain the predicted effects from the Dale and Krueger measures under specification k for a student i in regime r using:

$$PDK_{ir}^{(k)} = DK_{ir}^{(k)} \hat{\psi}_r^{(k)} \tag{13}$$

from equation (5). However, we need to be able to map the pre-Proposition 209 effects of the Dale and Krueger controls, $PDK_{ir}^{(k)}$, into their post-Proposition 209 counterparts. We do this in two ways, one of which we believe provides an upper bound on the increase in graduation rates due to university response, with the other providing a lower bound.

We first assume that the distribution of unobservables is the same both in the pre and post periods among minority students admitted to any campus, regardless of whether not the student enrolled. For those admitted to at least one campus, the nth percentile $PDK_{PRE}^{(k)}$ is matched to the nth percentile of $PDK_{POST}^{(k)}$. Recall that the change in graduation rates due to the university response is given by:

$$\begin{aligned}\Delta_{UR} &= \sum_x \sum_j Pr(g=1|j,x,POST)Pr(j|x,POST)Pr(x|PRE) \\ &-\sum_x \sum_j Pr(g=1|j,x,PRE)Pr(j|x,POST)Pr(x|PRE)\end{aligned} \tag{14}$$

Hence when we calculate the change in university response the x's we use in $Pr(g=1|j,x,POST)$ entail shifting the Dale and Krueger effects in the pre-Proposition 209 to their post-Proposition 209 counterparts by matching percentiles of the Dale and Krueger effects. The remaining graduation gap is then attributed to selection.

The university response as estimated above is likely an upper bound on the university response because minority students who enrolled post-Proposition 209 are likely stronger in unobservable dimensions, captured by our Dale and Krueger controls, than their pre-Proposition 209 counterparts due to more students being rejected from all schools. The share of minority applicants who are rejected from all UC campuses where they submitted applications rose by 9.2% from the pre-period to the post-period.

To get a lower bound on the university response, we drop the bottom 9.2% of pre-Proposition 209 admits. We then repeat the matching of the pre-Proposition 209 Dale and Krueger effects to their post-Proposition 209 counterparts by matching percentiles of their distributions.

But this still leaves the issue of calculating $PDK_{iPOST}^{(k)}$ for the bottom 9.2% of minority admits in the pre-Proposition 209 period. We assume that, had we observed the values of $PDK_{iPOST}^{(k)}$ for those rejected from all schools in the post-Proposition 209 period but who would have been accepted to at least one school in the pre-Proposition 209 period, the distribution of $PDK_{iPOST}^{(k)}$ would be normal, implying what we actually observe is a truncated distribution. Given the truncated distribution, we can calculate the variance for the full distribution and forecast $PDK_{iPOST}^{(k)}$ for those in the left tail.

6.4 Decomposition Results

The results for the decomposition for our five specifications are given in Table 9, showing both the level changes in graduation rates due to each of the three factors (matching, university response, and selection) as well as the share of the total post-Proposition 209 gain. The first row gives the matching effects from the first row of Table 8, but now adding the share of the total graduation gain. The share of the total is very small absent the Dale and Krueger controls, with the Dale and Krueger controls the share ranges from 14.7% to 27.7% of the total gain.

The next set of rows present our estimates of the upper and lower bounds for the university response accompanied by the corresponding estimates of the selection component. With the Dale and Krueger controls, the upper bound on the university response ranges from 2.2 percentage points to 2.9 percentage points, or between 50% and 67% of the total. The lower bound estimates range from 1.0 percentage points to 1.5 percentage points, or between 23% and 33% of the total. Interestingly, these gains, particularly those for the lower bound, line up well with the reduced-form gains for whites found in Table 3.

7 Conclusion

In this paper we have examined how the match between the student and the school affects college graduation rates. We have found evidence that less-selective UC schools tend to be better at graduating less-prepared students, with more selective schools better at graduating more-prepared students. These results are relevant to the debate over the merits of affirmative action in university admissions to the extent that affirmative action leads to inefficient sorting.

Using data before and after an affirmative action ban, we found evidence that Prop 209 did lead to a more efficient sorting of minority students within the UC system. However, the effects were relatively small and we can say little about what happened to those that did not attend a UC school as a result of Prop 209.[27] Given large differences in academic preparation due to differences in the family backgrounds of students and the quality of the primary and secondary

[27] While estimates suggest selective schools see a drop in minority enrollment following affirmative action bans (Long 2004 and Hinrichs 2012), overall college enrollment rates remain relatively unaffected following a ban (Backes 2012 and Hinrichs 2012).

Table 9: Decomposing the Effect of Proposition 209 on URM Graduation

Specification:	Baseline		1		2		3		4	
	Level	Share of Total	Level	Share of Total	Level	Share of Total	Level	Share of Total	Level	Share of Total
(A) Improved Matching	0.13	3.0%	0.64	14.7%	0.69	15.8%	1.20	27.7	0.77%	17.8
Upper Bound on University Response										
(B) University Response	3.06	70.5%	2.91	67.0%	2.92	67.1%	2.21	50.8%	2.80	64.4%
(C) Selection	1.15	26.6%	0.79	18.2%	0.74	17.1%	0.93	21.5%	0.77	17.8%
Lower Bound on University Response										
(B') University Response			1.44	33.2%	1.33	30.7%	0.43	9.8%	1.01	23.3%
(C') Selection			2.26	52.1%	2.33	53.5%	2.72	62.5%	2.56	58.9%

Specifications as listed in Table 5

Selection effect calculated as *Total Increase* $-(A) - (B)$.

For results dropping bottom of PRE admit distribution, baseline not reported because there is no DK distribution from admission variables schools they attended, there is little scope for dramatic shifts in graduation outcomes by re-sorting of students across campuses.[28] That being said, our results indicate that better matching of students to campuses based on academic preparation does produce the largest graduation rate gains for those students in the bottom part of the distribution of academic preparation. Further, while matching effects are small when comparing five-year graduation rates, a companion paper (Arcidiacono, Aucejo, and Hotz, 2013) shows that mismatch effects are much larger when looking at persistence in STEM fields and in time to graduation.

Possibly our most intriguing finding is that the imposition of an affirmative action ban may have induced a response by universities in their efforts to keep students from dropping out and completing their studies. Previous studies of affirmative action have ignored the potential for such an institutional response targeted at those minorities that do enroll after a ban and our results suggest that the magnitude of the potential detrimental effects of affirmative action bans may be overstated by not taking these responses into account.

More generally, finding ways to improve the college graduation rates of minorities – regardless of the motivation – would appear to be of growing importance, given the evidence that attending but not graduating from college has sizeable consequences in one's later life. Consider, for example, the disparity in labor market earnings between those who attend but do not graduate from college and those that do graduate. Based on data from the 2008-2010 waves of the American Community Survey (ACS), we estimate that the annual earnings of African American men who completed their BA degree is 47.1% higher than for those who attended but did not graduate from college. The corresponding differentials are even larger for African American women (51.1%) and sizeable for both Hispanic men (36.1%) and women (41.1%).[29]

[28] These results are consistent with Arcidiacono and Koedel (2013) who find that most of the black/white differences in college graduation rates stem from differences in student academic preparation.

[29] By way of comparison, the corresponding differentials are 46.5% for white men and 43.0% for white women.

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A Appendix

Table 10: Characteristics of UC Applicants, Admits, and Enrollees by Race, Pre-Prop 209 and Change Post Prop 209†

	Applied		Admitted		Enrolled		Graduated	
	Pre-Prop 209	Change	Pre-Prop 209	Change	Pre-Prop 209	Change	Pre-Prop 209	Change
Asians:								
No. of Asians	53,894	9,638	42,591	6,440	26,134	4,315	19,338	4,265
High School Acad. Index	701.9	8.2***	723.7	5.4***	717.2	9.8***	729.6	8.3***
Parents have BA	0.652	0.004	0.659	-0.007**	0.636	-0.002	0.656	-0.008*
Parents' Income $\leq$ \$30K	0.293	-0.026***	0.301	-0.022***	0.322	-0.028***	0.301	-0.027***
Parents' Income $\geq$ \$80K	0.291	0.053***	0.288	0.046***	0.266	0.052***	0.280	0.054***
Graduation Rate							0.749	0.037***
Others, including Unknowns:								
No. of Others	10,190	12,265	8,249	8,867	4,138	4,696	3,087	3,623
High School Acad. Index	719.3	-2.6**	741.3	-2.8**	731.2	2.0	741.6	1.1
Parents have BA	0.745	0.018***	0.765	0.010	0.751	0.010	0.769	0.009
Parents' Income $\leq$ \$30K	0.195	-0.013**	0.186	-0.008	0.203	-0.010	0.184	-0.004
Parents' Income $\geq$ \$80K	0.402	0.044***	0.413	0.034***	0.384	0.047***	0.409	0.040***
Graduation Rate							0.741	0.015*

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

Data Source: UCOP individual data, Pre-Prop 209 (1995-97); Post-Prop 209 (1998-2000).

Variables: *No. of Observations* is the total number of students who engaged in activity indicated in column heading; *No. of Obs./No. of HS Grads* is ratio of a column's No. of Observations to the number of public high school graduates per year in California; *Graduation Rate* is share of enrolled students that graduated in 5 years or less; *High School Acad. Index* is sum of re-scaled student's SAT I score (0 to 600 scale) plus re-scaled student's UC-adjusted high school GPA (0 to 400 scale); *Parents have BA* is indicator variable of whether student has at least one parent with Bachelor Degree or more; *Parents' Income* $\leq$ *\$30K* is indicator variable for whether parents' annual income is $\leq$ \$30,000, where Pre-Prop 209 income are inflation-adjusted to Post-Prop 209 levels; *Parents' Income* $\geq$ *\$80K* is corresponding variable whether parents' annual income is $\geq$ \$80,000; and where *Graduated* denotes those who graduated in 5 years or less.

Totals in each category include occasional cases with missing data; when calculating average sample characteristics, individuals missing that data are dropped. This includes enrollees with missing graduation information, so Graduation Rate is not identical to graduates/enrollees

Table 11: Other Coefficients From Intercept/Slope Grad Rates Table

	Baseline	(1)	(2)	(3)	(4)
Log Par Income	0.037***	0.037***	0.037***	0.039***	0.037***
P. Inc. Missing	0.326***	0.325***	0.324***	0.343***	0.327***
P. Inc. Top Coded	0.004	0.002	0.003	0.003	0.003
Parents Educ.					
HS Grad	-0.044***	-0.041***	-0.040***	-0.041***	-0.040***
Some Coll.	-0.042***	-0.038***	-0.037***	-0.040***	-0.037***
Coll. Grad	-0.009	-0.004	-0.004	-0.007	-0.004
Post-Grad	-0.004	0.001	0.002	-0.002	0.002
Initial Major					
Science	-0.081***	-0.082***	-0.082***	-0.081***	-0.082***
Social Science	0.018	0.018	0.018	0.018	0.018
Applied:					
Berkeley		-0.013	-0.017		0.005
UCLA		-0.013	-0.018		-0.013
San Diego		-0.019	-0.024		-0.018
Davis		0.010	0.014		0.021
Irvine		-0.051**	-0.047**		-0.051**
Santa Barbara		-0.020	-0.017		-0.025
Santa Cruz		-0.072	-0.028		-0.027
Riverside		-0.048	-0.005		-0.020
Admitted:					
Berkeley		0.044***	0.044**		0.028
UCLA		0.028*	0.029		0.017
San Diego		0.053***	0.055***		0.049**
Davis		-0.002	-0.006		-0.012
Irvine		0.084***	0.081***		0.081***
Santa Barbara		0.048*	0.045		0.050
Santa Cruz		0.075	0.012		0.010
Riverside		0.060	-0.001		0.009
Applied:					
Top Tier			0.012		0.044
Mid Tier			0.007		0.003
Low Tier			-0.051		-0.072
Admitted:					
Top Tier			0.067*		0.029
Mid Tier			0.025		0.034
Low Tier			0.108		0.127*
Adm Top & App Low			-0.069***		-0.065***
Adm Low & App Top			0.011		0.014
Adm Top & App Mid			-0.037		-0.026
Adm Mid & App Top			-0.002		-0.012
"Best" Admitted:					
Berkeley				0.026	
UCLA				0.001	
San Diego				0.004	
Davis				0.010	
Irvine				0.076***	
Santa Barbara				-0.006	
Santa Cruz				0.031	
Avg. AI at Applied					-1.963*
Avg. AI at Admitted					1.113*
Constant	0.679***	0.657***	0.601***	0.628***	1.175*

Data Source: UCOP.

Table 12: Coefficients From URM Students' Assignment Rule Multinomial Logits

	Berkeley	UCLA	San Diego	Davis	Irvine	Santa Barbara	Santa Cruz
Pre-Proposition 209							
Acad. Index - Normalized	1.279***	1.209***	1.163***	0.592***	0.434***	0.220***	0.049
Log Par Income	-0.153***	-0.041	-0.006	0.125**	0.016	0.040	-0.086
P. Inc. Missing	-1.020*	-0.075	0.358	1.728***	-0.151	0.518	-0.470
P. Inc. Top Coded	0.657***	0.630***	0.478**	0.409**	0.388*	0.640***	0.568***
Parents Educ.							
HS Grad	0.282**	0.091	0.294**	0.390***	0.020	0.185	-0.283*
Some Coll.	0.132	0.048	0.370***	0.523***	-0.220*	0.229**	-0.016
Coll. Grad	0.380***	0.056	0.434***	0.638***	0.057	0.352***	0.186
Post-Grad	0.670***	0.282**	0.814***	0.866***	0.124	0.699***	0.829***
Initial Major							
Science	-0.398***	0.113	1.002***	0.524***	0.953***	0.243***	0.352***
Social Science	0.259***	0.583***	0.671***	0.024	0.457***	0.302***	0.604***
Const.	0.426***	0.719***	-0.851***	-0.150	-0.228**	0.154	-0.617***
Post-Proposition 209							
Acad. Index - Normalized	1.558***	1.732***	1.888***	0.691***	0.720***	0.764***	0.201***
Log Par Income	-0.361***	-0.359***	-0.289***	0.046	0.064	-0.079	0.056
P. Inc. Missing	-3.426***	-3.945***	-3.084***	0.486	0.728	-0.581	0.675
P. Inc. Top Coded	0.111	0.136	0.334**	0.033	0.193	0.345**	0.249*
Parents Educ.							
HS Grad	0.096	-0.110	-0.042	0.195*	0.050	0.086	-0.099
Some Coll	-0.588***	-0.589***	-0.451***	-0.083	-0.272***	-0.117	-0.124
Coll. Grad	-0.463***	-0.647***	-0.400***	0.244**	-0.021	0.009	0.295**
Post-Grad	-0.022	-0.333***	-0.141	0.457***	0.178	0.301**	0.802***
Initial Major							
Science	-0.310***	0.029	0.701***	0.242***	1.115***	-0.242***	0.264***
Social Science	0.122	0.602***	0.885***	0.210**	0.726***	0.279***	0.388***
Const.	-0.466***	-0.234***	-1.436***	-0.366***	-0.738***	-0.076	-0.790***

Data Source: UCOP.
In both periods, utility of Riverside normalized to zero

Table 13: Extended Controls from Baseline Regressions

	URM:			
	w/o Quartiles		w/Quartiles	
	Extended Controls 1	Extended Controls 2	Extended Controls 1	Extended Controls 2
Acad. Index - Normalized	0.837***	0.646***	0.904***	0.702***
Log Par Income	0.035***	0.000	0.035***	-0.007
P. Inc. Missing	0.348***	-0.121	0.346***	-0.210
P. Inc. Top Coded	-0.005	-0.023	-0.005	-0.032
Parents Educ.				
HS Grad	-0.033***	-0.105	-0.033***	-0.112
Some Coll.	-0.038***	-0.164***	-0.038***	-0.170***
Coll. Grad	-0.008	-0.189**	-0.007	-0.195**
Post-Grad	0.004	-0.170**	0.004	-0.174**
Initial Major				
Science	-0.079***	-0.138***	-0.079***	-0.147***
Social Science	0.031***	0.028	0.031***	0.028
Const.	0.137***	0.255***	0.094***	0.218***
Acad. Index *				
Log Par Income		0.056		0.068
P. Inc. Missing		0.751		0.889
P. Inc. Top Coded		0.021		0.035
Parents Educ.				
HS Grad		0.119		0.131
Some Coll.		0.203**		0.214**
Coll. Grad		0.285**		0.295**
Post-Grad		0.269**		0.278**
Initial Major				
Science		0.089		0.104
Social Science		0.004		0.004

	Whites:			
	w/o Quartiles		w/Quartiles	
	Extended Controls 1	Extended Controls 2	Extended Controls 1	Extended Controls 2
Acad. Index - Normalized	0.825***	0.674***	0.826***	0.671***
Log Par Income	0.024***	0.037	0.024***	0.035
P. Inc. Missing	0.255***	0.388	0.254***	0.367
P. Inc. Top Coded	-0.001	-0.096**	-0.001	-0.096**
Parents Educ.				
HS Grad	-0.061***	-0.229**	-0.061***	-0.228**
Some Coll.	-0.034***	-0.133	-0.034***	-0.134
Coll. Grad	0.009	-0.033	0.009	-0.035
Post-Grad	0.018*	0.028	0.018*	0.023
Initial Major				
Science	-0.050***	-0.209***	-0.050***	-0.215***
Social Science	0.014***	-0.040	0.014***	-0.040
Const.	0.178***	0.286***	0.178***	0.288***
Acad. Index *				
Log Par Income		-0.019		-0.017
P. Inc. Missing		-0.192		-0.164
P. Inc. Top Coded		0.131**		0.131**
Parents Educ.		-0.192		-0.164
HS Grad		0.239		0.237
Some Coll.		0.141		0.142
Coll. Grad		0.060		0.063
Post-Grad		-0.010		-0.004
Initial Major				
Science		0.216***		0.223***
Social Science		0.075		0.075

Data Source: UCOP.

Table 14: Intercept and Slope for Graduation Rates for Post Prop-209 Period

Specification	Baseline	(1)	(2)	(3)	(4)
Campus-Specific Intercepts:					
Berkeley	0.044**	0.013	0.029	-0.048	0.006
UCLA	0.046**	0.007	0.020	-0.021	0.002
San Diego	0.087***	0.046	0.060*	0.018	0.044
Davis	0.013	0.016	0.017	-0.037	0.001
Irvine	0.061***	0.052**	0.051**	-0.017	0.038
UCSB	0.082***	0.067***	0.067***	0.048**	0.053**
Santa Cruz	0.032*	0.048**	0.046**	0.000	0.042*
Campus-Specific Slopes:					
AI	0.042***	0.032**	0.032**	0.029**	0.028**
Berkeley	0.043***	0.040**	0.035**	0.056***	0.044**
UCLA	0.048***	0.047***	0.043**	0.057***	0.050***
San Diego	-0.001	0.002	-0.002	0.009	0.005
Davis	0.044**	0.044**	0.043**	0.053***	0.048**
Irvine	0.006	0.008	0.009	0.019	0.014
UCSB	0.000	0.001	0.000	0.003	0.005
Santa Cruz	-0.015	-0.016	-0.013	-0.008	-0.009

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

Campus-specific intercepts are evaluated at mean academic index for pre-209 Minority students and are measured relative to UC-Riverside.

Campus-specific slope coefficients on standardized academic index variable, $AI_{std,r,t}$ for $r = Minority$ and $t = Pre - 209$. Each coefficient measures the effect of a one S.D. increase in academic index on probability of graduation and these effects are measured relative of that for UC-Riverside.

All specifications include the following control variables: parents' income and education and initial major.

Specification 1 adds a full set of dummy variables indicating whether the student applied to and/or admitted to each of the eight UC campuses.

Specification 2 adds to Specification 1 the number of campuses applied to and admitted to for each of three tiers of UC campuses, with Tier 1 which includes UC-Berkeley, UCLA and UC-San Diego, Tier 2 which includes UC Davis, UC Irvine and UC Santa Barbara, and Tier 3 which includes UC Santa Cruz and UC Riverside, and also dummy variables that indicate whether a student applied to campuses in the Tier above or in the Tier below the Tier to which they were admitted.

Specification 3 includes the base specification plus a set of dummies for the highest ranked campus a student was admitted to.

Specification 4 includes the controls in Specification 2, plus a student's total number of applications and admissions, respectively, as well as an average of average academic index of the applicants/admits for campuses the student applied/was admitted.

Table 15: Other Coefficients From Intercept/Slope Grad Rates Table, Post-209 Period

	Baseline		(1)		(2)		(3)		(4)	
Log Par Income	0.038	***	0.039	***	0.039	***	0.039	***	0.039	***
P. Inc. Missing	0.403	***	0.414	***	0.420	***	0.416	***	0.421	***
P. Inc. Top Coded	-0.017		-0.019		-0.019		-0.018		-0.019	
Parents Educ.										
HS Grad	-0.016		-0.016		-0.014		-0.015		-0.015	
Some Coll.	-0.023	*	-0.018		-0.016		-0.019		-0.017	
Coll. Grad	0.004		0.010		0.012		0.008		0.012	
Post-Grad	0.018		0.023		0.026	*	0.022		0.024	*
Initial Major										
Science	-0.083	***	-0.082	***	-0.082	***	-0.082	***	-0.082	***
Social Science	0.035	***	0.035	***	0.035	***	0.036	***	0.035	***
Applied:										
Berkeley			-0.027	***	-0.034	***			-0.017	
UCLA			0.012		0.000				0.007	
San Diego			0.013		0.002				0.007	
Davis			-0.012		-0.010				-0.009	
Irvine			-0.034	**	-0.031	*			-0.034	**
Santa Barbara			0.007		0.010				0.007	
Santa Cruz			0.020		0.093	**			0.095	**
Riverside			-0.072	*	0.016				0.004	
Admitted:										
Berkeley			0.041	*	0.047	**			0.027	
UCLA			0.026		0.036	*			0.022	
San Diego			0.031	*	0.046	**			0.039	**
Davis			0.021		0.010				0.010	
Irvine			0.042	**	0.030				0.028	
Santa Barbara			0.020		0.007				0.007	
Santa Cruz			-0.023		-0.101	**			-0.106	**
Riverside			0.083	**	-0.008				0.005	
Applied:										
Top Tier					0.079	**			0.101	**
Mid Tier					-0.018				-0.016	
Low Tier					-0.144	**			-0.170	***
Admitted:										
Top Tier					-0.037				-0.103	**
Mid Tier					0.060	*			0.051	
Low Tier					0.182	***			0.219	***
Adm Top & App Low					-0.022				-0.018	
Adm Low & App Top					-0.026				-0.018	
Adm Top & App Mid					0.021				0.053	
Adm Mid & App Top					-0.037				-0.045	
"Best" Admitted:										
Berkeley							0.029			
UCLA							-0.006			
San Diego							0.023			
Davis							-0.037			
Irvine							0.066	***		
Santa Barbara							-0.004			
Santa Cruz							0.055	**		
Avg. AI at Applied									-1.698	*
Avg. AI at Admitted									1.463	***
Constant	0.648	***	0.627	***	0.573	***	0.612	***	0.728	

Data Source: UCOP.