# Does Banning Affirmative Action Lower College Student Quality?

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**Abstract**

Banning affirmative action from college admissions cannot prevent an admissions office that cares about diversity from achieving it in ways other than explicitly considering race. We model college admissions where candidates from two groups with different average qualifications compete for a fixed number of seats. Under affirmative action, an admissions office that cares both about quality and diversity admits the best-qualified candidates from each group. Under a ban, it may promote diversity by partially ignoring candidates' qualifications and therefore not admitting the best-qualified candidates from either group. A ban always reduces diversity and may also lower quality. (JEL J71, J15, I28)

American colleges and universities value both the academic qualifications and the ethnic and racial diversity of their student bodies. Because candidates from minority groups tend to have lower high-school grades and standardized-test scores than their majority counterparts, elite colleges and professional schools achieve diversity through lower admissions standards for minority students.[1] Thomas J. Kane (1998) estimates that at the most selective American colleges and universities in 1982, African-American candidates were as likely to be admitted as white candidates with SAT scores 400 points higher.

Affirmative action, as such race-conscious admissions policies are commonly known, has come under a flurry of attack in recent years. In 1995, the Regents of the University of California banned race-conscious admissions.[2] In 1996, a panel from the Fifth Circuit Court of

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[1] In the context of college admissions, the term "minority" usually refers to African Americans, American Indians, Chicanos, and Latinos. Asians are excluded because they are overrepresented.

[2] The ban was repealed in 2001, by which time Proposition 209 precluded affirmative action.

Appeals struck down the admissions system at the University of Texas at Austin's law school in a ruling that forbids race-conscious admissions at all public universities in Louisiana, Mississippi, and Texas. In the same year, California voters approved Proposition 209, prohibiting public colleges and universities from using race in any admissions or financial-aid decision. More challenges are underway in several other states.[3]

Critics argue that affirmative action lowers quality by rejecting majority candidates in favor of less-qualified minority candidates. But banning affirmative action does not simply replace minority candidates who would be admitted through affirmative action with better-qualified majority candidates. Since American colleges and universities control their own admissions policies, those institutions that consider diversity an important part of their missions may react to bans on affirmative action by changing their admissions policies to favor minority candidates. An evaluation of the pros and cons of a ban must take these reactions into account.

This paper models the decision problem of a college admissions office that values both student quality and diversity. In the model, candidates from a majority group and a minority group compete for a limited number of seats in an entering class; minority candidates are on average less academically qualified than majority candidates. Under affirmative action, the admissions office sets a lower admissions standard for the minority group, but within each group it admits the best-qualified candidates. Under a ban on affirmative action, the admissions office may adopt an admissions rule that partially ignores candidates' qualifications. Since minority candidates as a group are less qualified than majority candidates, ignoring qualifications increases minority enrollment. But such rules fail to admit the best-qualified candidates from either group. Hence, they are inefficient: for any admissions rule that partially ignore qualifications, there exists an affirmative-action rule that yields the same diversity and strictly higher student quality. In fact, affirmative action maximizes total student quality for any level of diversity. In addition, under a ban the admissions office may admit candidates who are less-qualified than all minority candidates admitted under affirmative action, or reject candidates who are better-qualified than some majority candidates admitted under

[3] In 1998, Washington state voters passed a proposition identical to California's 209. In 2001, a Federal Circuit court ended affirmative action at the University of Georgia. Not all legal challenges to affirmative action have been successful: in the 2000 case *Gratz v. Regents of the University of Michigan*, a district court upheld affirmative action in undergraduate admissions at the University of Michigan (while the next year in *Grutter v. Regents of the University of Michigan* the same court struck down affirmative action from law school admissions). Likewise, in the 2000 case *Smith v. University of Washington*, the Ninth Circuit Court of Appeals upheld affirmative action in law school admissions.

affirmative action. In either case—if the admissions office admits enough poorly-qualified candidates or rejects enough highly-qualified candidates—the quality of admitted candidates may fall relative to affirmative action.

Thus banning affirmative action cannot prevent an admissions office that cares about diversity from achieving it in ways other than explicitly considering race. Indeed, public universities in California and Texas have reacted to bans by de-emphasizing standardized tests in favor of high-school class ranking and other less tangible qualifications, where minority candidates perform relatively well. Not only are these new rules inefficient, but they may not be any fairer than explicit affirmative action. In our model, when under a ban quality falls, the admissions rule is also less “meritocratic”: it performs worse at matching the best-qualified candidates (from any ethnic group) to the college.

A number of economics papers examine discrimination or affirmative action.[4] Our model is similar to taste-based discrimination (Gary S. Becker, 1957) in the sense that the admission office's taste for diversity is tantamount to a preference for minority candidates. But our core result that a college may achieve diversity by partially ignoring candidates' qualifications derives from an intuition much like statistical discrimination (Edmund S. Phelps, 1972; Kenneth J. Arrow, 1973), except that instead of race serving as a signal of qualification, qualification serves as a signal of race.[5] Shelley J. Lundberg (1991) and Stephen Coate and Loury (1993), among others, examine the effects of affirmative action in the labor market. But in their papers firms are constrained by affirmative action, whereas in ours the admissions office is constrained by a ban on affirmative action. The paper closest to ours is Lundberg (1991), where workers from two racial groups and of two different heights have unobservable human capital; majority workers tend to have higher human capital and be taller than minority workers. Lundberg shows that when firms are prohibited from conditioning wages on group identity, they use height instead. When height also correlates with human capital (conditional on race), firms prefer a requirement equating the average wages of minority and majority workers to a ban on using height and group identity in wage setting. The intuition is similar to that behind our result that affirmative action is the most efficient means of achieving diversity.

The next section introduces a formal model of a college's admissions process. Section II

[4] Glenn Loury (2000) provides a survey of the literature.

[5] We are grateful to an anonymous referee for pointing out this connection to us.

characterizes admissions rules under affirmative action; Section III does the same under a ban; and Section IV compares the two regimes, giving an example where banning affirmative action lowers quality. Section V describes how bans on affirmative action in Texas and California were followed by changes in admissions policies consistent with our model. Section VI concludes.

# 1 A Model of College Admissions

## 1.1 Candidates

A college must admit a fraction $C$ of candidates applying for a fixed number of seats in its entering class. Each candidate comes from one of two groups, the minority group, $N$, or the majority group, $W$. Fraction $N$ of candidates come from group $N$, and fraction $W$ from group $W$, where $N + W = 1$.[6]

Each candidate has a standardized-test score $t$ in $[\underline{t}, \bar{t}]$. The expected academic promise or "quality" of a candidate with test score $t$ is simply $t$: the higher a candidate's score, the higher her quality. The quality of a candidate with a given test score does not depend upon her group identity.

The distributions of test scores for the two groups are described by the functions $n(t)$ and $w(t)$ that are positive everywhere on $(\underline{t}, \bar{t})$: $n(t)dt$ is the number of minority candidates who score in $(t, t + dt)$, so $\int_{\underline{t}}^{\bar{t}} n(t)dt = N$ (and likewise for $w(t)$). An important feature of the model is that minority candidates tend to have lower test scores than majority candidates. This reflects the empirical regularity that minority candidates for college admissions tend to have lower standardized-test scores and high-school grades than majority candidates.[7] We capture this by assuming the strict monotone-likelihood-ratio property (SMLRP):

**Assumption 1** $\frac{w(t)}{n(t)}$ *is continuously differentiable, and for each* $t \in (\underline{t}, \bar{t})$, $\frac{w(t)}{n(t)}$ *is strictly increasing in* $t$.

The SMLRP means that the higher a candidate's test score, the greater the probability that

[6] We do not formally assume that the majority group outnumbers the minority group but use the terms "majority" and "minority" to clarify the exposition and relate the formal model to current debate over admissions.

[7] Minority candidates may score lower because they are more likely to attend schools that are insufficiently funded, because they suffer discrimination, or simply because they are on average less prepared than majority candidates. (See Christopher Jencks and Meredith Phillips, 1998, for a discussion of racial test-score gaps, as well as Claude M. Steele and Joshua Aronson, 1998, for experimental evidence on stereotyping as a cause.) For the purposes of this paper, however, only the fact that these gaps exist matters.

she belongs to the majority group. Alternatively, the share of candidates scoring $t$ who belong to the majority group is increasing in $t$.

### 1.2 Admissions

When designing its admissions rule, the admissions office knows the number of candidates and test-score distributions from the two groups. All candidates apply, and all admitted candidates matriculate. Because candidates make no decisions in our model, the admissions rule does not affect the applicant pool.

An admissions rule assigns to each candidate a probability of admission based upon her group identity and test score. We require that admissions rules satisfy two conditions. First, within each group the probability of admission must be (weakly) increasing in test score, meaning that the higher a candidate's test score the more likely she is admitted. Second, the fraction of candidates admitted must equal $C$. Formally, $r \equiv (r_N, r_W)$ is an admissions rule if for each $G \in \{N, W\}$, $r_G(t) : [\underline{t}, \bar{t}] \to [0, 1]$ is weakly increasing in $t$, and $\int_{\underline{t}}^{\bar{t}} r_N(t)n(t) + r_W(t)w(t)dt = C$. If affirmative action is banned, then $r_N$ and $r_W$ must coincide. Using a random admissions rule—one that does not admit the highest-scoring candidates with probability one—is equivalent to adding "noise" to candidates' test scores and then accepting the highest-scoring candidates on this noisy test. Throughout the paper, $N(r)$ and $W(r)$ denote the number of candidates from the two groups admitted under rule $r$.

As we shall see, when affirmative action is banned the admissions office's preferred rule may not be increasing in test score. But we believe that a variety of factors make non-increasing rules socially undesirable or infeasible. These include fairness—people would not think a rule favoring low-scoring candidates over high-scoring candidates was fair if they thought the test was fair—and incentive compatibility constraints—candidates might deliberately do poorly on the test if that would increase their chance of admission.

### 1.3 Preferences

The admissions office wants to maximize the total quality or test score of admitted candidates and minimize the difference in group composition between the applicant pool and the entering class. Its preferences over rules are represented by

$$U^{AO}(r) = \int_{\underline{t}}^{\bar{t}} t(r_N(t)n(t) + r_W(t)w(t))dt - \alpha \left| N - \frac{N(r)}{C} \right|, \tag{1}$$

where $\alpha$ is a positive number capturing its taste for diversity. The integral is the total test score of candidates admitted by rule $r$, and $\left|N - \frac{N(r)}{C}\right|$ is the difference in group composition between the applicant pool and the class admitted. When $\alpha = 0$ the admissions office cares only about quality; when $\alpha$ is arbitrarily large the admissions office cares only about diversity; for intermediate values of $\alpha$, the admissions office trades quality off against diversity. Whatever their reasons, elite colleges and universities clearly do think that diversity is important.[8]

The admissions office picks an admissions rule to solve the constrained maximization program

$$\max_{r \in \mathcal{R}} \int_{\underline{t}}^{\bar{t}} t(r_N(t)n(t) + r_W(t)w(t))dt - \alpha \left|N - \frac{N(r)}{C}\right| \tag{2}$$

$$\text{s.t. } N(r) + W(r) = C, \tag{3}$$

where $\mathcal{R}$ is the set of allowable admissions rules. When the admissions office cannot use affirmative action, $\mathcal{R}$ includes only admissions rules that do not depend on group affiliation.

## 2 Affirmative Action

Under affirmative action, the admissions office can use a separate admissions rule for each group. Because the admissions office prefers candidates with higher test scores within each group, it sets a cutoff level for each group and admits any candidate scoring above her group's cutoff. Let $r_{th}(t_N, t_W)$ be the threshold rule that admits all minority candidates scoring at least $t_N$ and all majority candidates scoring at least $t_W$.

When the admissions office uses a threshold rule, its optimization problem becomes

$$\max_{t_{\mathsf{N}}, t_{\mathsf{W}}} \int_{t_{\mathsf{N}}}^{\bar{t}} tn(t)dt + \int_{t_{\mathsf{W}}}^{\bar{t}} tw(t)dt + \alpha \left|N - \frac{\int_{t_{\mathsf{N}}}^{\bar{t}} n(t)dt}{C}\right| \tag{4}$$

$$\text{s.t. } \int_{t_{\mathsf{N}}}^{\bar{t}} n(t)dt + \int_{t_{\mathsf{W}}}^{\bar{t}} w(t)dt = C. \tag{5}$$

[8] One reason an admissions office may care about diversity is that minority students may generate externalities that benefit all students; several studies indicate that to be the case (e.g., Derek C. Bok, 1982; Committee on Admissions and Enrollment, 1989; and William G. Bowen and Bok, 1998). Another is that a college degree may add more value to a minority student of a given academic ability than to a majority student of the same ability (Cecilia A. Conrad and Rhonda V. Sharpe, 1996; and Bowen and Bok, 1998). Finally, past discrimination against minority candidates may cause the admissions office to want to admit them in the interest of social justice.

The last two points suggest that rather than care about diversity *per se* the admissions office may prefer minority candidates to majority candidates with the same test score. (An admissions office that believes the test is biased against the minority group shares these preferences.) Because in our model the minority group is always underrepresented, a preference for minority candidates is equivalent to a taste for diversity.

**Proposition 1** *Given Assumption 1, the optimal admissions rule under affirmative action is the threshold rule* $r_{th}(t_N^*, t_W^*)$ *such that* $0 \leq t_W^* - t_N^* \leq \frac{\alpha}{C}$*. The minority group is weakly underrepresented under* $r_{th}(t_N^*, t_W^*)$*.*

The minority group is never overrepresented under the optimal admissions rule, for if it were the admissions office could simultaneously improve diversity and quality by admitting more majority candidates, as the majority group has higher test scores than the minority group. Whether the admissions office adopts affirmative action (by setting $t_N^* < t_W^*$) depends upon its preference for diversity. If $\alpha = 0$, the admissions office does not care about diversity and therefore maximizes the quality of the entering class by setting $t_N^* = t_W^*$. In this case, the minority group is strictly underrepresented. If $\alpha$ is large, the admissions office cares very much about diversity and therefore admits the two groups in proportion to their shares of the applicant pool. Let $r_{th}(\widetilde{t}_N, \widetilde{t}_W)$ be the threshold rule that achieves proportionate representation. If $\frac{\alpha}{C} > \widetilde{t}_W - \widetilde{t}_N$, then $r_{th}(\widetilde{t}_N, \widetilde{t}_W)$ is optimal. For intermediate values of $\alpha$, the admissions office cares about diversity, but not so much that it is willing to sacrifice any amount of quality to achieve it. We shall focus on this case, which best describes most elite American colleges and universities.

**Assumption 2** $0 < \frac{\alpha}{C} < \tilde{t}_W - \tilde{t}_N$.

**Corollary 1** *Given Assumptions 1 and 2,* $t_N^* < t_W^*$*, but the minority group is strictly underrepresented. Moreover,* $t_W^* - t_N^* = \frac{\alpha}{C}$*.*

When the minority group is underrepresented, the value of the marginal majority candidate is her test score, $t_W^*$, and the value of the marginal minority candidate is her test score plus her positive effect on diversity, $t_N^* + \frac{\alpha}{C}$. Under the optimal rule, the admissions office is indifferent between marginal candidates from the two groups.

## 3 A Ban on Affirmative Action

When affirmative action is banned, the admissions office must use a rule that treats the two groups identically. Let $\mathcal{R}_{NA}$ be the set of such admissions rules; since a rule in $\mathcal{R}_{NA}$ depends only on test score, we drop the group subscript and refer to such a rule as $r(t)$. Assumption 1 (SMLRP) implies that, so long as $r$ is increasing in $t$, the minority group is weakly underrepresented. Thus, we can ignore the absolute-value sign in the admissions office's objective function and drop the constant term $\frac{\alpha N}{C}$ to rewrite the admissions office's problem as

$$\max_{r \in \mathcal{R}_{\mathrm{NA}}} \quad \int_{\underline{t}}^{\bar{t}} r(t)\gamma(t)\left(n(t)+w(t)\right) dt \tag{6}$$

$$\text{s. t.} \quad \int_{\underline{t}}^{\bar{t}} r(t)\left(n(t)+w(t)\right) dt = C, \tag{7}$$

where $\gamma(t) \equiv t + \frac{\alpha}{C}\frac{n(t)}{n(t)+w(t)}$. The function $\gamma$ represents the increase in the admissions office's utility from admitting a candidate with test score $t$. It incorporates the admissions office's taste for diversity: *ceteris paribus*, the higher is the share of candidates scoring $t$ from the minority group, the more the admissions office likes candidates scoring $t$.

The admissions office would like to fill its class with candidates with the highest $\gamma$. When $\gamma$ is everywhere increasing in $t$, it simply uses a threshold rule. However, $\gamma$ might not be monotone in $t$. When the share of candidates belonging to the minority group declines sufficiently quickly at $t$, then $\gamma$ falls at $t$. In this case, the admissions office might not be able to admit its favorite candidates without violating the constraint that the probability of admission be increasing in $t$.

**INSERT FIGURE 1 ABOUT HERE**

In Figure 1, $\gamma$ attains its maximum at $t_a$: the admissions office prefers candidates scoring $t_a$ to all others. Since $r$ must increase in $t$, the admissions office cannot admit candidates scoring $t_a$ without also admitting all candidates with higher test scores. If $C$ is too small to admit all such candidates, the only way to admit some candidates scoring $t_a$ is to adopt a random rule. To determine which random rule is optimal, let, for $t_1 \leq t_2$,

$$\Gamma(t_1,t_2) \equiv \begin{cases} \frac{\int_{t_1}^{t_2} \gamma(t)(n(t)+w(t))dt}{\int_{t_1}^{t_2} n(t)+w(t)dt} & \text{for} \quad t_1 < t_2 \\ \gamma(t_1) & \text{for} \quad t_1 = t_2. \end{cases} \tag{8}$$

$\Gamma(t_1,t_2)$ is the average value of $\gamma$ over $(t_1,t_2)$. In Figure 1, let $t_m$ be the global maximum of $\Gamma(\cdot,\bar{t})$. This means that the admissions office prefers a randomly drawn candidate scoring above $t_m$ to a randomly drawn candidate scoring above any other $t$. Consequently, the admissions office fills its class as follows: first, it randomly admits candidates scoring in $[t_m,\bar{t}]$; second, if $C$ is large enough to admit all candidates scoring in $[t_m,\bar{t}]$ with probability one, it admits candidates scoring below $t_m$ in descending order of test score. Thus, whether the admissions office chooses a threshold rule depends on class size, $C$. With enough seats, the admissions office uses a threshold rule; with fewer seats, the admissions office uses a random rule—it conducts a lottery over all candidates scoring above $t_m$ that gives each of them the same chance of admission.

In general, whenever $\gamma$ is not monotone, the admissions office chooses a random admissions rule for some $C$. The optimal random rule takes a simple form. It is either, as above, a one-step rule—all candidates scoring above some threshold are admitted with equal probability—or a two-step rule—candidates with the highest scores are admitted with probability one and those with intermediate scores are admitted with the same probability less than one. A two-step rule is optimal when the admissions office likes the highest-scoring candidates best but prefers some low-scoring candidates to all those scoring in between.

**Proposition 2** *Whenever $\gamma$ is not everywhere increasing in $t$, the optimal admissions rule is a random rule for some $C$. Furthermore, there exists an optimal random rule that contains at most two steps.*[9]

The first part of Proposition 2 is straightforward. When $\gamma$ decreases in some interval $[t, t']$, the admissions office prefers a randomly selected candidate from $[t, t'']$, for $t'' \in (t, t']$, to any candidate scoring $t''$. A threshold rule, therefore, is not optimal when $C$ lies between the number of students scoring above $t'$ and the number scoring above $t$. The existence of an optimal two-step rule follows from the assumption that the admissions office's utility function is linear in diversity, which (when combined with the fact that the minority group is underrepresented under any admissions rule) allows preferences over entering classes to be decomposed into preferences over test scores that do not depend upon the overall group composition of the entering class.[10]

Without the constraint that the admissions rule must increase in test score, the admissions office would simply admit candidates with the highest $\gamma$, in which case its admissions rule would be deterministic. If it would use a threshold rule without the constraint, then clearly it also uses a threshold rule with the constraint. Because the converse is not true—if a threshold rule is optimal among all increasing rules, it might not be optimal among all rules—the

[9] Note that there may exist multiple optimal rules, some of which may contain more than two steps. See the appendix for details.

[10] However, linear preferences are not necessary; two-step rules are optimal as long as the admissions office's utility increases in test score and diversity, although proving this is beyond the scope of this paper.

monotonicity constraint increases the likelihood that the admissions office uses a threshold rule.

Proposition 2 allows us to explicitly characterize an optimal rule under a ban. We use $r_{2s}(t_1, t_2)$ to denote a two-step rule with cutoffs $t_1$ and $t_2$, and $r_{1s}(t_1)$ to denote the one-step rule with cutoff $t_1$. Corollary 2 summarizes the necessary conditions for an optimal random rule.

**Corollary 2** *If a one-step rule $r_{1s}(t_1)$ with $t_1 \in (\underline{t}, \overline{t})$ is optimal in $\mathcal{R}_{NA}$, then $\gamma(t_1) = \Gamma(t_1, \overline{t})$ and $\gamma'(t_1) \geq 0$. If a two-step rule $r_{2s}(t_1, t_2)$ with $t_1, t_2 \in (\underline{t}, \overline{t})$ is optimal in $\mathcal{R}_{NA}$, then $\gamma(t_1) = \Gamma(t_1, t_2) = \gamma(t_2)$, $\gamma'(t_1) \geq 0$, and $\gamma'(t_2) \geq 0$.*

In order for a one-step rule to be optimal, $\Gamma(\cdot, \overline{t})$ must attain its maximum at $t_1$. For a two-step rule to be optimal, $\Gamma(\cdot, t_2)$ must reach a maximum at $t_1$, and $\Gamma(t_1, \cdot)$ must reach a minimum at $t_2$. The last condition guarantees that the admissions office prefers a candidate scoring slightly above $t_2$ to one randomly drawn between $t_1$ and $t_2$. These necessary conditions reflect the admissions office's trade-off between quality and diversity. Admitting candidates with lower test scores improves minority enrollment but lowers total student quality; at the margin, the diversity gain exactly offsets the quality loss.

Random rules use the admissions test inefficiently. For instance, a random rule that admits every candidate scoring in $(t_1, t_2)$ with the same probability ignores test score in that range. The quality loss from randomization increases with the size of the gap $t_2 - t_1$, which, from the necessary conditions, is proportional to the change in group composition between $t_1$ and $t_2$. Roughly speaking, the quality loss from randomization tends to be larger when group composition changes rapidly with test scores. The following proposition underscores the inefficiency inherent in randomization.

**Proposition 3** *For each $r \in \mathcal{R}_{NA}$ that involves randomization, there exists an affirmative-action admissions rule $\tilde{r}$ that yields higher diversity and quality.*

Random admissions rules are inefficient because they do not select the most qualified candidates from either group. For any random rule $r$, we can construct an affirmative-action threshold rule, $\widetilde{r}$, that achieves the same diversity as $r$. Because $\widetilde{r}$ admits the best candidates from each group, it yields higher quality than $r$.

Proposition 3 shows that affirmative action is the most efficient way to achieve any given level of diversity. Given Assumption 1, the minority group is underrepresented under the common-threshold rule; if the admissions office wants a more diverse class, it must displace some majority candidates to make way for some less-qualified minority candidates. Affirmative action minimizes the cost of doing this by replacing the least-qualified majority candidates with the most-qualified minority candidates who otherwise would not be admitted.

It should be noted that the admissions office might not choose $\widetilde{r}$ under affirmative action, and, hence, Proposition 3 does not imply that using a random rule lowers quality relative to affirmative action.[11] The next section explores whether a ban lowers quality.

# 4 Comparing Regimes

A ban on affirmative action increases the "price" of diversity by forcing the admissions office to sacrifice within-group selection in order to achieve diversity. If the admissions office's taste for diversity is moderate enough that minority candidates are strictly underrepresented under affirmative action, then it admits a class that is less diverse than the one it admits under affirmative action.

**Proposition 4** *Under Assumptions 1 and 2, banning affirmative action strictly lowers minority enrollment.*

Under affirmative action, all minority candidates scoring above $t_N$ and all majority candidates scoring above $t_W$ are admitted. Thus, for the number of minority candidates to increase (and the number of majority candidates to decrease) under a ban, it must be that $r$, the admissions rule adopted when affirmative action is banned, admits some candidates scoring below $t_N$ and rejects some candidates scoring above $t_W$. Recall that Assumption 2 means that minority candidates are strictly underrepresented under affirmative action. From Corollary 1, $t_N + \frac{\alpha}{C} = t_W$. Write $\psi(t)$ for $n(t)/(n(t)+w(t))$, the share of candidates scoring $t$ who belong to the minority group. It follows that for all $t_1 \leq t_N$ and for all $t_2 \geq t_W$,

$$\gamma(t_1) = t_1 + \frac{\alpha}{C}\psi(t_1) < t_N + \frac{\alpha}{C} = t_W < t_2 + \frac{\alpha}{C}\psi(t_2) = \gamma(t_2). \tag{9}$$

That is, the admissions office strictly prefers candidates scoring above $t_W$ to those scoring below $t_N$. As a result, it can improve on $r$ by replacing an admitted candidate who scores below $t_N$ with a rejected candidate who scores above $t_W$. Hence, $r$ cannot be optimal.

[11] Indeed, Proposition 4 (below) shows that $\widetilde{r}$ cannot be optimal without violating Assumption 2.

Banning affirmative action may not raise student quality when the admissions office reacts by choosing a random rule. When minority enrollment does not fall under a ban, total quality must fall because randomization is less efficient than affirmative action (Proposition 3). However, for minority enrollment not to fall, the admissions office's preference for diversity must be so strong that minority candidates are proportionately represented under affirmative action (Proposition 4). Such an extreme taste for diversity seems unlikely. But even in the more common case where a ban causes diversity to fall, quality also may fall. The test-score gap between marginal majority and minority candidates under affirmative action, $t_W - t_N$, is larger than the difference between the two cutoff points of an optimal two-step rule, $t_2 - t_1$.[12] When $(t_1, t_2)$ is contained in $(t_N, t_W)$, the optimal two-step rule admits every high-scoring majority candidate admitted by affirmative action and rejects every low-scoring minority candidate rejected by affirmative action; hence, the total quality of the entering class increases.[13] However, when $(t_1, t_2)$ is not contained in $(t_N, t_W)$, under a ban the admissions office either admits some candidates scoring below all candidates admitted under affirmative action or rejects some high-scoring majority candidates admitted under affirmative action. In either case, total quality may be lower under a ban than under affirmative action. The following example illustrates why quality may fall when $t_1 < t_N < t_2 < t_W$. The case where $t_N < t_1 < t_W < t_2$ is similar and hence omitted.

**Example 1** *Let* $[\underline{t}, \overline{t}] = [-\pi, 5\pi]$, $\frac{\alpha}{C} = 2\pi$, $n + w$ *be symmetric about* $\pi$ *for* $t \in [0, 2\pi]$,

$$(11) \qquad \int_{2\pi}^{5\pi} (n(t) + w(t))\, dt < C = \int_{4\pi-1}^{5\pi} w(t) dt + \int_{2\pi-1}^{5\pi} n(t)\, dt,$$

*and*

$$(12) \qquad \frac{n(t)}{n(t) + w(t)} = \begin{cases} 1 & \text{if} \quad t < 0 \\ \frac{\sin(t) - t}{2\pi} + 1 & \text{if} \quad t \in [0, 2\pi] \\ 0 & \text{if} \quad t > 2\pi. \end{cases}$$[14]

[12] This follows from combining the first-order conditions for optimal affirmative action and optimal two-step rules, so that

$$(10) \qquad t_2 - t_1 \le \frac{\alpha}{C} \left(\psi(t_1) - \psi(t_2)\right) < t_W - t_N.$$

[13] Let $T_G(t_1, t_2)$ be the average quality of candidates from group $G$ scoring between $t_1$ and $t_2$. When $(t_1, t_2) \subset (t_N, t_W)$, then for some $\delta \in [0, 1]$ the average quality of those candidates displaced by the ban is $\delta T_N(t_N, t_1) + (1 - \delta) T_N(t_1, t_2)$, which is no greater than $T_N(t_1, t_2)$. For some $\beta \in [0, 1]$, the average quality of the candidates replacing them is $\beta T_W(t_1, t_2) + (1 - \beta) T_W(t_2, t_W)$, which is no smaller than $T_W(t_1, t_2)$. By Assumption 1, $T_W(t_1, t_2) > T_N(t_1, t_2)$, which implies that average quality is higher under a ban.

Under affirmative action, the optimal threshold rule, $r_{th}(t_N, t_W)$, must satisfy the first-order condition $t_N + 2\pi = t_W$ and the capacity constraint $\int_{t_W}^{5\pi} w(t)dt + \int_{t_N}^{5\pi} n(t)\,dt = C$; this happens when $t_N = 2\pi - 1$ and $t_W = 4\pi - 1$.

Under a ban, the admissions office's preferences over test scores are given by

$$\gamma(t) = \begin{cases} t + 2\pi & \text{if} \quad t < 0 \\ \sin(t) + 2\pi & \text{if} \quad t \in [0, 2\pi] \\ t & \text{if} \quad t > 2\pi. \end{cases} \tag{13}$$

Since $n + w$ is symmetric about $\pi$ for $t \in [0, 2\pi]$ and $\sin(t) = -\sin(\pi + t)$, $\gamma(0) = \Gamma(0, 2\pi) = \gamma(2\pi) = 2\pi$. This is the necessary condition for optimality of a two-step rule stated in Corollary 2, and it is straightforward to verify that $(0, 2\pi)$ are the only cutoffs that satisfy it. Since $\gamma$ increases in $t$ for $t \notin [0, 2\pi]$, the admissions office prefers any candidate scoring above $2\pi$ to a random candidate scoring in $[0, 2\pi]$, whom it prefers to a candidate scoring below 0. Since

$$\int_{2\pi}^{5\pi} (n(t) + w(t))\,dt < C < \int_{0}^{5\pi} (n(t) + w(t))\,dt, \tag{14}$$

the class is large enough to admit all candidates scoring above $2\pi$ but not large enough to admit all those scoring above 0, and the optimal admissions rule under a ban is a two-step rule with $t_1 = 0$ and $t_2 = 2\pi$. In this case, banning affirmative action replaces minority candidates scoring in $[2\pi - 1, 2\pi]$ with majority candidates in $[2\pi, 4\pi - 1]$ and a fraction of all candidates in $[0, 2\pi]$. The change in total quality is

$$-\int_{2\pi-1}^{2\pi} tn(t)\,dt + \int_{2\pi}^{4\pi-1} tw(t)\,dt + p\int_{0}^{2\pi} t(n(t) + w(t))dt, \tag{15}$$

where $p$ is the fraction of candidates in $[0, 2\pi]$ admitted. While a ban admits some high-scoring majority candidates that affirmative action does not, it also admits some low-scoring candidates that affirmative action does not, namely those scoring in $[0, 2\pi - 1]$. The first-order conditions of the two optimal rules, however, do not specify the exact distribution of candidates. If there are very few majority candidates between $2\pi$ and $4\pi - 1$, then total quality declines, as the ban essentially replaces candidates between $2\pi - 1$ and $2\pi$ with those between 0 and $2\pi - 1$.[15]

[14] Note that $w(t)/n(t)$ satisfies the MLRP.

[15] For example, suppose $n(t) + w(t) = 0$ for $t \in [2\pi, 4\pi - 1]$. A ban replaces minority candidates in $[2\pi - 1, 2\pi]$, whose average quality is at least $2\pi - 1$, with all candidates scoring in $[0, 2\pi]$, whose average quality is $\pi$ (by the symmetry of $n + w$ about $\pi$). Since $\pi < 2\pi - 1$, average quality falls under a ban.

## 5 Reactions to Bans on Affirmative Action

The University of California's ban on affirmative action went into effect with the selection of Fall 1998 freshmen. In March of 1999, the Regents of the University of California adopted a proposal granting every student in the top 4 percent of her high-school class eligibility to the University of California, starting in the fall of 2001.[16] Thus, whereas under the old policy a high-school senior was UC eligible if she was in the top 12.5 percent of high-school seniors statewide, under the new policy she is UC eligible if she is in the top 4 percent of her graduating class or in the top 8.5 percent of high-school seniors statewide who are not in the top 4 percent of their graduating classes.

Berkeley was affected by the ban more than any other UC campus. In 1999, Berkeley adopted a new admissions policy substantially changing its measure of academic achievement. UC policy requires that each campus fill at least half of its freshman class solely on the basis of academic achievement, which Berkeley previously measured by an Academic Index Score (AIS), a mathematical formula based on high-school GPA, SAT I, and SAT II (achievement test) scores. Berkeley's new admissions policy replaces the AIS with a broader measure of academic achievement that includes factors such as the type and number of high-school classes taken, grades in individual courses, and performance relative to high-school classmates. Unlike the AIS, the new measure of academic qualification does not assign specific weights to these various factors; instead, admissions committee members have the discretion to rate applications based on their overall impressions of candidates' credentials.

Boalt Hall, UC Berkeley's law school, attracted national media attention in 1997 when its entering class of 268 included only one African American.[17] The following year, administrators made a number of changes to their admissions policy. The new policy no longer assigns candidates Academic Index Scores—previously a function of undergraduate GPA (weighted by the quality of the candidate's undergraduate institution) and LSAT score. Indeed, it no longer adjusts candidates' GPAs to account for the quality of their undergraduate institutions. Nor does it consider candidates' exact LSAT scores; instead, LSAT scores are partitioned into intervals, and the admissions committee only learns which interval contains the candidate's score.

Texas's ban on affirmative was implemented in 1997. Later that year, the Texas state

[16] UC eligibility does not guarantee admission to every UC campus.

[17] The UC ban began a year earlier in graduate admissions than in undergraduate admissions.

legislature passed a law requiring that each campus of the University of Texas (e.g., UT Austin or Texas A&M) admit any candidate who graduated in the top ten percent of her high-school class, where rank is determined solely by high-school GPA. The law effectively creates two admissions tracks. Candidates belonging to the top-ten-percent group are judged solely by their school ranking, whereas other candidates are judged using more comprehensive criteria such as high-school GPA, SAT scores, and non-academic achievements. In 1997, 38 percent of the freshmen class at UT Austin belonged to the top ten percent of their high-school class. By 1999, the number had grown to 45 percent. Thus, approximately seven percent of the slots at UT Austin are affected by the law.[18]

With the exception of the California top-four-percent rule, all the changes we describe took effect one year after affirmative action was eliminated.[19] Tables 1-3 report enrollment figures for new first-year registrants at UC Berkeley, Boalt Hall, and UT Austin.[20] At all three institutions, minority enrollment dropped significantly immediately after the ban, but rebounded with the implementation of the new admissions policies.[21] At Berkeley, the fraction of freshmen belonging to an underrepresented minority group increased from 12.8 percent in 1998 to 15.6 percent in 2001. At Austin, it increased from 15.8 percent in 1997 to 17.8 percent in 2001. At Boalt Hall, the fraction of the entering class belonging to an underrepresented minority group increased from 5.2 percent in 1997 to 9.2 percent in 1999.

These recent changes in admissions policies confirm that admissions offices respond to bans on affirmative action by altering their admissions standards in ways favorable to minority candidates. The main reason why minority students are underrepresented in elite

[18] See Jodi Wilgoren (1999) and Bruce Walker (2000) on the impact of the top-ten-percent law in Texas.

[19] Saul Geiser (1998) reports simulations showing that the top-four-percent rule will increase the share of UC-eligible candidates who are African-American, Chicano, or Latino by approximately ten percent.

[20] All three institutions provide applicants the option of not reporting their ethnicities. At UC Berkeley, the share of new freshman not reporting grew from about 6 percent in 1997 to 15.3 percent in 1998 before falling to 8.8 percent in 1999. UC regulations prevent Berkeley from tracking non-reporting students, so it has no conclusive data on their ethnicities. We strongly suspect, however, that the increase in the non-response rate is due mainly to a change in the application form in 1998 and is not directly related to the ban on affirmative action. Before 1998, item 17 on the application form asked applicants to identify themselves as a member of one of several ethnic groups listed on the form. In 1998, the ethnicity question was moved back to item 130, and applicants had search a separate pamphlet for an ethnic-group code. In 1999, the ethnicity question stayed at item 130, but ethnic groups appeared once again on the application form. Thus, we report the size of ethnic groups at UC Berkeley by their shares of new first-year registrants reporting their ethnicities. At Boalt Hall and UT Austin, most students report voluntarily, and the fraction refusing to report has not changed significantly after the bans. For these two institutions, we report the size of ethnic groups as shares of all new registrants.

[21] Recall that the new admissions policies were implemented at Boalt Hall and UT Austin in 1998 and at UC Berkeley in 1999.

universities is that they score lower than majority students on standardized tests. Each of the four new admissions policies de-emphasizes standardized tests. Boalt Hall's new admissions policy is probably the most explicitly random: by not considering exact LSAT scores, it forces the admissions rule to be constant over intervals of test scores, so that even within an ethnic group higher-scoring candidates cannot be admitted with higher probability than lower-scoring candidates.[22] Berkeley's undergraduate admissions scheme is random in the sense that the same candidate may be accepted or rejected depending on which admissions officer rates her application.[23] In 1996, Berkeley accepted 94 percent of the top six percent of candidates by AIS score; by 2001, it accepted less than 66 percent.

An admissions office with an instrument perfectly correlated with ethnicity could use that instrument to admit any class it could under affirmative action. However, the evidence suggests that admissions offices only have access to instruments partially correlated with ethnicity. As a result, the new admissions policies do not admit the best candidates from any group. For example, since Texas high schools are partially segregated, the top-ten-percent rule probably admits better-qualified minority candidates than pure randomization. But since high schools are not perfectly segregated, the law forces colleges to reject (minority and majority) candidates in the second deciles of excellent high schools to make room for candidates in the top deciles of mediocre high schools, even when the former are more qualified than the latter.[24]

**INSERT TABLE 1 ABOUT HERE**

**INSERT TABLE 2 ABOUT HERE**

**INSERT TABLE 3 ABOUT HERE**

## 6 Conclusion

American colleges and universities control their own admissions policies. Because most elite institutions consider student-body diversity an important part of their missions, when affirmative action is banned they will find other channels to promote it. One is to adopt an admissions rule that partially ignores standardized-test scores and other traditional measures

[22] The law school's rationale for this change is that differences of one to three LSAT points are not significant. While this largely may be true, certain one-point differences are *very* significant, namely those that move a candidate from one element of the partition to the next.

[23] For a description of errors in expert judgment, see Colin Camerer and Eric Johnson (1991).

[24] The law also may reinforce ethnic segregation in high schools.

of academic ability. This is inefficient because it does not select the best candidates from any ethnic group. In our model, for every random admissions rule there is an affirmative-action rule with the same level of diversity and higher quality. In fact, random admissions rules may be so inefficient that a ban on affirmative action intended to improve student quality backfires and lowers it instead.

Changes in admissions policies in California and Texas suggest that the phenomena we describe are real and important. Following Texas, the Florida state legislature recently adopted a "One-Florida Plan" which replaces race-conscious admissions policies at ten public universities by a requirement that each of them admit any applicant in the top twenty percent of her high-school class. Proponents of Texas and Florida's rules claim that they can maintain diversity and quality simultaneously. But when minority students are on average less academically prepared than majority candidates, increasing diversity means lowering quality. Rather than confront this difficult trade-off, these new rules obscure it by adopting ostensibly "race-neutral" admissions policies designed to increase minority enrollment. Not only are such rules inefficient, but they may not be any fairer than explicit affirmative action. If the public judges the current gap between marginal minority and majority candidates too wide, then it may be better off limiting the extent of affirmative action rather than banning it completely. For example, an admissions office might be allowed to fill part, but not all, of its class using affirmative action.[25]

A ban on affirmative action affects characteristics of the entering class other than diversity and quality. One example is the gap in average test score between minority and majority matriculants. A large test-score gap may lead to harmful racial stereotyping.[26] In our model, a ban lowers majority matriculants' total test score since more majority candidates are admitted than under affirmative action. But if, like in the example in Section 4, the admissions office's preferred rule under a ban admits minority candidates who would not be admitted under affirmative action, then minority matriculants' average test score also may fall. In this case, a ban on affirmative action may cause the test-score gap to grow.

In our model, we have implicitly assumed that when affirmative action is banned the admissions office cannot discriminate between minority and majority candidates by using an instrument correlated with ethnicity. In reality, it could use class background for example,

[25] See Jimmy Chan and Erik Eyster (1999) for a more detailed discussion of limited affirmative action.

[26] See Jencks and Phillips (1998) for discussion of several facets of test-score gaps. See Loury (1987) for an argument why affirmative action may harm a minority group overall if it increases the test-score gap.

as whites and Asians are on average wealthier than African Americans and Latinos. But class-based affirmative action is unlikely to have much effect on diversity.[27] The reason is that within each ethnic group class is negatively correlated with academic ability. Kane (1998) shows that while a quarter of graduating high-school seniors have family incomes below $20,000, only seven percent of those scoring in the top tenth of their classes on reading and math tests have the same. As a result, an admissions policy that favors all low-income candidates will substantially reduce student quality. A policy that favors only low-income candidates who do well academically would not admit many minority students—only about one-tenth of one percent of minority students in Kane's sample both come from low-income families and belong to the top tenth of their high-school classes.

Our formal model considers admission decisions at one college. But as elite colleges compete against one another for the best students, how a ban affects one college depends on other colleges' affirmative-action policies. If most elite colleges have affirmative action, then the one college without it faces strong pressure to change its admissions policy to maintain some diversity. But if all elite colleges ban affirmative action, then the same college faces less pressure to change its admissions policy, since its pool of minority candidates expands when its competitors admit fewer minority candidates. Even in this case colleges may randomize, for otherwise, given the size of the test-score gap, minority enrollment would fall significantly.[28] A universal ban is also likely to have a larger effect on more competitive schools than on less competitive ones. As the most competitive colleges admit fewer minority candidates, the pool of qualified minority candidates may grow at less competitive schools. As a result, these schools may feel little pressure to randomize.

Throughout, we have ignored the decision problem of the outside authority actually banning affirmative action. In theory, it might overcome the agency problem studied in this paper in several different ways. One is by stipulating that the admissions office accept only the highest-scoring candidates. We do not think this is realistic because there is no obvious way to rank candidates who take more than one test; indeed, combining their various test scores into a single ranking is probably a crucial part of an admissions office's job. Since randomization in our model corresponds to a suboptimal weighting of multiple tests, it is impossible to prevent the admissions office from randomizing without knowing the proper

[27] Of course, class-based affirmative action may satisfy other policy objectives.

[28] See Bowen and Bok (1998) Chapter 2 for an estimate of the effect of a universal ban assuming no randomization.

weights to put on candidates' test scores. Forcing the admissions office to use a particular test may not work either: for instance, admitting candidates solely on the basis of SAT score may lower quality substantially.[29]

Another approach might be to provide the admissions office with monetary incentives that discourage randomization. For example, a college's admissions officers might be paid more the better qualified is its entering class. One problem with this is that matriculants' qualifications may not be readily observable: the common practice of grading "on a curve" obscures students' average qualifications. Admissions officers might also be paid to reduce the GPA gap between majority and minority matriculants. But these monetary incentives might not entirely eliminate the admissions office's incentive to randomize, for randomization might decrease the quality gap. Overall, although each of these schemes might reduce the agency problem, we do not believe that any combination of them could completely eliminate it.

While our model has focused on college admissions, its basic theme is likely to play out in other arenas. For example, many fire and police departments are under court order to increase diversity but also prohibited from using explicit affirmative action to achieve it. (See John R. Lott, Jr., 2000, for examples.) Several have dropped tests of physical strength, speed, etc. Doing so may increase diversity, but it may also reduce the quality of new police officers from each ethnic group. As a result, total quality may fall.

[29] See Jencks and Phillips (1998) for discussion of several facets of test-score gaps. See Loury (1987) for an argument why affirmative action may harm a minority group overall if it increases the test-score gap. Using admissions records from a selective college's 1989 freshman class, Frederick E. Vars and Bowen (1998) find that an academic index incorporating candidates' many qualifications predicts college grades better than SAT scores alone (with $R^2$ statistics of 0.37 versus 0.28).

# 7 Appendix: Proofs

**Proof of Proposition 1** Under affirmative action, the admissions of majority and minority candidates can be treated separately. Consider admissions rules for the majority group that admit $K$ majority candidates. Let $r_W^*$ be the threshold rule satisfying the capacity constraint and $r_W$ be some other admissions rule. Because for each $t \in [\underline{t}, \overline{t}]$ $\int_{\underline{t}}^{t} r_W^*(t)w(t)dt \leq \int_{\underline{t}}^{t} r_W(t)w(t)dt$,

$$\text{(A1)} \qquad U_W^{AO}(r_W^*) = \int_{\underline{t}}^{\overline{t}} tr_W^*(t)w(t)dt \geq \int_{\underline{t}}^{\overline{t}} tr_W(t)w(t)dt = U_W^{AO}(r_W),$$

and, thus, $r_W^*$ is optimal. By the same argument, a threshold rule is optimal for the admissions of $C - K$ minority candidates. Since a threshold rule is optimal for any group composition, it is optimal regardless of the admissions office's preferences for diversity.

If we ignore the absolute-value sign in its objective function, the admissions office solves

$$\text{(A2)} \qquad \max_{t_N, t_W} \int_{t_N}^{\overline{t}} \left(t + \frac{\alpha}{C}\right) n(t)dt + \int_{t_W}^{\overline{t}} tw(t)dt$$

subject to the capacity constraint. If the solution to the modified problem has the minority group underrepresented, then it is also the solution to the original problem. First-order conditions of the modified problem imply that $t_N + (\alpha)/(C) = t_W$. Recall that $r_{th}(\widetilde{t}_N, \widetilde{t}_W)$ is the threshold rule that achieves proportionate representation. If $\widetilde{t}_W < t_W$ and $\widetilde{t}_N > t_N$, then $r_{th}(\widetilde{t}_N, \widetilde{t}_W)$ is the optimal rule. On the other hand, if $\widetilde{t}_W > t_W$ and $\widetilde{t}_N < t_N$, then the minority group is strictly underrepresented, and $r_{th}(t_N, t_W)$ is the optimal rule. Finally, since $\alpha > 0$, $t_W > t_N$.

**Proof of Proposition 2** The proof of the first part is contained in the text.

We refer to random rules containing at most $k$ steps as $k$-step rules. To prove the existence of an optimal two-step rule, consider a $k$-step rule that is optimal among $k$-step rules. Let $t_1, t_2, ..., t_k$ be the thresholds of the $k$ steps and $p_1, p_2, ..., p_{k-1}$ be the step probabilities; that is, $p_j$ is the probability of acceptance for candidates in $(t_j, t_{j+1})$. For each $j \in \{2, ..., k - 1\}$, $\Gamma(t_{j-1}, t_j) = \Gamma(t_j, t_{j+1})$; if not, the admissions office could raise its utility from either lowering $p_{j-1}$ and raising $p_j$ or *vice versa.* Because the admissions office is indifferent between candidates drawn from each of the first $k-1$ steps, starting from any optimal $k$-step rule, by setting the probabilities of admission in the first $k-1$ steps equal, we can merge the first $k-1$

steps into one step without affecting the utility of the admissions office . As a result, for every optimal $k$-step rule, $r_{ks}$, there is a two-step rule $r_{2s}$ such that $U^{AO}(r_{2s}) = U^{AO}(r_{ks})$. More generally, for any feasible admissions rule $r$, which by definition is integrable, there exists a sequence of $k$-step rules $\{r_{ks}\}_{k=1}^{\infty}$ such that $U^{AO}(r) = \lim_{k\to\infty} U^{AO}(r_{ks})$. From above, we know that there exists a sequence of two-step rules, $\{r_{2s}^k\}_{k=1}^{\infty}$, such that $U^{AO}(r_{ks}) \leq U^{AO}(r_{2s}^k)$. It is straightforward to show that $\{r_{2s}^k\}$ converges to some well-defined two-step rule, $r_{2s}^*$. It follows that $U^{AO}(r) = \lim_{k\to\infty} U^{AO}(r_{ks}) \leq \lim_{k\to\infty} U^{AO}(r_{2s}^k) = U^{AO}(r_{2s}^*)$, meaning that for any feasible admissions rule, $r$, there is a two-step rule, $r_{2s}^*$, that is at least as good. Hence, an optimal rule that contains at most two steps must exist.[30]

**Proof of Corollary 2** By Proposition 2, we can rewrite the admissions office's maximization problem as

$$\text{(A3)} \qquad \max_{t_1,t_2,p} \int_{t_2}^{\bar{t}} \gamma(t)(n(t)+w(t))dt + p\int_{t_1}^{t_2} \gamma(t)(n(t)+w(t))dt$$

$$\text{(A4)} \qquad s.t. \quad p\int_{t_1}^{t_2} (n(t)+w(t))dt = C - \int_{t_2}^{\bar{t}} (n(t)+w(t))dt,$$

for $\underline{t} \leq t_1 \leq t_2$, $t_2 \leq \bar{t}$, and $0 \leq p \leq 1$. The necessary conditions follow from the Kuhn-Tucker theorem.

[30] An earlier draft of the paper showed that when the set of $\gamma$'s critical points ($\{t : \gamma'(t) = 0\}$) is finite, the only optimal rules are step rules, and that if a $k$-step rule is optimal, then $\gamma$ has at least $2k-3$ critical points. Together these imply that when $\gamma$ has no more than two critical points, the only optimal rules are two-step rules; moreover, it can be shown in this case that the optimal admissions rule is unique.

# References

[1] Arrow, Kenneth J. "The Theory of Discrimination," in Orley Ashenfelter and Albert Rees, eds., *Discrimination in Labor Markets*. Princeton: Princeton University Press, 1973, pp. 3-33.

[2] Becker, Gary S. *The Economics of Discrimination*. Chicago: The University of Chicago Press, 1957.

[3] Bok, Derek C. *Beyond the Ivory Tower: Social Responsibilities of the Modern University*. Cambridge: Harvard University Press, 1982.

[4] Bowen, William G. and Bok, Derek. *The Shape of the River: Long-Term Consequences of Considering Race in College and University Admissions*. Princeton: Princeton University Press, 1998.

[5] Chan, Jimmy and Eyster, Erik. "Does Banning Affirmative Action Lower College Student Quality?" Working Paper No. 440, Johns Hopkins University, 1999.

[6] Camerer, Colin F. and Johnson, Eric J. "The Process-Performance Paradox in Expert Judgment: How Can Experts Know So Much and Predict So Badly?" in K. Anders Ericsson and Jacqui Smith, eds., *Toward a General Theory of Expertise: Prospects and Limits*. Cambridge: Cambridge University Press, 1991, pp. 195-217.

[7] Coate, Stephen and Loury, Glenn. "Will Affirmative Action Policies Eliminate Negative Stereotypes." *American Economic Review*, December 1993, *83*(5), pp. 1220-1240.

[8] Committee on Admissions and Enrollment, Berkeley Division, Academic Senate, University of California. *Freshman Admissions at Berkeley: A Policy for the 1990s and Beyond*. Berkeley: The Senate, 1989.

[9] Conrad, Cecilia A. and Sharpe, Rhonda V. "The Impact of the California Civil Rights Initiative (CCRI) on University and Professional School Admissions and the Implications for the California Economy." *Review of Black Political Economy*, Summer 1996, *25*(1), pp. 13-59.

[10] Geiser, Saul. "Redefining UC's Eligibility Pool to Include A Percentage of Students From Each High School: Summary of Simulation Results." Oakland: UC Office of the President, 1999.

[11] Jencks, Christopher. "Racial Bias in Testing," in Christopher Jencks and Meredith Phillips, eds., *The Black-White Test Score Gap*. Washington: Brookings Institution Press, 1998, pp. 55-85.

[12] Jencks, Christopher and Phillips, Meredith, eds. *The Black-White Test Score Gap*. Washington: Brookings Institution Press, 1998.

[13] Kane, Thomas J. "Racial and Ethnic Preferences in College Admissions," in Christopher Jencks and Meredith Phillips, eds., *The Black-White Test Score Gap*. Washington: Brookings Institution Press, 1998, pp. 431-456.

[14] Lott, John R., Jr. "Does a Helping Hand Put Others at Risk?: Affirmative Action, Police Departments, and Crime." *Economic Inquiry*, April 2000, *38*(2), pp. 239-277.

[15] Loury, Glenn C. "How to Mend Affirmative Action." *Public Interest*, Spring 1987, pp. 33-43.

[16] Loury, Glenn. "Conceptual Problems in the Enforcement of Anti-Discrimination Laws," in Kenneth Arrow, Samuel Bowles, and Steven Durlauf, eds., *Meritocracy and Economic Inequality*. Princeton: Princeton University Press, 2000, pp. 296-316.

[17] Lundberg, Shelly. "The Enforcement of Equal Opportunity Laws Under Imperfect Information: Affirmative Action and Alternatives." *Quarterly Journal of Economics*, February 1991, *106*(1), pp. 309-326.

[18] Phelps, Edmund S. "The Statistical Theory of Racism and Sexism." *American Economic Review*, September 1972, *62*(4), pp. 659-661.

[19] Steele, Claude M. and Aronson, Joshua. "Stereotype Threat and the Test Performance of Academically Successful African Americans," in Christopher Jencks and Meredith Phillips, eds., *The Black-White Test Score Gap*. Washington: Brookings Institution Press, pp. 401-430.

[20] Vars, Frederick E. and Bowen, William G. "Scholastic Aptitude Test Scores, Race and Academic Performance in Selective Colleges and Universities," in Christopher Jencks and Meredith Phillips, eds., *The Black-White Test Score Gap*. Washington: Brookings Institution Press, pp. 457-479.

[21] Walker, Bruce. "Implementation and Results of HB 588 at The University of Texas at Austin, Report Number 2: Academic Performance and Persistence of Top 10% Students, Academic Year 1998-1999 and Fall 1999." <www.utexas.edu/student/research/reports/admissions/HB5882000329.html>

[22] Wilgoren, Jodi. "Texas' Top 10% Law Appears to Preserve College Racial Mix," *The New York Times*, November 24, 1999.

Table 1: First-Time Freshmen at UC Berkeley by Ethnicity

(Percent of Fall Registrants Reporting Ethnic Data, Number in Parentheses)

| | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|
| African American | 6.6 | 7.6 | 3.9 | 3.8 | 4.4 | 4.1 |
| | (233) | (257) | (126) | (126) | (148) | (143) |
| American Indian | 1.5 | 0.7 | 0.4 | 0.7 | 0.6 | 0.6 |
| | (52) | (23) | (14) | (22) | (20) | (22) |
| Asian American | 40.8 | 43.4 | 49.0 | 47.6 | 48.0 | 48.2 |
| | (1,432) | (1,468) | (1,565) | (1,583) | (1633) | (1689) |
| Chicano and Latino | 15.6 | 13.9 | 8.5 | 9.9 | 9.6 | 11.1 |
| | (549) | (470) | (271) | (330) | (327) | (388) |
| White | 31.0 | 30.1 | 34.1 | 33.4 | 33.1 | 32.4 |
| | (1,090) | (1,017) | (1,090) | (1,111) | (1124) | (1135) |
| Foreign | 2.7 | 2.1 | 2.5 | 2.7 | 2.3 | 2.0 |
| | (96) | (75) | (81) | (91) | (77) | (70) |
| Other | 1.7 | 2.2 | 1.5 | 1.8 | 1.9 | 1.5 |
| | (60) | (76) | (48) | (61) | (63) | (54) |

Source: UC Berkeley Office of Student Research

Table 2: First-Year Registrants at Boalt Hall by Ethnicity

(Percent of Fall Registrants, Number in Parentheses)

| | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|
| African American | 7.9 | 7.6 | 0.4 | 3.0 | 2.6 |
| | (21) | (20) | (1) | (8) | (7) |
| American Indian | 1.9 | 1.5 | 0.0 | 0.7 | 0.7 |
| | (5) | (4) | (0) | (2) | (2) |
| Asian | 12.0 | 14.4 | 12.7 | 14.1 | 11.2 |
| | (32) | (38) | (34) | (38) | (30) |
| Chicano and Latino | 13.5 | 10.6 | 5.2 | 8.6 | 5.9 |
| | (36) | (28) | (14) | (23) | (16) |
| Non-Minority | 64.7 | 65.8 | 81.7 | 73.6 | 79.6 |
| | (172) | (173) | (219) | (198) | (214) |

Source: UC Berkeley School of Law, 1999 Annual Admissions Report

Note: Non-Minority Includes Registrants Not Reporting Ethnicity

Table 3: First-Time Freshman at UT Austin by Ethnicity

(Percent of Fall and Summer Entrants, Number in Parentheses)

| | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|
| African American | 4.1 | 2.7 | 3.0 | 4.1 | 3.9 | 3.3 |
| | (266) | (190) | (199) | (286) | (296) | (242) |
| American Indian | 0.5 | 0.5 | 0.5 | 0.4 | 0.4 | 0.5 |
| | (34) | (36) | (37) | (28) | (32) | (34) |
| Asian American | 14.7 | 15.9 | 16.8 | 17.3 | 17.2 | 19.3 |
| | (942) | (1,130) | (1,133) | (1,221) | (1325) | (1413) |
| Chicano and Latino | 14.5 | 12.6 | 13.2 | 13.9 | 13.2 | 14.0 |
| | (932) | (892) | (891) | (976) | (1011) | (1024) |
| White | 64.7 | 66.8 | 65.2 | 63.2 | 62.5 | 60.6 |
| | (4,159) | (4,730) | (4,399) | (4,447) | (217) | (139) |
| Foreign | 1.5 | 1.5 | 1.2 | 1.2 | 2.8 | 1.9 |
| | (97) | (107) | (83) | (82) | (4) | (38) |

Source: UT Austin Statistical Handbook 1999-2000

(www.utexas.edu/academic/ois/)

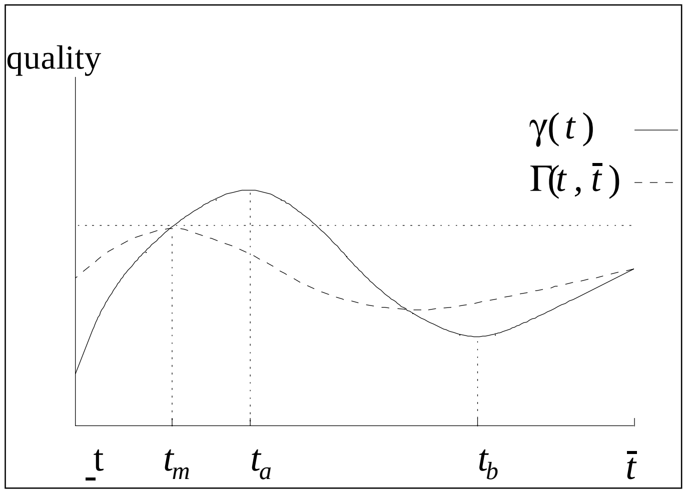


Figure 1