The Top-Ten Way to Integrate High Schools*

Fernanda Estevan†, Thomas Gall‡, Patrick Legros§,
Andrew F. Newman¶

This Version: September 2019

Abstract

We investigate the effects of "top-N percent" policies in college admission as possible instruments for increasing ethnic diversity at the high-school level. These policies produce incentives for students to relocate to schools with weaker academic competition. We provide theoretical conditions under which such school arbitrage will contribute to the desegregation of high schools. Along the way, we show that arbitrage can neutralize the policy at the college level, and we characterize inter-school flows, which display a cascade effect. Our model's predictions are supported by empirical evidence on the effects of the Texas Top Ten Percent Law, indicating that a policy intended to support diversity at the college level actually helped achieve it in the high schools in Texas.
Keywords: Matching, general equilibrium, affirmative action, education, college admission, high school segregation, Texas Top Ten Percent.
JEL: C78, I24, I28, D50, J78.

*For valuable comments and discussion, the authors are grateful to Matteo Bobba, Louis Kaplow, Michael Kremer, Louis-Philippe Morin, Bill Dickens, and seminar participants at BU, Bristol, Cambridge, Essex, EESP FGV, FEA-USP, FEA-RP, Harvard Law School, IZA, Mannheim, NGO, Northeastern, Ottawa, PUC-Rio, the 2019 ThReD conference, UQAM, Wilfrid Laurier University, and the 2018 Y-RISE Conference. Gall thanks DFG for financial support (Grant GA-1499) and BU for its hospitality. The research leading to these results has received funding from the European Research Council under the European Union's Seventh Framework Programme (FP7-IDEAS-ERC) / ERC Grant Agreement n^0 339950. Chaker El Mostafa and Deborah Goldschmidt provided excellent research assistance during this project.

†Sao Paulo School of Economics - FGV. fernanda.estevan@fgv.br
‡University of Southampton. t.gall@soton.ac.uk
§Université Libre de Bruxelles, Northeastern University, and CEPR. plegros@ulb.be
¶Boston University and CEPR. afnewman@bu.edu

1 Introduction

Could a law designed to maintain racial diversity in a state's universities help to integrate its high schools instead? Based on a theoretical and empirical analysis of the effects of such a policy implemented in the state of Texas, we show that it can.

Ever since *Brown vs Board of Education*, desegregation policies in the US have overwhelmingly been implemented by mandate. The main desegregation instrument, busing, took students out of their neighborhoods to faraway schools at significant private and social cost, resulting in political tension and occasional violence. The policies have been undermined by arbitrage, especially by whites, in the form of flight to the suburbs or enrollment in private schools. Such arbitrage limited the effects of desegregation laws, and increased differences in segregation between districts (Clotfelter, 2004, 2011; Logan, Oakley and Stowell, 2008). For example, though other factors may also have contributed, the percentage of blacks in majority white schools in the U.S. South, which had been trending upward since 1954, peaked in 1986 and then began to fall, so that by 2011 was back at its 1968 level (Orfield, Frankenberg, Ee and Kuscera, 2014).

This experience raises the question of whether a policy could be designed to harness market forces in a way that could help rather than hinder high school integration. For the economist, the most natural approach would be to provide monetary subsidies to whites who move to non-white districts or to tax them for staying in white districts. But not only would this raise a political ruckus, it would be unlikely to pass constitutional muster for its failure to be "color blind."

One color-blind strategy would be to offer tax breaks that are dependent on the relationship between a student's achievement (measured for example by standardized test scores) and those in the school he attends. A tax that decreases in the difference between his own achievement and the mean in the community, in which he attends high school, could make it attractive for a high achiever to move to a district in which mean achievement is low. If race and achievement are appropriately correlated, the attendant movement potentially would decrease racial segregation. Such policies have been absent in practice, however, possibly because of the evident budgetary and political costs they would impose.

An alternative instrument to monetary incentives is the allocation of valuable slots (civil service jobs, places in state universities) controlled by the policy maker at some level subsequent to high school. Thus the policy maker could allow the probability of obtaining a job or university admission to depend on the racial or achievement distribution of the school one attends (a special case of a "club-based policy" proposed in Gall, Legros and Newman 2009). For instance, suppose that for a given academic achievement level, admission to the university is a decreasing function of the difference between a student's achievement and some average for his school. Then moving to a school with a lower difference will increase the probability that the student is admitted, and will create incentives for movement *within* the public school system.

While we are not aware of any prior academic discussion along these lines, or of any pilot studies designed to asses their feasibility or possible effects, it turns out that such a set of policies *does* exist. Ostensibly conceived for something else, namely ethnic integration of universities rather than schools, their scale may be small compared to what might be needed to fully integrate high schools. Nonetheless, they can serve as a proof of concept for more comprehensive non-monetary integration subsidy policies, and it is in that capacity that this paper assesses how one of them performed to help integrate high schools.

In the late 1990's, several U.S. states, including three of the largest (California, Texas, and Florida) passed "top-N percent" laws, guaranteeing state university admission to every high school student who graduates in the top N percent of his or her class.[1] Following court decisions earlier in the decade, the use of affirmative action policies to maintain racial or ethnic balance in higher education was discontinued. The top-N percent laws (or top-n laws for short) were adopted in response: since high schools were highly racially segregated, the expectation was to draw a representative sample of the statewide high school population, guaranteeing diversity on campus.

Though top-n laws have attracted academic attention with respect to their efficacy in achieving the college diversity goal – the consensus appears to be that in this dimension, they have fallen rather short – there has been no study of the potential role of this policy for increasing diversity in high schools. Our theory and evidence serve as a first step in understanding the effects of policies like top-n on high school composition.

[1] California started admitting the top four, Florida the top twenty, and Texas the top ten percent performing students of every high school.

The implications of the arbitrage opportunity generated by top-n are hardly straightforward, for two distinct kinds of reasons. First, movement between schools by a even small fraction of students is fraught with externalities, which obscures what the overall allocation of students to schools will be post-policy. Second, even with a precise assessment of the flows of student achievement levels across schools, there is no immediate implication for how all this movement affects high school ethnic composition.

To see the first complication, suppose that a top-10 law is imposed in a state whose flagship university has only enough capacity for the top 10% of the state's students. Consider a high quality school that sent its top two deciles of students to the flagship pre-top-10. The second decile of students is now no longer eligible if they remain in that school, but can find places in other schools in which they would figure in the top ten. Upon their departure, however, the students in the 10th percentile are no longer eligible because of an "outflow externality" due to the population drop (the 10th best student in a school of 100 is in the top decile, but not so in a school of 90). So some of the students in the top decile will have an incentive to move as well.

The moving students' target schools are also affected. If the school population increases as a result, this could cement some students' place in the top decile (for instance, if the incoming students are weaker than they are). On the other hand, students who might have been in the top decile of a school before the policy may find themselves out of it if incoming students have higher achievement (an "inflow externality"), and thus may be induced to move elsewhere. Because of all these effects, the overall degree of churning may be larger (or smaller) than what may be expected if movement were limited just to the initially impacted.

The second issue is that achievement-based flows need not reduce racial segregation if, for example, the high achievers who move out of a top school into a racially representative mid-level one are predominantly from a majority group, while the students they displace into a low-quality, predominantly minority school are predominantly minority themselves. In such a case, the effect of the top-n law would be to increase segregation. Predicting the effects of top-n laws therefore requires finding conditions under which the movements it induces lead to more rather than less integration.

We provide a simple "general-equilibrium" model of students' relocation following the policy change – the first theoretical analysis of a top-n policy, as

far as we are aware – and establish two general and robust results. First, the Top-N Percent Neutrality Theorem states that if the private cost of moving across high schools is sufficiently low, the equilibrium sets of admitted students in university with and without a top-n policy are identical. This result is consistent with the disappointing performance of top-n policies in achieving ethnic integration of the universities. But it also tells us that in terms of top-n policies, high schools could be where the action is.

Specifically, our second main result, the Unbiased Mixing Theorem, shows that arbitrage *must* reduce the overall level of ethnic segregation at the high school level, as conventionally measured, if the flow of students between any pair of schools is ethnically representative of their origin schools. Hence, the movement of arbitrageurs across schools has the potential to blend the ethnic composition of *all* high schools.

In the case in which high schools can be ranked by their achievement distributions, the equilibrium analysis (summarized in Proposition 1) highlights an amplifying effect of relocation: movement of students will not confined only to the relatively few students who are just below the $N\%$ threshold in their original schools. Rather, there is a general-equilibrium effect in the form of a "cascade," resulting from the two externalities, which in this case both serve to increase flows. Students who move into a lower-quality school displace some of those who previously were above the threshold, departures renders some students above who were above the threshold ineligible as well because of the shrinking school population. The result is that displaced students then move further down, displacing others, and so on, leading to considerably more churning than a simple count of the initially impacted students would suggest. It is this result that gives rise to the possible efficacy of top-n and similar policies as a practical policy tool.

The hypotheses of the two theorems are sufficient for the policy to increase high school integration while leaving university enrollment unchanged. There are (extreme) violations of unbiasedness that may not lead to an increase in the high school integration, but more reasonable deviations from unbiasedness are consistent with an increase in high school integration.

Though the neutrality theorem is broadly consistent with empirical findings on the effects on university diversity of the top-n laws, the mixing theorem has no counterpart in the empirical literature. Our second contribution is to provide evidence for it, as well as for our theoretical mechanism, in what as far as we

are aware is the first empirical appraisal of the effects of a top-n policy on high school ethnic composition.

We use a rich data set constructed using a combination of multiple administrative and public school census data from Texas. We find that there was indeed a drop in high school racial segregation associated to the introduction of the top-n policy, and that the flow of students is consistent with the assumption of unbiasedness (or limited unbiasedness), and our theoretical mechanism. Furthermore, since Texas's top-n policies mainly condition on class rank in the final years of high school, students who value attending their initial school will delay a school change as long as possible if the cost of moving away from one's school is decreasing in the time spent in that school (for instance if students want to keep in touch as long as possible with their friends.)

Figure 1 provides a first glance at the evidence, showing a time series of high school segregation – measured by the mutual information index – for 9th and 12th grades of all Texas high schools from 1990 to 2007.[2] The mutual information index measures segregation by indicating how well information about a student's high school predicts that student's ethnicity. Consistent with our reasoning above, a substantial drop in segregation coincides with the introduction of the policy in 1998 for 12th grade but not for 9th grade.[3] Trends in residential segregation do not explain the pattern in Figure 1, see Figure 5 in the Appendix.



Figure 1: Time series of the mutual information index for 9th and 12th grades.

[2]One school is excluded from the analysis due to an atypical large number of students with Native American origins in 1998.

[3]Using alternate measures of segregation, such as the Theil index, yields similar pictures. See appendix for further graphs corresponding to 10th and 11th grades. The policy was announced in 1996, signed into law in early 1997, and took effect with 1998-99 school year.

This observation is corroborated at the high school level using a difference-in-differences estimation strategy on an index of local segregation. In line with the theory, we test for a significant change in the difference between the degree of segregation in 12th and 9th grades after 1998. We show a reduction in local segregation in 12th grade with respect to 9th grade, controlling for school-grade unobserved heterogeneity, coinciding with the introduction of the Top Ten Percent policy. To investigate whether moves between schools could have led to the decrease in segregation, we use individual-level data. We find that the pattern of moves taking place during 11th and 12th grades changes with the introduction of the policy: students became more likely to move to schools with less college-bound students (i.e., students taking either SAT or ACT tests) and lower SAT average. These effects are significant for moves taking place within school districts, where moving costs are presumably lower. We also find that student movement is unbiased. This empirical corroboration of the unbiasedness assumption in the mixing theorem lends credibility to the mechanism highlighted by our theory.

Thus a policy instrument that may appear to have yielded disappointing results with respect to integrating universities, may nonetheless be a powerful tool for achieving integration in high schools. More generally, our results show that integration at lower educational tiers can be achieved by rewarding relative performance without the need to force integration or to condition on race.

Literature

High school integration has been a goal of policy makers at least since the 1950's. Benabou (1993) highlights the inefficiencies linked to residential segregation resulting from mobility, and Durlauf (1996) makes the general case for the social benefits of intervention in matching markets "associational redistribution") such as schools or communities. Overwhelmingly, most policies that have been implemented have tried to impose diversity at the high school level *directly*. Lutz (2011*a*) summarizes the history of court-ordered high school integration in the USA, as well as the resulting political tensions these orders created.

Our model shows that integration in high schools may be increased *indirectly* through the design of admissions or recruiting policies at subsequent levels. The general equilibrium relocation effects of the policy proceed from a well understood principle (at least since Tiebout, 1956): if a policy changes the

relative returns of different associations, individuals will be tempted to relocate. This arbitrage has not escaped scholars who studied educational policies. For instance, in their survey of affirmative action, Fryer and Loury (2005) suggest that "color-blind" policies, of which top-n is an example, may induce students to move schools or to choose less challenging courses in order to increase their chances of benefiting from the policy. Cortes and Friedson (2014) document above-trend real-estate price increases in neighborhoods that could be "natural" targets for students who try to arbitrage the top-n laws. Cullen, Long and Reback (2013) estimate a positive though very small in aggregate increase in cross-school movement by 9th grade high school students directly affected by the Top Ten Percent Law in Texas. Our estimates of aggregate flows are larger both because we focus on movement by older students and because we take account of the general-equilibrium effects induced by the directly impacted.

None of these papers present a model that could articulate and quantify the general equilibrium consequences of relocation induced by a policy, and, in the case of Texas Top-Ten law, do not examine the law's impact on high school racial and ethnic composition, which is the main focus of this paper.

In addition to guiding us toward uncovering new empirical regularities on the effects of top-n policies, our model provides a unifying framework for a number of existing and separate findings in the empirical literature on the effects of the Texas Top-n law: that racial integration in flagship universities in Texas was not much affected by the law (Horn and Flores, 2003; Kain, O'Brien and Jargowsky, 2005; Long and Tienda, 2008), consistent with our Neutrality Theorem. and that, following the law, more high schools send students to the flagship universities (Long, Saenz and Tienda, 2010), consistent with the fact that university-bound students move to lower-ranked schools.

In the next section of the paper, we lay out a model of school choice that generates testable predictions about flows across schools and their effects on segregation. Then, in Section 3, we confront the data. Finally we offer some remarks about the possibility of broadening top-n laws in order to increase high school integration. All tables and figures omitted from the text can be found in the Appendix.

2 Conceptual Framework

2.1 The Basic Model

The economy is populated by a unit-measure continuum of students, each characterized by an educational achievement $a \in [0, \overline{a}]$.[4] Each student is initially enrolled in one of a finite set of high schools $s \in \{1, ..., S\}$. School s has measure q_s of students, with $\sum_{s=1}^{S} q_s = 1$ and is characterized by its distribution of achievements $F_s(a)$ with support $[0, \bar{a}]$.[5] The aggregate distribution is $F(a) = \sum_{s=1}^{S} q_s F_s(a)$.

Prior to admission to college, each student initially in a school s may *(re)-locate* by selecting a school s' at a cost $c(s, s') \geq 0$; remaining in one's initial school is costless ($c(s, s) = 0$). It will simplify matters to suppose that from any initial school, the relocation costs among all target schools are unique: for each s, $c(s, s') \neq c(s, s'')$ whenever $s' \neq s''$.

Note that this model can accommodate an interpretation in which there are positive effects of school characteristics on human capital. For instance, advance placement courses or inspiring teachers will increase the set of skills needed to perform well at the university or in the labor market, in which case student i has a total skill $a_i + r_i(s)$ for future performance, where a_i is the ability we use in the model and $r_i(s)$ is this future return from attending school s. The difference $r_i(s) - r_i(s')$ is part of the cost $c(s, s')$.

Location decisions are made simultaneously after the admission policy is announced, and we consider Nash equilibria in location choice. Schools have no say in the location decisions; as is the situation in most public schools in the US, any student becomes eligible to attend a high school simply by moving into its geographic catchment.[6]

Upon graduation, students can either go to the university U or pursue an alternative option, denoted u, which could be moving to another, less prestigious, state university, or moving to an out-of-state university, or entering in

[4] We abstract here from peer effects within schools that could bear on achievement. Thus a is best interpreted as capturing parental or community investment in students in early childhood or primary and middle school.

[5] The requirement that the distributions share a common support rules out certain pathologies, such as the possibility that a school could empty out completely once the top-n policy is in place.

[6] In practice, students sometimes can gain admission to local schools at even lower cost, e.g., by claiming to live with a relative in the catchment or having a parent rent a small dwelling there.

the labor market. A policy maker controls admission to the U, which has fixed capacity $k < 1$. U is more desirable than u for all students in the population – students for whom u is preferred to U will not be competing for spots in the U under any policy, and so can be ignored for the purposes of this analysis. Specifically, for a student of achievement a, the return to attending the U is $U(a)$, which strictly exceeds $u(a)$, the return to attending u. The notation signifies that returns may vary across education levels, as may the interpretation of the opportunity cost $u(a)$ of attending the U: for some levels it might mean the value of attending another university than U, while for others it might be the value of immediate entry into the labor market. A student of type a who moves from s to s' and enters the U (resp. u) receives payoff $U(a) - c(s, s')$ (resp. $u(a) - c(s, s')$).

We will be comparing an initial admission policy selecting the top achievers in the state, (hence a "school-blind" policy), against a top-n law that admits the top N percent in each high school; if there is a residual capacity, the rest of the places in the U are covered by the school-blind policy.

Under a school-blind policy, the university U admits all students with the highest endowments, up to capacity. Since all students admitted strictly prefer the U, they will attend, and the marginal student achievement a^* satisfies

$$F(a^*) = 1 - k. \tag{1}$$

Since location is irrelevant to attending the U under the school-blind policy, no one has any incentive to relocate (and if there is any cost to moving, a strict incentive not to).

Now consider a top-n policy. In this case, every student in the top n percentile of his high school class is admitted to the U, and the residual capacity $k-n$ is allocated on to the highest-achieving students in the state who have not already been admitted. Because students may decide to move across schools as a result of the policy, there will be new distributions $\hat{F}_s(a)$ in each school.

Formally, the policy induces a location game in which students simultaneously choose *moving strategies*, i.e., maps $\sigma(a, s, s') \in [0, 1]$ indicating the probability that a student of achievement a moves from initial school s to school s'; thus, $\sum_{s'} \sigma(a, s, s') = 1$. An equilibrium is a profile σ of moving strategies such that for almost all a and associated s, $\sigma(a, s, \cdot)$ is a best response to σ.[7]

[7]Since a student is admitted with probability 1 or 0 from his destination school and there

Our Neutrality Theorem states that as long as the cost of moving to any school is less than the benefit $U(a)-u(a)$ of attending the U, the set of admitted students is the same as when the policy was not in place.

The logic behind why equilibria with and without the top-n policy must have the same U enrollments is very simple. Suppose an equilibrium of the relocation game induced by the top-n policy has a set of admitted students that differs from that of the school-blind policy. Then somewhere in the state, there is a "winner" $a_w < a^*$ who is admitted, as well as a "loser" $a_\ell > a^*$ who is rejected (more precisely, there is a positive measure of winning achievement levels, and because of the capacity constraint, an equal measure of losing levels). Now, a_w must be admitted as a member of the top n of his school and a_ℓ and a_w must be in different schools, else a_ℓ would also have been admitted under the top-n rule. But now, a_ℓ can secure admission to the U, and strictly gains from doing so, simply by relocating from his school to a_w's school. Thus we are not looking at an equilibrium.

In the appendix we show an equilibrium always exists and is characterized by a set of cutoffs, one for each school, weakly exceeding a^* and such that each student below his initial school's cutoff and above a^* moves to another school, while all others remain.

Notice that the only types that might engage in arbitrage are the potential losers ($a \geq a^*$) from the top-n policy. Thus only their costs need to be compared with the benefit of attending the U in order to reach the neutrality conclusion.

Theorem 1. (The Top-N Percent Neutrality Theorem). *If $c(s,s') < U(a) - u(a)$ for all students with $a \geq a^*$, university enrollments under the top-n and school-blind admission policies are identical.*

Thus, with low moving costs, the top-n law will have no impact on enrollment in the University. As a result, there can be no change in the ethnic, socio-economic, gender, or racial composition of the student body there.

However, all of this movement is *not* neutral with respect to the composition of the high schools.[8] In particular, movement of students induced by the top-n law may modify segregation by ethnic group or socio-economic status.

is never indifference between schools because moving costs are distinct, it suffices to consider pure strategy equilibria.

[8] Necessary and sufficient condition for some movement of students to occur is that there is a school s such that $1 - F_s(a^*) < n$. Then, absent any movement, the top-n policy would allow some students in s with $a < a^*$ to enter the U, which contradicts neutrality.

Let $g \in G$ be a student's ethnic or socioeconomic group, where G is some finite set. Denote by $p_s^g \in p_s = (p_s^1, ..., p_s^{|G|})$ the population share of group g in school s and by $p^g \in p = (p^1, ..., p^{|G|})$ g's share in the aggregate population. To measure the degree of segregation we consider indexes of the form:

$$\mathcal{I}(p, \{p_s\}) \equiv A_1(p) - A_2(p) \sum_s q_s H(p_s),$$

where $A_1(p)$ and $A_2(p) \neq 0$ are functions of the aggregate distribution of groups p, $H(p_s)$ is a strictly concave function of the distribution of groups at school s, and q_s the measure of students in school s, with $\sum_s q_s = 1$. A leading example is when $H(p_s) = \sum_g p_s^g \log(p_s^g)$ is the entropy of p_s, $A_1(p) = H(p)$ the entropy of p, and $A_2(p) \equiv 1$, in which case $\mathcal{I}(p, \{p_s\})$ is the mutual information index (MMI). If $H(\cdot)$ is the entropy, $A_1(p) = 1$, $A_2(p) = 1/H(p)$, then $\mathcal{I}(p, \{p_s\})$ is Theil's information index (Theil, 1972; Theil and Finizza, 1971). Other segregation indexes that are consistent with our formulation are the variance ratio index (James and Taeuber, 1985) or the Bell-Robinson Index (Kremer and Maskin, 1996).

Intuitively, the mutual information index, which features in our empirical analysis, is a measure of how much information the knowledge of the school a student attends conveys on the student's race, and vice versa.[9] For instance, if all schools have exactly the same racial composition as the state, then the mutual information index is zero, as knowing a student's school does not allow any inference on the student's race. Conversely, a larger index value reflects that more information is gained on students' race by learning about their school.

2.2 Effects of Movement

To illustrate the effect of relocation, consider the case of two groups and three schools, which have initial proportions $p_1^1 = 1$, $p_2^1 = 1/2$, and $p_3^1 = 0$ of the first group and equal masses of students, $q_1 = q_2 = q_3 = 1/3$. Suppose that the policy induces a random sample of students with mass $m > 0$ from school 1 to move to school 2. This movement makes school 2 more segregated, as the proportion of the first group there moves away from the population average $1/2$. Schools 1 and 3 do not become less segregated either since the proportions of the

[9]Like other widely used entropy indices, the mutual information index has a number of desirable properties, such as decomposability and scale invariance (Alonso-Villar and Del Ro, 2010; Frankel and Volij, 2011).

first group remains 1 in school 1 and 0 in school 3. Nevertheless the segregation index $\mathcal{I}(p)$ will decrease! This is because, after students have moved, the population weight of the fully segregated school 1 decreases and the weight of the now marginally segregated school 2 increases. The aggregate effect is to decrease segregation, as strict concavity of $H(p_s)$ ensures that the increase in population weight of the less segregated school 2 overcompensates the increase in segregation in school 2.

To show this denote equilibrium quantities by hats. Then the new segregation index is

$$\hat{\mathcal{I}} = A_1(p) - A_2(p)\left[(q_1 - m)H(p_1) + (q_2 + m)H(\hat{p}_2) + q_3 H(p_3))\right].$$

Because students move only from one school to another, not into or out of the system as whole, $A_1(p)$ and $A_2(p)$ remain unchanged, so

$$\hat{\mathcal{I}} - \mathcal{I} \propto mH(p_1) - (q_2 + m)H(\hat{p}_2) + q_2 H(p_2). \tag{2}$$

Since we can write $\hat{p}_2 = \frac{m}{m+q_2}p_1 + \frac{q_2}{m+q_2}p_2$, concavity of H and $p_1 \neq p_2$, imply that

$$H(\hat{p}_2) > \frac{m}{m+q_2}H(p_1) + \frac{q_2}{m+q_2}H(p_2).$$

Substituting this inequality into the right hand side of (2), we have $\hat{\mathcal{I}} - \mathcal{I} < 0$. Indeed, this establishes that whenever two schools have different proportions of the two groups, the segregation index will decrease after a move of a random sample students from one school to another, because more students will be in less segregated schools after the move.

The result and the mechanism at work in the example can be generalized (see appendix) to any number of schools or groups, so long as the system as a whole remains closed (no student exits and no new student enters) and movement is (group) *unbiased*: the initial group distribution p_s in school s is equal to the distribution among those who move from s to any target school s'. Formally, if $p_{s,s'}$ is the group distribution among the movers from school s to school s', we have $p_{s,s'} = p_s$ for all s'.

Theorem 2. (The Unbiased Mixing Theorem). *Suppose the school system is closed, that schools initially have different proportions of groups, and that movement of students is group unbiased. Then the segregation index $\mathcal{I}$ falls following movement.*

Of course, unbiasedness is only sufficient for reducing segregation, not necessary. To illustrate this point, we revisit the case of two groups and three schools. Suppose initial proportions are $p_1^1 = 0.9$, $p_2^1 = 0.5$, and $p_3^1 = 0.1$ of the first group, with equal masses of students in each school, $q_1 = q_2 = q_3 = 1/3$. The overall degree of segregation (using the MMI) is approximately 0.107.

Suppose a tenth of school 1 students move out, with half of these targeting each of the other two schools. If movement is unbiased, the new proportions are $\hat{p}_1^1 = 0.9$, $\hat{p}_2^1 = 0.52$, and $\hat{p}_3^1 = 0.14$. In this case the Theorem applies, and segregation decreases to 0.092. But even if there is biased sampling, for instance with 0.7 instead of 0.9 of the movers being from group 1, the new proportions $\hat{p}_1^1 = 0.92$, $\hat{p}_2^1 = 0.51$, and $\hat{p}_3^1 = 0.13$ yield a decrease in the segregation index to 0.102.

Finally, unbiased sampling might be accompanied by biased targeting and yet still generate a decrease in segregation: suppose an unbiased sample from school 1 splits along group lines, with all of the group 1 students targeting school 2 and all the group 2 students targeting school 3. Then the final proportions are $\hat{p}_1^1 = 0.9$, $\hat{p}_2^1 = 0.54$, and $\hat{p}_3^1 = 0.099$. Even in this extreme case of biased targeting, the MMI falls, to 0.103.

2.3 Equilibrium Flows

Putting additional structure on the achievement distributions and moving costs allows one to characterize the location equilibrium and the associated flows of students more precisely. Assume that schools are ordered by quality: if $s < s'$, $F_s(a)$ strictly first order stochastically dominates $F_{s'}(a)$. That is, for any $a \in (0, \overline{a})$, $F_s(a) < F_{s'}(a)$. The moving cost $c(s, s')$ strictly increases in the "distance" between schools, captured by the absolute difference in their indexes $|s - s'|$.[10] In addition to geographic distance, this preference might reflect horizontal differentiation of schools, or, perhaps more importantly, fixed school characteristics that are correlated with quality, such as teacher or facility quality or reputation. Assume that at least one school s satisfies the movement condition in Footnote 8, i.e. that $1 - F_s(a^*) < n$, so that there will be movement in equilibrium.

Under these conditions, we can show (see appendix) that there exists a

[10] Even though distance measured in this way admits the possibility that $c(s, s') = c(s, s'')$, where $s' > s > s''$, it turns out with this construction, target schools always have index higher than s, so that costs remain unique among targets.

unique equilibrium outcome that is characterized by two properties.

Proposition 1. *Suppose that $F_s(a)$ strictly first order stochastically dominates $F_{s'}(a)$ if $s < s'$, and that the cost of moving from s to $s' \neq s$ is an increasing function of the distance $|s - s'|$. In the unique equilibrium outcome,*

(i) There is a sequence of cutoffs $\{\hat{a}_s, s = 1, \ldots, S\}$, with $\hat{a}_s$ weakly decreasing in s, and $\hat{a}_1 > a^* = \hat{a}_S$. Only students with ability greater than $\hat{a}_s$ are admitted from school s.

(ii) In school $s \leq S - 1$, students with ability in $[\hat{a}_{s'}, \hat{a}_{s'-1})$ move to school $s' \geq s + 1$; students in $[\hat{a}_s, \overline{a}]$ and $[0, a^*)$ do not move.

Hence in equilibrium students who would not get into the U from their original school will move to the closest school that will enable them to obtain a place at the U. Since schools are stochastically ordered, movement is always to ex-ante lower quality schools, and to the best (nearest) school that will allow a to be among the top n.

If $n < k$, then some students are admitted at large. The proof shows that they are all drawn from the highest-quality (lowest index) schools, which share a common threshold $\hat{a}^L$ that exceeds the threshold for all other schools. There is no movement into those schools. In the trivial case that n is very small (i.e., $1 - F_s(a^*) \geq n$ for all s), the policy has no bite, all schools have some at-large admission with $\hat{a}^L = a^*$, and there is no movement at all.

Figure 2 is a graphical illustration of these flows. Students from school 1 with achievement closely below the cutoff $\hat{a}_1$ (with mass $x_{1,2}$ in the figure) will move to neighboring school 2, while their counterparts with achievements closely above a^* (with mass $x_{1,3}$) need to move further to school 3 in order to ensure admission to the U. School 2 students with achievements between a^* and school 2's cutoff (with mass $x_{2,3}$) move to school 3.

Notice that "cascades" may be part of the equilibrium allocation, due to two sorts of externalities. First is an *inflow* externality: in this example, school 2 students with achievements closely below $\hat{a}_2$ are crowded out by the competition of incoming, high achieving students from school 1 (m_2), inducing them to move to school 3. And there is also an *outflow* externality: here, students just below $\hat{a}_1$ were initially in the top n there, but following exit of students below them, are no longer in the top n and therefore leave as well (it is easy to see that if $1 - F(a_1) = n$, then $a_1 < \hat{a}_1$). In general, both externalities will be operative in

schools other than 1, where only the outflow externality is at play, and school S, where there is only an inflow externality. Thus the set of students who move is larger than those directly affected by the policy (i.e., those in $[a^*, a_s]$, who are below the initial top$-n$ cutoffs in their original schools).[11]

As mentioned in the Introduction, there is evidence that the number of schools sending students to the University of Texas increased after the introduction of the Top Ten Percent Law. This is easy to see with the aid of the present model: if, say, school 3 initially had no one above the threshold a^*, then after the policy change, this school will have an inflow of above-a^* students. Now some students will attend the U from a school that previously had sent no one. As the other two schools continue to send some students, the number of sending schools has increased. This is a general result: all schools that sent students to the U continue to do so under the top-n policy, and some that did not before do so now. The set of sending schools cannot become smaller and in general will increase. But the set of students who attend the U does not change.

The flows described in this case will tend to equalize average achievement across schools: this is an easy consequence of our characterization if the mean achievement in school 1 (and therefore all other schools) is below a^*. Mean achievement falls in schools that are net exporters (schools with the initially highest distributions), and rises in schools that are net importers (initially lowest). However, further assumptions need to be maintained if these flows are to result in decreased ethnic segregation. As Theorem 2 tells us, group unbiasedness is sufficient to assure this outcome.

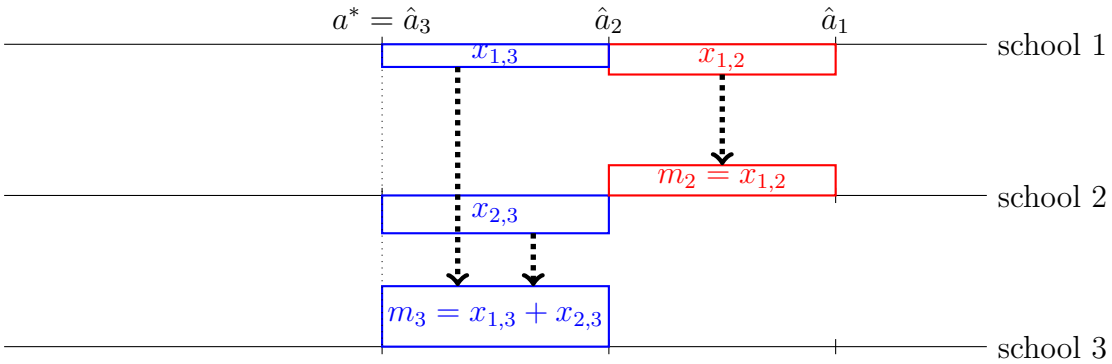


Figure 2: Post-policy flows with three schools

[11] This can be checked from equation (14) in the Appendix.

One situation in which unbiasedness is satisfied is where every school's ethnic composition is *independent* of a: within a school, it is the same for all a, though it differs across schools. This situation could arise from a process similar to the one in which public schools are chosen in the US and some other nations: parents choose communities and the schools therein on the basis of their own achievement, aspirations for their children, or other attributes correlated with their children's achievement.

To see how this works, denote these attributes α and suppose they take S values $s \in \{1, \ldots, S\}$ with the frequencies q_s in the population. Different ethnic groups g have different distributions p^g ($p^g_s \neq p^{g'}_s$ for at least some s) over the attributes, and $q_s = \sum_g p^g_s$. In this case, a student's achievement is the realization of a random variable with distribution $\mathcal{F}(a|\alpha)$, a continuous distribution with support $[0, \overline{a}]$ that is stochastically decreasing in α. If parents sort perfectly into communities by the attribute α then their children's school achievement distributions will be $F_s(a) = \mathcal{F}(a|s)$.

The distributions $F_s(a)$ will be stochastically decreasing in s. Moreover, the fraction of group g in school s will be p^g_s, and the achievement distribution will be the same $F_s(a)$ for each group in school s. Any sample of students exiting school s will have the same distribution of groups, as will any subsample entering another school s'. In this case the unbiasedness conditions of Theorem 2 are satisfied by the flows depicted in Proposition 1 and it follows that the top-n policy not only equalizes mean achievements across schools but also reduces segregation.

To get some appreciation of the role played by independence for unbiasedness, consider the following example. Suppose that of the schools in Figure 2, Schools 1 and 2 are initially slightly integrated: they are populated by red students, except for those in the interval $[a^*, \hat{a}_2]$, who are all blue. School 3 is entirely blue.[12] Once the policy is implemented, students in $[\hat{a}_2, \hat{a}_1)$, who are all red, move from school 1 to school 2. Students in $[a^*, \hat{a}_2)$, who are all blue, move out of schools 1 and 2 into school 3. Thus after the policy, schools 1 and 2 are entirely red, while school 3 remains entirely blue: the outcome is now perfect segregation, and integration has therefore decreased.

This example violates unbiasedness because the ethnic mix among movers depends on the achievement level. As a group, the movers from school 1 are

[12]The initial situation might arise if blue parents take advantage of a metropolitan-area busing program that sends inner-city blues to largely red suburban schools.

ethnically diverse, more so than the school as a whole; the movers from school 2 are entirely blue but come from a largely red school. In neither case are the emigrants ethnically representative of the school. More saliently, the targeting is also biased: red movers target the overwhelmingly red school 2, while blue movers target the entirely blue school 3. Notice this biased targeting occurs even though there is *no* preference for ethnic groups motivating movement.

This case is rather extreme in the degree of bias. As we suggested above, for more moderate departures from unbiasedness, the Unbiased Mixing Theorem suggests that top$-n$ policies will decrease segregation. Ultimately, whether they do or not is an empirical question.

2.4 First Steps toward Bringing the Theory to the Data

A plausible hypothesis is that the distribution of ex-ante achievement referred to in the discussion following the Proposition is stochastically increasing in socio-economic status or higher for some ethnic groups than others. Texas high-schools display some signs of student sorting, as shown in Figure 3: the percentage of minority students enrolled at a high school correlates positively with the percentage of economically disadvantaged students and negatively with the high school pass rate in TAAS.[13] That is, a school's ethnic composition is a good predictor of socio-economic status and test score results. Our results would then suggest that the policy would induce student flows from better (i.e. majority) to worse (i.e. minority) schools, and that these flows tend to consist proportionally of majority students, which in turn would reduce segregation.

Under the top-n policy, students have the opportunity to choose not only whether to move between schools but also when to move, conditional on eligibility rules.[14] Supposing therefore that students can choose the date at which to move, the time spent in the initial school will affect the cost of moving. Moving earlier rather than later from one's initial school is costly: it is more difficult to make long-lasting friends in the new school since existing students have already created their social network; the initial school had been chosen because it was the best at the time and moving early means spending more

[13]The figures use data for 1997, but the picture looks very similar for other school years. A similar exercise using percentage of minority and average or median SAT score shows a negative correlation.

[14]As will be discussed later, the Texas Top Ten Percent Policy did not impose a minimum stay period in order to be eligible and we could not find any evidence that school districts enforced a minimum stay rule.

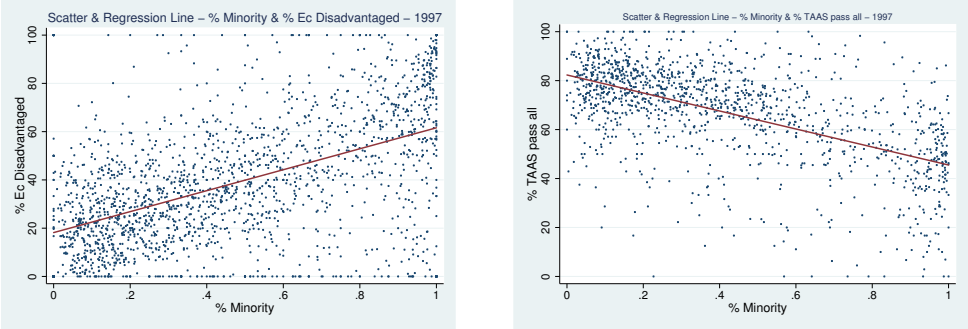


Figure 3: Share of minority and economically disadvantaged students (left) and share of minority and TAAS pass rate (right). *Source*: AEIS data.

time in a less preferred environment; or moving is the only means of increasing one's admissions chances by grade 12, while in grade 9 there is still time to work harder, enroll in supplemental courses, etc. An example is a simple modification of the cost function used in Proposition 1, namely

$$c(s, s', t) = F - t + |s - s'|,$$

where F is a fixed cost of moving. Since the cost function satisfies the distance property: $\forall s, s', s'', \forall T, \forall t < T$, $c(s, s', t) + c(s', s'', T - t) \geq c(s, s'', T)$, students will choose to move only once.

Corollary 1. *For cost functions $c(s, s', t)$ decreasing in t and satisfying the distance property, students move as late as possible from their initial school and move directly to their final school.*

Hence, students who move for strategic reasons will do so mainly in later grades, suggesting that the effect on segregation should be small in early grades and more pronounced in later grades.

2.5 Predictions

The results in the previous section show that if schools are segregated with respect to socioeconomic background such as race or SES, a top-n policy may induce some desegregation in background, if socioeconomic background correlates positively with education levels. This is because the policy can change individuals' ranking of different schools, making it profitable to move to a school that would not have been chosen without the policy.

There are three results from the theoretical analysis that we will be able to test in our empirical analysis.

P.1 Arbitrage by students leads to lower segregation index for high schools. Hence the information index should decrease following the policy.

P.2 Students who arbitrage "move down": they move from schools with higher average educational achievement to schools with lower average educational achievement.

P.3 Arbitrage should be more pronounced for students in the later grades.

3 A Closer Look at the Data

Figure 1 in the introduction suggests there was a persistent decrease in segregation in 12th grade, but not in 9th grade, from 1998 onwards, which coincides with the start of the Texas Top Ten Percent policy. In this section we will investigate whether this is verified using school-level data and whether that is consistent with strategic rematch using individual data.

3.1 Data and Descriptive Statistics

We use three databases for public schools in Texas for school years 1994-1995 to 2000-2001 obtained from the Texas Education Agency (TEA).[15]

The first database contains school-level enrollment data. We use data on student counts per grade and per race/ethnicity (classified into five groups: White, African American, Hispanic, Asian, and Native American).[16] The data are provided at the school (campus) level for all ethnic groups with more than

[15]TEA does not have oversight of private schools in Texas and, therefore, does not collect data on them. If a student moves into a private school, drops out or moves out of state, her identification code disappears from the school census. Similarly, if a student moves out of a private school into a public school, or moves from another state into Texas, a new identification code is created. We analyze the proportion of identification codes activated and deactivated by grade, and do not find different trends per grade. Thus, while we cannot rule out that the Top Ten Percent Law affected transitions between public and private schools, the school grades do not seem to be affected differently, validating our empirical strategy.

[16]We merge the school-level enrollment data with the Public Elementary/Secondary School Universe Survey Data from the Common Core of Data (CCD) dataset of the National Center for Education Statistics (NCES), accessible at http://nces.ed.gov/ccd/pubschuniv.asp. It contains information such as school location and school type. By merging the TEA enrollment counts and the CCD, using campus number (TEA) and state assigned school ID (NCES) as unique identifiers, we have information on all schools that were active in Texas.

five students enrolled in school.[17] We use this data to compute the segregation measures that will be explained below.

The second one is the Academic Excellence Indicator System (AEIS).[18] This database provides information on several performance indicators at the school level, e.g., average and median SAT and ACT scores, the share of students taking ACT or SAT, of students above criterion, and of students completing advanced courses.[19]

The third database contains individual-level data for students enrolled in 8th and 12th grades in a Texan public school.[20] For each student, we observe the grade and school they are enrolled in, and their ethnic group and economic disadvantaged status. Each record is assigned a unique student ID, allowing us to track students as they change schools, as long as they remain in the Texas public education system. The database does not contain information on individual's test scores, but we can merge it with the AEIS dataset described above. Since we are interested in characterizing school moves related to the Top Ten Percent Policy, we restrict the sample to school moves in which we can identify either ACT or SAT averages for both the school of origin and destination. In such sample, 64 percent of students have moved schools at least once since the 8th grade. Also, there are no apparent differences in terms of ethnic composition and economically disadvantaged status between those who moved schools at least once and those who did not move schools between the 8th and 12th grades. Thus, these last two databases enable us to identify patterns in students' movements between schools.

Segregation Measure

To measure the degree of segregation empirically we use the mutual information index. As discussed in section 2.1, this index measures the degree of segregation in terms of the information that can be gained from the sorting of groups into

[17] If less than five students belong to an ethnic group in a given grade, the TEA masks the data in compliance with the *Family Educational Rights and Privacy Act* (FERPA) of 1974. We use three different strategies to deal with masking: the first and the second replace masked values by 0 and 2, respectively, and the third one replaces the masked value by a random integer between 1 and 5. The results we report use the first strategy, but results remain largely unchanged for the other strategies.

[18] The data can be accessed at http://ritter.tea.state.tx.us/perfreport/aeis/.

[19] The data are based on students graduating in the spring of a given year. For instance, the data for 1998-99 provides information on students graduating in the spring 1998.

[20] Like the other databases these data are subject to masking based on FERPA regulations.

schools, with higher segregation corresponding to higher index values. This index is defined for multiple groups and can be aggregated over several organizational layers (such as school district, region, or others) (see Reardon and Firebaugh, 2002; Frankel and Volij, 2011; Mora and Ruiz-Castillo, 2009).

In our context, the index is

$$M = \sum_{s=1}^{S} p_s M_s^{Texas}, \tag{3}$$

where M_s^{Texas} is the local segregation index comparing school to state composition, and p_s is the share of Texan students who attend school s.

The basic component of the mutual information index, M_s^{Texas}, is the *local segregation index* calculated with respect to the state composition. In general, the local segregation index compares the composition of a school s to the composition of a larger unit x (e.g., state, region, or school district):

$$M_s^x = \sum_{g=1}^{G} p_{gs} \log\left(\frac{p_{gs}}{p_{gx}}\right), \tag{4}$$

where p_{gs} and p_{gx} denote the share of students of an ethnic group $g = 1, ..., G$ in school s and in the benchmark unit x, respectively. In our regressions, we calculate the local segregation index at the school-grade (and not only school) level and the benchmark unit is the region. This allows us to take into account demographic trends and education policies that may affect a given region in Texas. We adopt the Texas Educational Agency's classification, which divides Texas into 20 regions. Each of these regions contains an Educational Service Center (ESC) and provides support to the school districts under their responsibility. The alternative of using the school districts, instead of regions, is problematic, as the local segregation index would be zero by definition in school districts containing only one school.

Table 1 provides summary statistics for the main variables used in the regressions. While the mean of the local segregation index (using the region as a benchmark) has increased between the periods 1994-1996 and 1998-2000, the increase seems to be less pronounced for 12th than for 9th grade.[21] The summary statistics of individual level data show that, after the Top Ten Percent

[21] Using a placebo exercise, we show that the parallel trend assumption needed for our differences-in-differences strategy holds, see Table 3.

Law, moving students were more likely to move to schools with less college-bound students and lower SAT average.

3.2 Empirical Strategy and Regression Results

We now verify whether the differential change in segregation observed in the aggregate for the whole of Texas is observed as well at the school level, i.e., whether segregation of individual schools has changed differentially in earlier and later grades. Using individual level data, we also investigate whether school movements are consistent with the pattern suggested by our theoretical model.

Under the Texas Top Ten Percent rule admission was granted based on the class rank at the end of 11th, middle of 12th, or end of 12th grade. Therefore strategic school movements may well have taken place as late as between 11th and 12th grades for some schools, and we will focus on all possible rematch occurring between 9th and 12th grades. For the school-level segregation exercise, we are unable to account for the 8th grade, as most schools offer only 9th to 12th grades. Using 9th grade as the reference point means losing any strategic rematch having occurred earlier than 8th grade in students' careers, which will again bias the segregation estimates downwards. However, in our individual level data analysis, we also analyze the school transition between 8th and 9th grades.

The Texas Top Ten Percent rule did not impose a minimum period at school in order to be eligible for the policy, but allowed school districts to define rules regarding that matter. We could not find any evidence that districts imposed minimum attendance rules in order to qualify for the Top Ten Percent rule.[22] Moreover, even if some did, this would bias our estimates of the policy effects downwards.

Local Segregation Index

We use a differences-in-differences approach and start with 9th grade as the control group and 12th grade as the treatment group. As discussed in Section 2.4 above, we expect moving costs, and therefore the amount of movement, to vary with grade level (most plausibly with lower costs in the later grades). Below we also introduce 10th and 11th grades to check for effects of the policy

[22]For instance, we contacted three large school districts by phone and none of them had any such rule in place.

on these grades.

The dependent variable of interest in our difference-in-difference approach is the local segregation index M^r_{yst} (defined in (4)) for grade level y in school s at time t, where the benchmark unit is the region r to which the school belongs. We consider school years 1994-1995 to 1997-1998 to be pre-treatment, while 1998-1999 to 2000-2001 correspond to post-treatment periods.[23] For grade levels $y = \{9; 12\}$ we estimate the model:

$$M^r_{yst} = \beta_1 \left(G12_{ys} \times POST_t\right) + \boldsymbol{\delta}'\mathbf{T} + u_{ys} + \varepsilon_{yst}, \tag{5}$$

where $G12_{ys} = 1$ if $y = 12$, $POST_t = 1$ if $t \geq 1998$, $\mathbf{T}$ is a vector of year dummies (or region-year dummies), u_{ys} is a school-grade fixed effect, and ε_{yst} is the error term. The school-grade fixed effect allows for time invariant school heterogeneity that may vary by grade, including the ethnic composition of principals and teachers and the availability of school resources, which are unlikely to change in the short run. The vector of year dummies, $\mathbf{T}$, controls for the overall trend in segregation of all schools in Texas. Some specifications also allow these trends to be region-specific to control for changes in the student population in a given region that may be caused by immigration, for example. The coefficient of interest in this regression is β_1 and it indicates the relative change in the local segregation index in the grade and school years affected by the Top Ten Percent Law.

We start by presenting the year-by-year β_1 coefficients in Figure 4. Indeed, there was a decline in local segregation for 12th grade with respect to 9th grade after the introduction of the Top Ten Percent law in 1998. The graph also shows the absence of pre-existing trends before 1998.

The estimation results are presented in Table 2. Columns (1) and (2) show a significant decrease in school segregation for 12th grade as compared to 9th grade coinciding with the Top Ten Percent Law. The relative reduction in 12th grade corresponds to about 3% of a standard deviation in the local segregation index. Interestingly, additional regression results (available from the authors) indicate that this effect is not driven by schools located in larger school districts or in MSAs. Thus, the effect we find seems not to operate through greater

[23]The results are very similar when using different masking strategies (i.e., replacing masked observations by 2 or a random integer between 1 and 5). If we add or exclude one school year on the pre- and post-treatment, the results also remain the same. Since the policy was signed in 1997 and implemented in 1998, school year 1997-1998 may be partially affected by the reform and is excluded from the analysis.

school choice in the neighborhood, but rather through strategic choice of students who move house and school district, possibly for exogenous reasons such as a parental job change. We will return to this issue below.

Finally, we include data on 10th and 11th grades to detect in which grade the decrease in segregation took place. For $y = \{9, 10, 11, 12\}$, we estimate:

$$\begin{aligned} M^r_{yst} =& \beta_1(G12_{ys} \times POST_t) + \beta_2(G11_{ys} \times POST_t) + \beta_3(G10_{ys} \times POST_t) \\ &+ \boldsymbol{\delta}'\mathbf{T} + u_{ys} + \varepsilon_{yst}, \end{aligned} \tag{6}$$

The results are presented in columns (3) and (4). In both specifications, we cannot reject that the magnitudes of the coefficient estimates are identical. However, the estimates for the 10th grade are not statistically significant at conventional levels. That is, while some of the decrease in segregation may have already happened by 10th grade, a significant change occurs only beginning with 11th grade. There seems to be little action between 11th and 12th grade in terms of a change in segregation. Finally, to show that the results presented in Table 2 do not reflect pre-existing trends in the local segregation indexes, we run equations (5) and (6) for school years 1990-1991 to 1996-1997, excluding 1993-1994. Table 3 presents the results. The coefficient estimates are positive and not statistically significant. This confirms that our results for the Top Ten Percent Law in Table 2 are not driven by pre-existing trends in the data.

Strategic Movement of Students

The evidence presented so far suggests a decrease in high school segregation in 12th grade relative to that in 9th grade within the same year, coinciding with the introduction of the Top Ten Percent Law. Our theoretical model in Section 2 would imply that this decrease was induced by strategic movement of students across schools.

Changing schools is a relatively common phenomenon in Texas, however. The fluctuation of students between high schools in Texas is high, at more than 10% of the student population per year before and after the policy change. Almost 50% of Texan students will change schools between the 8th and 12th grades, the great majority of them because the following school grade is not offered in their school (92% of moves). Indeed, the strategic movement of students necessary to bring about the decrease in segregation could have been simply part of the natural fluctuation (a simulation shows that strategic move-

ment of about 1.5% of the student population would easily suffice to generate the effect). That is, students who have to leave one school for exogenous reasons could choose there target schools strategically.

Another indicator for strategic movements may be the use of transfers: transfer students are students whose district of residence is not the same as the school district they attend. Indeed, as shown in Figure 8, the number of transfer students has more than doubled since 1998, which is in line with our expectations, even when one discounts charter school students.[24]

To examine the hypothesis that at least some students who changed schools did so strategically, be it by applying for a transfer or in the course of natural fluctuation, we will use student-level individual data. Our hypothesis is that students who change schools will prefer schools where they are more likely to be in the top ten percent of their class. We are interested in whether the introduction of the Top Ten Percent policy was associated with a change in the characteristics of target schools of moving students, and whether the change differed between lower and higher grades.

We examine prediction P.2 that after the introduction of the policy movers in 11th and 12th grades were more likely to move to schools with less college-bound students and lower SAT average with respect to those who moved schools in 9th and 10th grades.[25] These variables are plausible indicators of a move to an academically worse school.

We use the characteristics of schools in the year that the student transferred to them, consistent with rational expectations. The results remain qualitatively unchanged if we use instead school characteristics in the year before the move. We therefore estimate equations with a dependent variable Y_{it} that takes the value 1 if this is indeed the case (e.g., school of destination has less college-bound students than school of origin) and 0 otherwise:

$$Y_{it} = \beta_1 \left(G12_i \times POST_t\right) + \beta_2 \left(G11_i \times POST_t\right) + \boldsymbol{\gamma}'\mathbf{G_i} + \boldsymbol{\rho}'\mathbf{X_i} + \boldsymbol{\delta}'\mathbf{T} + \varepsilon_{it}, \quad (7)$$

where $\mathbf{G_i}$ is a vector of grade dummies, $\mathbf{X_i}$ is a vector of individual and school controls including ethnic group, economic disadvantage status, a dummy for

[24]Students attending a charter schools are usually considered to be transfer students. Additional analysis (available upon request) shows that the role of introducing charter schools in explaining the decrease in segregation appears rather limited.

[25]Note that universities in Texas require SAT scores even for Top Ten Percent applications, so that the policy would not affect the probability of taking SAT exams, which were also required by out-of-state universities.

grade not offered, and a constant; the other variables are defined as above. We cluster the standard errors at the school of origin level.

Because students move strategically if the benefits of moving outweigh its cost, strategic movements should be particularly salient for moves within the same school district, and less so among moves across school districts. Apart from school proximity, moves across school districts are more costly since they require either moving residence or applying for a transfer. To test this prediction we split the sample of student moves into those that occur within and across districts, and expect that treatment effects are greater for within district moves.[26]

The results are presented in Table 4. Columns (1) to (3) show that the probability of moving to a school with less college-bound students than the previous school increases for movers in the 11th and 12th grades by 2.8 and 6.4 percentage points, respectively, consistent with prediction P.3. This is amplified under the Top Ten Percent rule, by 2.5 and 3.1 percentage points for 11th and 12th grades, respectively. This corresponds to an increase of 4.7% and 5.9%, respectively. This effect is driven mainly by moves within districts. That is, under the Top Ten Percent rule students in higher grades were significantly more likely to move to academically worse schools within the same district. Columns (4) to (6) show a similar pattern for SAT averages. Considering the transition from 11th to 12th grade, the probability of moving to a school with lower SAT average than the school of origin increases by 2.3 percentage points for non-economically disadvantaged students. This corresponds to a 5.3% increase, given that the sample mean of the dependent variable is 0.435. The effect is only significant for moves that occur within districts.

Taken together, these results very strongly suggest that students who have moved schools in 11th and 12th grades were more likely to choose their new school strategically than students in lower grades after the introduction of the Top Ten Percent policy. In particular, the data are consistent with students targeting schools with a lower proportion of college-bound students and lower SAT average. As expected, these strategic moves tend to occur within the school districts, where moving costs would tend to be minimized.

[26]Numbers of observations differ across regressions depending on the dependent variable used, as not all variables are available for every school. For example, if students move from a school without 12th grade, the information on the share of college-bound students is not available for that school, so that data for these students will be missing.

Evidence on Unbiasedness of Flows

Our theory suggests that the decrease in Texas school segregation following the introduction of the Top Ten Percent Law can be explained by arbitrage behavior of students moving to schools that enhance their chances of graduating in the top decile of their class. However, the theoretical argument for desegregation also rests on the assumption of sufficient unbiasedness in the flows: moving students should be close to ethnically representative of their schools and should be close to ethnically neutral in targeting destinations. This raises the question of whether actual movements in Texas displays this sort of unbiasedness.

To address this question we first test for biased sampling using a linear probability model that regresses an indicator of whether a student moving from school s to school s' at time t is from the majority (white + Asian) on the share of the majority among the sending school's students:

$$MAJ_{it} = \beta_0 + \beta_1 MAJ_{st} + \beta_2 \left(MAJ_{st} \times POST_t\right) + \boldsymbol{\gamma}' \mathbf{G_i} + \boldsymbol{\delta}' \mathbf{T} + \varepsilon_{it}, \qquad (8)$$

where the dependent variable MAJ_{it} takes the value 1 if a moving student is from the majority and 0 otherwise; MAJ_{st} is the share of majority students in i's school of origin s, and the other variables are defined as above. We cluster the standard errors at the school of origin level. If the sampling of school leavers is in fact unbiased under the policy, then that probability will exactly reflect the school majority share and we would expect the sum of the coefficients β_1 and β_2 to equal one.

Table 5 presents the result. In column (1), we show the correlation between majority status of moving student and the proportion of majority in school of origin without any additional controls. The estimated coefficient is very close to 1, consistent with unbiased sampling. The introduction of year and grade fixed effects yields very similar results (column (2)). In column (4), we also allow for this correlation to have changed after the implementation of the Top Ten Percent Law. While we cannot rule out that majority students were slightly oversampled after 1997, the coefficient of the interaction term is very close to zero.

To test for unbiased targeting, we regress the residuals of equation (8) on the majority share in the receiving school s':

$$MAJ_{it} - \widehat{MAJ_{it}} = \beta_1 MAJ_{s't} + \beta_2 \left(MAJ_{s't} \times POST_t\right) + \varepsilon_{it}, \qquad (9)$$

where the dependent variable $MAJ_{it} - \widehat{MAJ_{it}}$ is the residual of regression (8) and $MAJ_{s't}$ is the share of majority students in i's target school. Under unbiased targeting we expect the coefficient to be zero, because the target school composition will not affect the composition of incoming students conditional on their origin school composition.[27]

Columns (3) and (5) in Table 5 present the results. While the estimated coefficients are statistically significant, they are very close to zero. The introduction of the policy was not associated with a change of biasedness. To interpret the coefficients we used actual student movements of 11th graders in 1998 to compute the effect of biased sampling and targeting on the regression coefficients. Unbiased flows would produce coefficients of 1 and 0 in regressions (8) and (9). Assuming a very small oversampling of majority students going to majority schools, by setting the majority share among moving students to $MAJ_{st} + 0.03MAJ_{s't}$, produced coefficients (1.006 and 0.020) that are very close to the ones we observe.

This appears rather small and in line with the assumption of our theory, in particular when recalling our examples accompanying Theorem 2. If the case of biased targeting coupled with biased sampling considered there had generated the data, we would by contrast obtain coefficients of 1 and 0.5, yet still have observed reduced segregation.

As a robustness check we also run specification (8) including fixed effects for pairs of origin and destination schools. Thus controlling for the association between the actual flows and the share of majority students we would again expect the coefficient β_1 to equal 1 if there was no bias in sampling or targeting. For computational purposes we have to restrict our analysis to samples of pairs of schools, with enough movement between them. The results in Table 6 yield coefficients close to 1, suggesting low bias, which is consistent with the results obtained from our preferred specification.

Overall, the evidence suggests that school migration in Texas displayed remarkably little ethnic bias, a finding that helps support the view that the Unbiased Mixing Theorem can account for the reduction in segregation trends

[27]Based on our theory we would expect some correlation between the ethnic composition of sending and targeted schools: Proposition 1 predicts that the expected quality of target schools increases with the quality of sending schools. If in turn ethnic composition is correlated with quality along the lines of the discussion following the Proposition, then when i moves from s to s', MAJ_{st} and $MAJ_{s't}$ are correlated, so we cannot simply add $MAJ_{s't}$ as a control to equation (8).

in Texas high schools following the introduction of its Top Ten Percent Law.

3.3 Robustness Checks

Residential Segregation

Another potential concern is that the decrease in high school segregation might simply reflect residential desegregation, given that students usually attend schools in their district of residence. Using population data, we compute mutual information indexes for the total population and for the group aged 15-19. The indexes are calculated by comparing the composition of the population in a given county with the composition of the population of the state. For comparison we also plot the mutual information index for 9th to 12th grades with the county as the unit of observation. Figure 5 shows that, if anything, residential segregation has increased over the period 1990 to 1999[28] and cannot explain the decrease in segregation among the student population over the period.

Dropout rates

A change in dropout rates could potentially be a confounding effect. Possible differences in the dropout rates between majority and minority students are taken care of by our differences-in-differences approach. A possible concern is that the trends were significantly different between ethnic groups in 9th and 12th grades. Unfortunately, the data do not allow us to compute grade specific dropout rates. However, Figure 6 shows that dropout rates for 7th to 12th graders in Texas are low and the trends are very similar for different ethnic groups. Thus it seems unlikely that dropout rates drive the reduction in segregation we observe in the data.

4 Discussion

Theory and evidence show that a policy intended to achieve ethnic integration at the college level may actually have contributed to achieving it in the high schools. By basing admission on relative performance at high school, the Texas Top Ten Percent policy appears to have induced an increase in the rate at which students to move from higher- to lower-quality schools. Coupled with

[28]Starting in 2000, individuals were able to choose more than one race/ethnicity. Therefore, we had to limit the analysis to the period 1990-1999.

evidently low differences in the ethnic composition of movers relative to their origin schools and low ethnic bias in targeting behavior, the result is a reduction in high-school ethnic segregation.

It should come as no surprise, given the relative sizes of the Texas elite-college population and that of the student population as a whole, that our measured effects are not overwhelming compared to what was accomplished via court ordered busing in the 1960s and 1970s. For instance, Rossell and Armor (1996) estimates (using the dissimilarity index)[29] that segregation declined from 0.60 to 0.42 between 1968 and 1974, then decreased at a smaller rate (due to "white flight") to 0.35 by 1991. However, following the 1990s Supreme Court dismissal of several desegregation plans, segregation increased further (again due to "white flight") from 0.35 to 0.37 by 1995 (Lutz, 2011*b*), or a two percentage point increase.

We have computed the dissimilarity index in our Texas sample and it changed from 0.555 in 1990 to 0.54 in 2000, that is a 1.5 percentage point decrease. Thus, while the magnitude of our results is much smaller than court-ordered integration plans or busing, they are comparable in size to changes due to desegregation after 1990. In particular, they would compensate increases in segregation that have occurred after the Supreme Court dismissed integration plans in the 1990s.

It is worth asking whether the movements of students needed to account for the observed change in high school segregation following the introduction of the Top Ten Percent Law are enough to account for the oft-noted diversity shortfalls in the University of Texas system. A numerical simulation shows that the observed drop in segregation could have been generated by strategic movement by as little as 1,500 students (of about 20,000) per year per grade. On the other hand, comparing post-policy admission numbers at the UT campuses at

[29]The index of dissimilarity can be interpreted as the share of students that would have to be moved to different schools to reproduce the overall racial composition of Texas in each individual school. It measures school-level integration, conditional on the racial composition of the district. The dissimilarity index is inversely related to integration. The dissimilarity index for two groups (minority and majority) can be written as $D = \frac{1}{2}\sum_{s=1}^{S} \frac{N_s}{N} \left| \frac{p-p_i}{p(1-p)} \right|$, where N, N_s are, respectively, the number of students in Texas and in school s and p, p_s are the proportion of majority students in Texas and in school s. and MAJ are the number of minority and majority students in Texas and MIN_s and MAJ_s are these numbers for school s. A related measure is the exposure index $E := \sum_{s=1}^{S} \frac{N_s}{N} \frac{p_s(1-p_s)}{p}$ which calculates the probability that a minority students randomly drawn schoolmate is also a minority – the minimum value for this measure is the percent minority overall in the state. Both indexes are limited to two groups.

Austin, Dallas, and A&M to those expected if the minority share had remained equal to the one under affirmative action, produces a shortfall of around 650 minority students.

The apparent excess of movement can be accounted for if one realizes that in practice the effects of an individual arbitrage decision are uncertain. For at the time a decision to move has to be made, it is likely that one is unsure about one's final performance that will be used to determine admission. Then one might contemplate a move of schools even if one is below the threshold for eligibility in both schools, as there is a chance to get over the bar, and a better chance in a worse school. By the same token, someone just above the percentile threshold might move as insurance against the possibility of falling below it.

The experience of apparently unintended consequences in Texas suggests that top-N percent policies may be an effective tool for achieving broader social goals than was previously understood: they offer a novel way to integrate high schools. As it happens, similar policies are being rolled out around the world. For instance, Sciences Po in France uses preferential admission based on zip codes; the University of Bristol in the UK offered lower entry standards for applicants from lower-performing schools; and Brazilian public universities set aside places for students who come from public schools. Although differing in detail from top-n policies, all of these "school-based" policies generate similar incentives for some high school students to move and will therefore affect high school integration.

A natural question that arises concerns the optimal design of school-based policies if the intent is to accomplish school integration.[30] Since policies such as those at Sciences Po and Bristol are likely too small to have much impact, an increase in the number of universities participating in such schemes would be required. This corresponds to increases in the policy threshold n in our model: given the capacity k, increasing n increases cross-school flows, so as long as movement is unbiased, segregation falls with participation.

Increasing capacity at elite universities may be very costly, but increasing capacity can be effectuated by other means. For instance, suppose that elite universities can accommodate 10% of the college bound population, and that a set of "second-tier" universities can accommodate an additional 10%. With a

[30]Obviously we are abstracting from the weighing of moving costs against the ostensible benefits of integration, as well as constraints to policy emanating from limited capacities of target high schools.

top-10% policy, movement among high schools only affects the top ten percent of the population. Now consider a modified top 20% rule which offers priority admission to the state's universities in order of high school rank, and that all students prefer elite to second-tier schools. Then a student graduating in the top 10% would end up in an elite university, while one graduating in the second 10% would end up in the second tier, since the elite university would already be full by the time the offer got to her. The neutrality theorem would still apply, so assuming moving costs are small, university enrollment would be identical to that under school-blind or top-10 admission. But flows among high schools would now affect the top twenty, rather than top ten, percent of the population.

Finally, analysis of optimal policy needs to acknowledge the timing of desegregation. As our analysis shows, in the absence of lengthy residency requirements, students tend to delay their movements to the later grades. Policies that lengthen these requirements in order to increase exposure during high school among students of differing backgrounds must contend with the evident increase in moving costs, which would tend to reduce flows.

References

Alonso-Villar, O. and Del Ro, C. (2010), 'Local versus overall segregation measures', *Mathematical Social Sciences* **60**(1), 3038.

Benabou, R. (1993), 'Workings of a city: location, education, and production', *The Quarterly Journal of Economics* **108**(3), 619652.

Clotfelter, C. T. (2004), 'Private schools, segregation, and the southern states', *Peabody Journal of Education* **79**(2), 7497.

Clotfelter, C. T. (2011), *After Brown: The rise and retreat of school desegregation*, Princeton University Press.

Cortes, K. E. and Friedson, A. (2014), 'Ranking up by moving out: The effect of the texas top 10% plan on property values', *National Tax Journal* **67**(1), 51–76.

Cullen, J. B., Long, M. C. and Reback, R. (2013), 'Jockeying for position: High school student mobility and texas' top ten percent rule', *Journal of Public Economics* **97**, 32–48.

Durlauf, S. N. (1996), 'Associational redistribution: A defense', *Politics & Society* **24**(2), 391–410.

Frankel, D. M. and Volij, O. (2011), 'Measuring school segregation', *Journal of Economic Theory* **146**(1), 1–38.

Fryer, R. G. and Loury, G. C. (2005), 'Affirmative action and its mythology', *Journal of Economic Perspectives* **19**(3), 147–162.

Gall, T., Legros, P. and Newman, A. F. (2009), 'Mismatch, rematch and investment'.

Horn, C. L. and Flores, S. M. (2003), 'Percent plans in college admissions: A comparative analysis of three states' experiences'.

James, D. and Taeuber, K. (1985), 'Measures of segregation', *Social Methodology* **15**, 61–32.

Kain, J. F., O'Brien, D. M. and Jargowsky, P. A. (2005), 'Hopwood and the top 10 percent law: How they have affected the college enrollment decisions of texas high school graduates', *mimeo* . University of Texas at Dallas.

Kremer, M. and Maskin, E. (1996), 'Wage inequality and segregation by skill', *NBER Working Paper* **5718**.

Logan, J. R., Oakley, D. and Stowell, J. (2008), 'School segregation in metropolitan regions, 1970-2000: The impacts of policy choices on public education', *American Journal of Sociology* **113**(6), 1611–1644.

Long, M. C., Saenz and Tienda, M. (2010), 'Policy transparency and college enrollment: Did the texas top ten percent law broaden access to the public flagship?', *The ANNALS of the American Academy of Political and Social Science* **627**(1), 82–105.

Long, M. C. and Tienda, M. (2008), 'Winners and losers: Changes in texas university admissions post-hopwood', *Educational Evaluation and Policy Analysis* **30**(3), 255–280.

Lutz, B. (2011*a*), 'The end of court-ordered desegregation', *American Economic Journal: Economic Policy* **3**(2), 130–168.

Lutz, B. (2011*b*), 'The End of Court-Ordered Desegregation', *American Economic Journal: Economic Policy* **3**(2), 130–168.

Mora, R. and Ruiz-Castillo, J. (2009), The invariance properties of the mutual information index of multigroup segregation, *in* S. F. R. Flückiger, Y. and J. Silber, eds, 'Occupational and Residential Segregation (Research on Economic Inequality', Vol. 17, pp. 3–53.

Orfield, G., Frankenberg, E., Ee, J. and Kuscera, J. (2014), *Brown at 60: Great progress, a long retreat and an uncertain future*, Civil rights project/Proyecto derechos civiles.

Reardon, S. F. and Firebaugh, G. (2002), 'Measures of multigroup segregation', *Sociological Methodology* **32**, 33–67.

Rossell, C. H. and Armor, D. J. (1996), 'The effectiveness of school desegregation plans, 1968-1991', *American Politics Quarterly* **24**(3), 267–302.

Theil, H. (1972), *Statistical Decomposition Analysis*, Elsevier, New York, NY.

Theil, H. and Finizza, A. J. (1971), 'A note on the measurement of racial integration of schools by means of informational concepts', *Journal of Mathematical Sociology* **1**, 187–194.

Tiebout, C. M. (1956), 'A pure theory of local expenditures', *Journal of Political Economy* **64**(5), 416–424.

A Proofs

Neutrality Theorem: Proof of Existence of an Equilibrium

In the text we have established that any equilibrium must satisfy neutrality. To ensure this is not a vacuous result, the following provides a proof of existence. First, we establish that all equilibria are characterized by cutoff values $\hat{a}_s$ in each school s that determine which students move out. Using this structure we then establish existence of an equilibrium satisfying neutrality.

Lemma A. *Any equilibrium has cutoff values $\hat{a}_s$, one for each school s such that:*

(i) a student in school s is admitted to the U if $a \geq \hat{a}_s$.

(ii) Define $\underline{a} = \min_s\{\hat{a}_s\}$. Then, $\sigma(a, s, s) = 1$ if $a < \underline{a}$, or $a \geq \hat{a}_s$.

(iii) $\sum_{s' \neq s} \sigma(a, s, s') = 1$ if $a \in [\underline{a}, \hat{a}_s)$.

Proof. (i) For a given strategy profile σ, there are new distributions $\hat{F}_s(a)$ and new masses $\hat{q}_s$ of students. Given these, if a student with a in school s is admitted to the U (either through the top-n policy or through at-large admission) then a student with $a' > a$ in school s is admitted to the U as well. Define by $\hat{a}_s$ the minimal ability such that a student in school s is admitted to the U.

(ii) By construction a student $a < \underline{a}$ cannot be admitted in any school s', hence $\sigma(a, s, s) = 1$ is a strict best response for such students, because moving is costly. A student from school s with $a \geq \hat{a}_s$ can be admitted in her initial school; hence $\sigma(a, s, s) = 1$ is a strict best response for such a student.

(iii) Students from school s in $a \in [\underline{a}, \hat{a}_s)$ are not admitted if they stay and get admitted in another school if they move; since the cost of moving is smaller than the benefit of being admitted, they should move to another school with a cutoff less that their ability; hence $\sum_{s' \neq s} \sigma(a, s, s') = 1$. □

Under neutrality only students with $a \geq a^*$ are admitted to the U. This implies that $\underline{a} = a^*$. Since any equilibrium satisfies neutrality, cutoffs lie in the interval $[a^*, \overline{a}]$.

Lemma A states that any equilibrium entails a set of thresholds $\{\hat{a}_1, \ldots, \hat{a}_S\}$. In each school, the set of students who attend the U are natives with attainment above the threshold plus any "immigrants"; other students may leave. By Lemma A and neutrality all students below a^* remain in their initial school.

Denote by $\hat{a}_s^N$ the lowest achievement admitted in equilibrium via the top-n rule: $1 - \hat{F}_s(\hat{a}_s^N) = n$. In case $n < k$, some students are admitted at large. Let $\hat{a}_s^L$ be the lowest such student from school s. In equilibrium, we must have $\hat{a}_s^L = \hat{a}_{s'}^L$ for any two schools s, s' admitting students at large; if instead $\hat{a}_s^L < \hat{a}_{s'}^L < \hat{a}_{s'}^N$, there are students in s who are admitted at large, while higher attainment students originally in s' (those in $(\hat{a}_s^L, \hat{a}_{s'}^L)$ could also have been admitted at large simply by staying put). Thus we write $\hat{a}^L$ for the common at large threshold, and $\hat{a}_s = \min\{\hat{a}_s^N, \hat{a}^L\}$. Note that $\sum_s \hat{q}_s \hat{F}_s(\hat{a}_s^N) = \sum_s q_s F_s(\hat{a}_s^N) = 1 - n$ and $\sum_s q_s F_s(a^*) = 1 - k$.

Immigrants to s consist of those who, given the threshold in their own school s', find s to be the cheapest school to move to with a threshold below their attainment. Thus the measure of students who migrate from s' to s is $q_{s'}(F_{s'}(\hat{a}_{s'}) - F_{s'}(\hat{a}_s))$ if $\hat{a}_{s'} > \hat{a}_s$ *and* $s = \arg\min_{\{s''|\hat{a}_{s'} > \hat{a}_{s''}\}} c(s', s'')$ (since $c(s'', s) \neq c(s''s')$ for all s, s' the minimum is unique). Define $\mathbb{M}^s_{s'}(\hat{a}) = q_{s'}$ if $\hat{a}_{s'} > \hat{a}_s$ and $s = \arg\min_{\{s''|\hat{a}_{s'} > \hat{a}_{s''}\}} c(s', s'')$, and 0 otherwise.

The threshold to be admitted in equilibrium through the top-n rule, $\hat{a}^N_s$, has to satisfy:

$$\begin{aligned} & q_s(1 - F_s(\hat{a}^N_s)) + \sum_{s'} \mathbb{M}^s_{s'}(\hat{a})(F_{s'}(\min\{\hat{a}^N_{s'}, \hat{a}^L\}) - F_{s'}(\hat{a}^N_s)) \\ & = nq_s(1 - F_s(\hat{a}^N_s)) + n\sum_{s'}[\mathbb{M}^s_{s'}(\hat{a})(F_{s'}(\min\{\hat{a}^N_{s'}, \hat{a}^L\}) - F_{s'}(\hat{a}^N_s))] \\ & \quad + nq_s \max\{F_s(\hat{a}^N_s) - F_s(\hat{a}^L), 0\} + nq_s F_s(a^*). \end{aligned}$$

That is, in each school s the natives above the top-n threshold plus the immigrants (who only move in if they are admitted through the top-n rule) constitute N percent of the equilibrium population, which consists of natives and immigrants admitted through the top-n rule, natives admitted at large and natives who are not admitted to the U. The last two terms on the right hand side denote those admitted at large, if any, and those who are not admitted at all.

Letting $\omega_s \equiv \frac{n}{1-n} q_s F_s(a^*)$ and $\hat{a} = (\hat{a}^N_1, \ldots, \hat{a}^N_S, \hat{a}^L)$ we can rewrite this condition as the requirement that the "excess demand" in school s be zero:

$$\begin{aligned} z_s(\hat{a}) \equiv & \, q_s(1 - F_s(\hat{a}^N_s)) + \sum_{s'}[\mathbb{M}^s_{s'}(\hat{a})(F_{s'}(\min\{\hat{a}^N_{s'}, \hat{a}^L\}) - F_{s'}(\hat{a}^N_s))] \\ & - \frac{n}{1-n} q_s \max\{F_s(\hat{a}^N_s) - F_s(\hat{a}^L), 0\} - \omega_s = 0. \end{aligned}$$

The common threshold for at-large admission $\hat{a}^L$ has to satisfy the capacity constraint; thus

$$z_{S+1}(\hat{a}) \equiv \sum_s q_s \max\{F_s(\hat{a}^N_s) - F_s(\hat{a}^L), 0\} - (k - n) = 0.$$

Let $a = (a_1, \ldots, a_{S+1}) \in [a^*, \overline{a}]^{S+1}$. Note that continuity of the c.d.f's $\{F_s\}$ implies $z(a) = (z_1(a), \ldots, z_{S+1}(a))$ is continuous. Define a map $B : [a^*, \overline{a}]^{S+1} \to$

$[a^*, \overline{a}]^{S+1}$ by

$$B_s(a) = \max[\min(z_s(a) + a_s, \overline{a}), a^*] \text{ for } s = 1, \ldots, S \text{ and}$$
$$B_{S+1}(a) = \max[\min(z_{S+1}(a) + a_{S+1}, \overline{a}), a^*].$$

$B(\cdot)$ is continuous and therefore by Brouwer's theorem has a fixed point $\hat{a} = (\hat{a}_1^N, \ldots, \hat{a}_S^N, \hat{a}^L) \in [a^*, \overline{a}]^{S+1}$. We claim that $\hat{a}$ is an equilibrium for our model, i.e., that $z(\hat{a}) = 0$.

Start with $z_{S+1}(\hat{a})$. First, $\hat{a}^L \neq \overline{a}$ for $k > n$; if instead $\hat{a}^L = \overline{a}$, we would have $B_{S+1}(\hat{a}) = \max\{\overline{a} - (k-n), a^*\} < \overline{a}$, a contradiction. But for $k = n$, $z_{S+1}(\hat{a}) = 0$ when $\hat{a}^L = \overline{a}$.

Second, if $\hat{a}^L \in (a^*, \overline{a})$, then $z_{S+1}(\hat{a}) + \hat{a}^L \in (a^*, \overline{a})$ as well; assuming otherwise leads to a contradiction: if $z_{S+1}(\hat{a}) + \hat{a}^L \geq \overline{a}$ then $B_{S+1}(\hat{a}) = \overline{a} \neq a^L$. Similarly, supposing that $z_{S+1}(\hat{a}) + a^* \leq a^*$ would imply $B_{S+1}(\hat{a}) = a^* \neq a^L$. Therefore $z_{S+1}(\hat{a}) = 0$, as desired.

Third, if $\hat{a}^L = a^*$, then $z_{S+1}(\hat{a}) = 0$, because $\max\{F_s(\hat{a}_s^N) - F_s(a^*), 0\} = F_s(\hat{a}_s^N) - F_s(\hat{a}^*)$, so $\sum_s q_s(F_s(\hat{a}_s^N) - F_s(\hat{a}^*)) = k - n$ by definition (since $\sum_s q_s F_s(a^*) = 1 - k$ and $1 - n = \sum_s \hat{q}_s \hat{F}_s(\hat{a}_s^N) = \sum_s q_s F_s(\hat{a}_s^N)$).

Hence, for any fixed point $\hat{a}$ we have that $z_{S+1}(\hat{a}) = 0$.

Turning to $z_s(\hat{a}^N)$, note first that $\hat{a}_s^N \neq \overline{a}$ for any s; if instead $\hat{a}_s^N = \overline{a}$, we would have $B_s(\hat{a}) = \max\{\overline{a} - \frac{n}{1-n} q_s(1 - F_s(\hat{a}^L)) - \omega_s, a^*\} < \overline{a}$, a contradiction.

Second, if $\hat{a}_s^N \in (a^*, \overline{a})$, then, to the case of $\hat{a}^L$ above, $B_s(\hat{a}) = z_s(\hat{a}) + \hat{a}_s^N$, which implies $z_s(\hat{a}) = 0$.

Third, if $\hat{a}_s^N = a^*$, then $z_s(\hat{a}) + a^* < \overline{a}$, else $B_s(\hat{a}) = \overline{a} > a^*$, a contradiction. Thus if $z_s(\hat{a}) + a^* \geq a^*$, then $B_s(\hat{a}) = z_s(\hat{a}) + a^* = a^*$, so $z_s(\hat{a}) = 0$, as desired. The final possibility is that $z_s(\hat{a}) + a^* < a^*$, but this implies $z_s(\hat{a}) < 0$, which we now show leads to a contradiction.

We have shown $z_s(\hat{a}) \leq 0$ for all $s = 1, \ldots, S$; if $z_s(\hat{a}) < 0$ for some s, which can only happen if $\hat{a}_s = a^*$, then $\sum_{s \leq S} z_s(\hat{a}) < 0$. Denote by $M_s = \sum_{s'} [\mathbb{M}_{s'}^s(\hat{a})(F_{s'}(\min\{\hat{a}_{s'}^N, \hat{a}^L\}) - F_{s'}(a^*))]$ the mass of immigrants into s. The mass of "emigrants" $X_{s'}$ from s' is $q_{s'}(F_{s'}(\min\{\hat{a}_{s'}^N, \hat{a}^L\}) - F_{s'}(a^*))$ (recall we

are supposing $\hat{a}_s^N = a^*$). Since the system is closed, $\sum_s M_s = \sum_s X_s$. Then

$$\begin{aligned}
0 > \sum_{s\leq S} z_s(\hat{a}) &= \sum_{s\leq S}[q_s(1-F_s(\hat{a}_s^N)) + M_s - \frac{n}{1-n}q_s\left(\max\{F_s(\hat{a}_s^N) - F_s(\hat{a}^L), 0\} + F_s(a^*)\right)] \\
&= \sum_{s\leq S}[q_s(1-F_s(\hat{a}_s^N)) + X_s - \frac{n}{1-n}q_s\left(\max\{F_s(\hat{a}_s^N) - F_s(\hat{a}^L), 0\} + F_s(a^*)\right)] \\
&= \sum_{s\leq S}[q_s(1-F_s(\hat{a}_s^N)) + q_s(F_s(\min\{\hat{a}_s^N, \hat{a}^L\}) - F_s(a^*)) \\
&\qquad - \frac{n}{1-n}q_s \max\{F_s(\hat{a}_s^N) - F_s(\hat{a}^L), 0\} - \frac{n}{1-n}q_s F_s(a^*)] \\
&= \sum_{s\leq S} q_s\left[1 - \frac{1}{1-n}F_s(a^*)\right] - \sum_{s:\hat{a}_s^N \geq \hat{a}^L} q_s \frac{F_s(\hat{a}_s^N) - F_s(\hat{a}^L)}{1-n}
\end{aligned}$$

Since $z_{S+1}(\hat{a})$ can be written as $\sum_{s:\hat{a}_s^N \geq \hat{a}^L} q_s[F_s(\hat{a}_s^N) - F_s(\hat{a}^L)] - (k-n)$, and we have established that $z_{S+1}(\hat{a}) = 0$, using $\sum_s q_s F_s(a^*) = 1-k$, the last line vanishes, and we obtain $0 > \sum_{s\leq S} z_s(\hat{a}) = 0$, a contradiction. We conclude that $z_s(\hat{a}) = 0$. □

Proof of The Unbiased Mixing Theorem

Let $x_{s,s'}$ be the mass of students from school s who move to school s'; $m_{s,s'}$ the mass of students entering school s from school s'; x_s the mass of students leaving school s; m_s the mass of students entering school s. Since moving decisions depend only on ability and distance between schools but not on group, the ratios of the masses of students from different groups in school s' entering school s from school s' are equal to the ratios of their initial proportions in school s'. That is, the proportion of group g among students moving to s from s' is $p_{s'}^g$ and among students who stay at s by p_s^g.

The flows must balance, that is

$$m_s = \sum_{s'} x_{s',s} \quad \text{and} \quad \sum_s x_s = \sum_s m_s. \tag{10}$$

In equilibrium, accounting for the equilibrium movement of students, we have new proportions of groups within school s:

$$\hat{p}_s^g = \frac{(q_s - x_s)p_s^g + \sum_{s'} m_{s,s'} p_{s'}^g}{q_s - x_s + m_s}. \tag{11}$$

where $q_s - x_s + m_s$ is the equilibrium mass of students in school s. The new

segregation index is

$$\hat{\mathcal{I}} = A_1(p) - A_2(p) \sum_s (q_s - x_s + m_s) H(\hat{p}_s).$$

Hence the change in segregation indexes $\hat{\mathcal{I}} - \mathcal{I}$ is proportional to

$$\sum_s (q_s H(p_s) - (q_s - x_s + m_s) H(\hat{p}_s))$$

The new proportion of students of background g can be written as,

$$\hat{p}_s^g = \frac{q_s - x_s}{q_s - x_s + m_s} p_s^g + \sum_{s'} \frac{m_{s,s'}}{q_s - x_s + m_s} p_{s'}^g,$$

concavity of $H(p)$ and the fact that the weights are independent of g imply that

$$H(\hat{p}_s) \geq \frac{q_s - x_s}{q_s - x_s + m_s} H(p_s) + \sum_{s'} \frac{m_{s,s'}}{q_s - x_s + m_s} H(p_{s'}).$$

where the inequality is strict if $m_s \neq 0$ since $p_s \neq p_{s'}$. Hence, we have

$$\begin{aligned}
\hat{\mathcal{I}} - \mathcal{I} &< \sum_s \left(x_s H(p_s) - \sum_{s'} m_{s,s'} H(p_{s'}) \right) \\
&= \sum_s x_s H(p_s) - \sum_s \sum_{s'} m_{s,s'} H(p_{s'}) \\
&= \sum_s x_s H(p_s) - \sum_{s'} \left(\sum_s m_{s,s'} \right) H(p_{s'}) \\
&= 0
\end{aligned}$$

where the strict inequality is due to the assumption that a positive mass of students move (hence $m_s \neq 0$ for some s), and that $p_s \neq p_{s'}$ for all schools s, s'. The last equality follows (10). Hence we have $\hat{\mathcal{I}} - \mathcal{I} < 0$ as claimed. □

Proof of the Proposition

As shown in lemma A, the equilibrium is characterized by a set of thresholds $\{\hat{a}_1^N, \ldots, \hat{a}_S^N, \hat{a}^L\}$. Students in school s with $a \geq \hat{a}_s^N$ are admitted through the top-n policy; if $n < k$ there will be students admitted at large with achievement

$a \in [\hat{a}^L, \hat{a}^N_s)$. Hence, the cutoff for admission to the U in school s is $\hat{a}_s = \min\{\hat{a}^L, \hat{a}^N_s\}$ and cutoffs are at most equal to $\hat{a}^L$.

Note that all schools s with cutoff $\hat{a}_s = \hat{a}^L$ cannot have students moving in: any student who would be admitted to the U through s would also have been admitted in their initial school and, because of the moving cost, would have strictly preferred to stay there. The population of students admitted from such a school is therefore $q_s(1 - F_s(\hat{a}^L))$, and its equilibrium population is $q_s(1 - F_s(\hat{a}^L)) + q_s F_s(a^*)$, since all students in $[a^*, \hat{a}^L]$ have incentives to move elsewhere.

For schools that have students admitted at large, with $\hat{a}^N_s \geq \hat{a}^L$, it must be that

$$\frac{q_s(1 - F_s(\hat{a}^L)}{q_s(1 - F_s(\hat{a}^L)) + q_s F_s(a^*)} \geq n,$$

i.e., a student at the at-large threshold must be outside the top N percent.

Denote the set of schools that admit students at large by L; given $\hat{a}^L$ a school $s \in L$ if $1 - F_s(\hat{a}^L) \geq \frac{n}{1-n} F_s(a^*)$. Note that $s \in L$ implies that $s' \in L$ if $s' < s$, since by hypothesis $1 - F_{s'}(\hat{a}^L) > 1 - F_s(\hat{a}^L) \geq \frac{n}{1-n} F_s(a^*)$. Therefore there is an index $\bar{s}$ such that $s \in L$ if $s \leq \bar{s}$, and all $s \leq \bar{s}$ have $\hat{a}_s = \hat{a}^L$.

The complementary set T of schools $s > \bar{s}$ have thresholds $\hat{a}_s = \hat{a}^N_s < \hat{a}^L$ and admit students only through the top-n policy. Denote by $[1]$ the school in T that has the highest equilibrium threshold, and assume it is not school $\bar{s}+1$. The only students who would like to move to school $[1]$ are students $a \geq \hat{a}_{[1]}$, but below the cutoff in their own school; the only candidates are students from schools in L. However, since $[1] > \bar{s} + 1$, students in schools in L with ability in $[\hat{a}_{[1]}, \hat{a}^L)$ prefer to move to school $\bar{s}+1$, since this also ensures admission but does so at lower cost. Hence, $[1]$ receives no new students, while school $\bar{s} + 1$ may have new students; denote them by $m_{\bar{s}+1}$. Then

$$\frac{1 - F_{\bar{s}+1}(\hat{a}_{\bar{s}+1}) + m_{\bar{s}+1}}{1 - F_{\bar{s}+1}(\hat{a}_{\bar{s}+1}) + m_{\bar{s}+1} + F_{\bar{s}+1}(a^*)} = \frac{1 - F_{[1]}(\hat{a}_{[1]})}{1 - F_{[1]}(\hat{a}_{[1]}) + F_{[1]}(a^*)} = n$$

Cross multiply and cancel terms to get

$$F_{[1]}(a^*)(1 - F_{\bar{s}+1}(\hat{a}_{\bar{s}+1})) + F_{[1]}(a^*) m_{\bar{s}+1} = F_{\bar{s}+1}(a^*)(1 - F_{[1]}(\hat{a}_{[1]}))$$

or

$$\frac{1 - F_{\bar{s}+1}(\hat{a}_{\bar{s}+1}) + m_{\bar{s}+1}}{1 - F_{[1]}(\hat{a}_{[1]})} = \frac{F_{\bar{s}+1}(a^*)}{F_{[1]}(a^*)}$$

The right hand side is less than 1 by FOSD. The left side weakly exceeds $\frac{1-F_{\bar{s}+1}(\hat{a}_{\bar{s}+1})}{1-F_{[1]}(a_{[1]})}$, since $m_{\bar{s}+1} \geq 0$. Thus, $\frac{1-F_{\bar{s}+1}(\hat{a}_{\bar{s}+1})}{1-F_{[1]}(a_{[1]})} < 1$, implying

$$F_{\bar{s}+1}(\hat{a}_{\bar{s}+1}) > F_{[1]}(\hat{a}_{[1]})$$

But $\hat{a}_{[1]} > \hat{a}_{\bar{s}+1}$ implies

$$F_{\bar{s}+1}(\hat{a}_{[1]}) > F_{\bar{s}+1}(\hat{a}_{\bar{s}+1}) > F_{[1]}(\hat{a}_{[1]}),$$

which contradicts FOSD.

The above argument can be repeated for schools greater than $\bar{s}+1$: supposing that school $[2] \in T$ is not school $\bar{s}+2$ leads to a similar contradiction, and so on through school S.

Monotonicity in $\hat{a}_s$ and students' preference for moving to the closest school proves (ii).

For uniqueness, start with $\hat{a}^L$ and derive then cutoffs $\hat{a}_s$ for $s > \bar{s}$ constructively. From the proof of the Neutrality Theorem we know that the equilibrium cutoff $\hat{a}^L$ satisfies

$$\sum_{s \in L} q_s(F_s(\hat{a}_s^N) - F_s(\hat{a}^L)) = k - n. \tag{12}$$

The thresholds for admission through the top-n rule in schools $s \in L$ are:

$$\frac{q_s(1 - F_s(\hat{a}_s^N)}{q_s(1 - F_s(\hat{a}^L) + q_s F_s(a^*)} = n.$$

Therefore $F_s(\hat{a}_s^N) = 1 - n(1 - F_s(\hat{a}^L) + F_s(a^*))$ and (12) becomes

$$\sum_{L} q_s((1-n)(1 - F_s(\hat{a}^L)) - nF_s(a^*)) = k - n, \tag{13}$$

The left hand side of (13) is decreasing in $\hat{a}^L$ because both the set $L = \{s : 1 - F_s(\hat{a}^L) \geq \frac{n}{1-n} F_s(a^*)\}$ is non-increasing and the summands are positive and decreasing in $\hat{a}^L$. For $\hat{a}^L = a^*$, the LHS is strictly greater than $k-n$ since there is at least one school s with $1 - F_s(a^*) < n$. On the other hand, at $\hat{a}^L = \overline{a}$ the set L is empty so the LHS is zero. Hence, there is a unique $\hat{a}^L$ solving

(13) whenever $n < k$ (if $n = k$ there is a continuum of solutions $[\hat{a}_1^N, \overline{a}]$, where $1 - F_1(\hat{a}_1^N) = \frac{n}{1-n} F_1(a^*)$; set $\hat{a}^L = \hat{a}_1^N$ in this case). Given the solution $\hat{a}^L$, the set L is defined (possibly comprising only school 1), and $\hat{a}_s = \hat{a}^L$ for $s \in L$.

For $s \in T$, admission is through the top-n rule so that cutoffs are defined by:

$$\frac{q_s(1 - F_s(\hat{a}_s)) + m_s}{q_s(1 - F_s(\hat{a}_s)) + m_s + q_s F_s(a^*)} = n.$$

which is equivalent to

$$1 - F_s(\hat{a}_s) + \frac{m_s}{q_s} = \frac{n}{1-n} F_s(a^*). \tag{14}$$

Proceeding recursively, given $\hat{a}_{s-1}$, note that $m_s = \sum_{s' \leq s-1} q_{s'}[F_{s'}(\hat{a}_{s-1}) - F_{s'}(\hat{a}_s)]$ from part (ii), and (14) can therefore be written

$$1 - \sum_{s' \leq s} \frac{q_{s'}}{q_s} F_{s'}(\hat{a}_s) + \sum_{s' \leq s-1} \frac{q_{s'}}{q_s} F_{s'}(\hat{a}_{s-1}) = \frac{n}{1-n} F_s(a^*). \tag{15}$$

Since the LHS of (15) is strictly decreasing in $\hat{a}_s$, the solution $\hat{a}_s$ is unique given $\hat{a}_{s-1}$, which establishes uniqueness of the sequence $\{\hat{a}_s\}$. □

B Tables and Figures

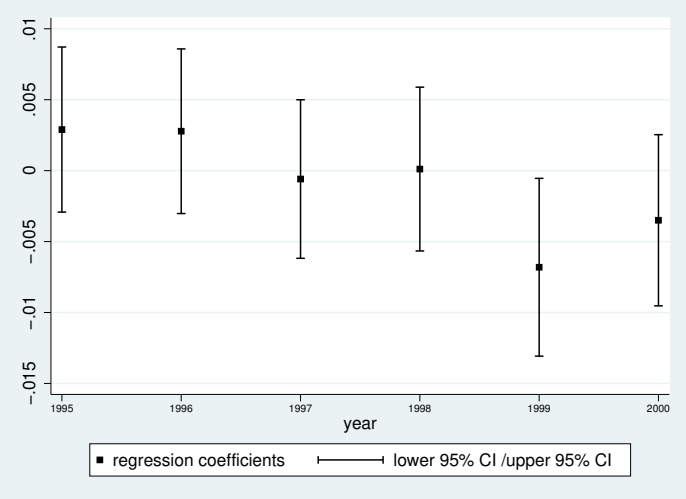


Figure 4: Year-by-Year DID regression coefficients

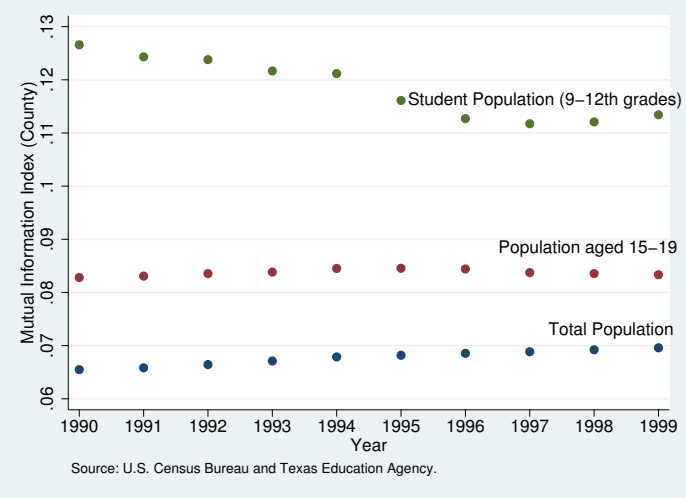


Figure 5: Residential versus School System Segregation

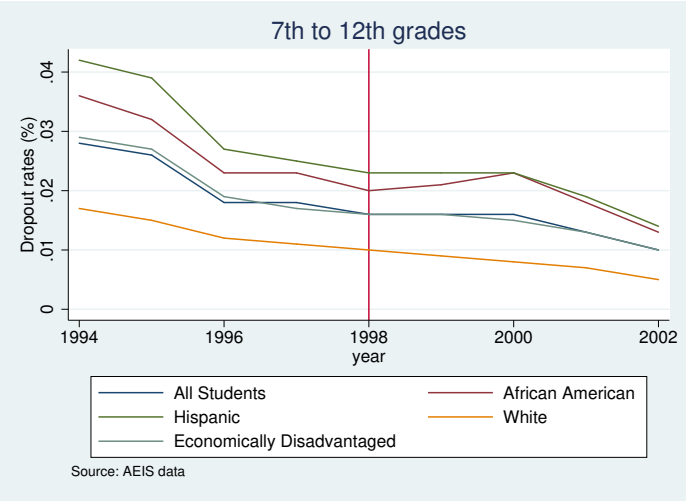


Figure 6: Dropout Rates

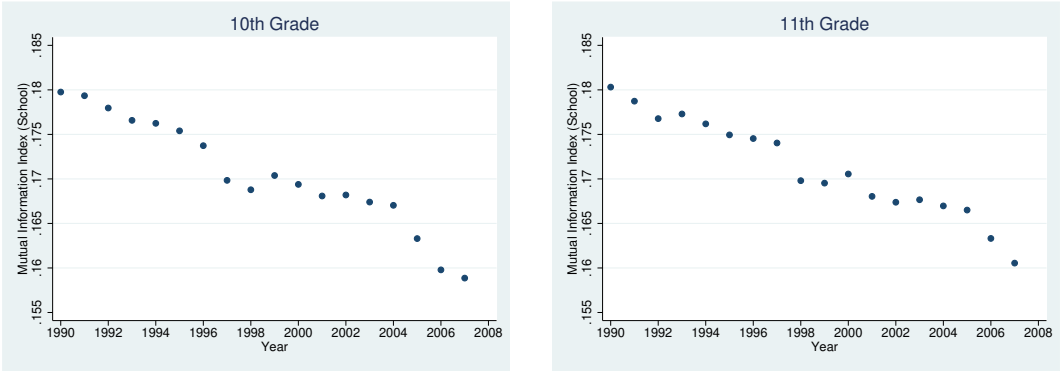


Figure 7: Time series of the mutual information index for 10th and 11th grades

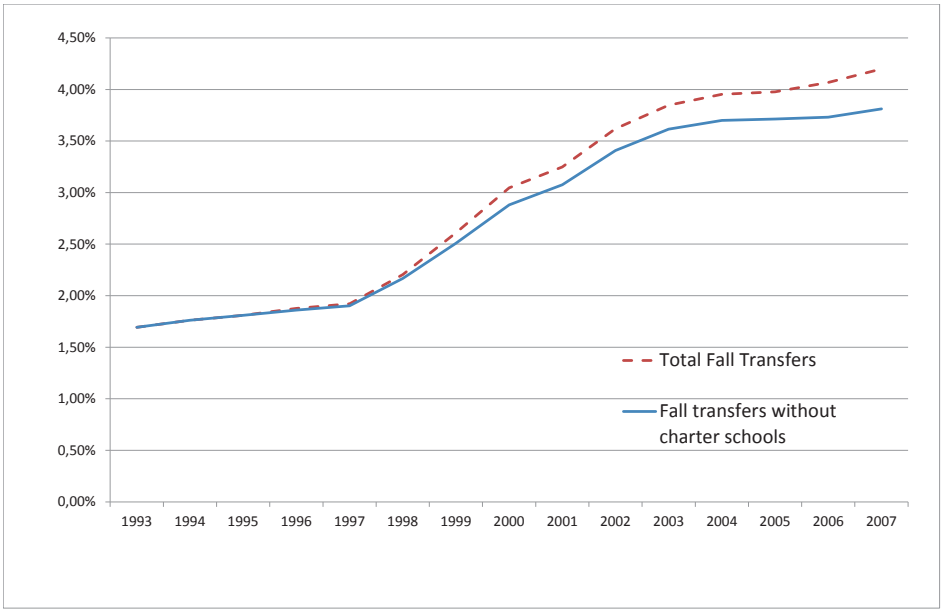


Figure 8: Share of students in 8th to 12th grades with a district of enrollment different from district of residence, 1993-2007. The dashed line corresponds to the total number, while the solid corresponds to all students except for those attending charter schools. *Source*: TEA.

Table 1: Descriptive Statistics

	Before (1994-1996)			**After (1998-2000)**		
	Mean	**Std. Dev.**	**N**	**Mean**	**Std. Dev.**	**N**
A. School Level Data						
A.1. Local segregation index with respect to region						
9th grade	0.134	0.132	4,563	0.150	0.151	5,000
10th grade	0.134	0.142	4,253	0.149	0.160	4,633
11th grade	0.128	0.139	4,103	0.140	0.153	4,411
12th grade	0.127	0.138	4,086	0.136	0.150	4,335
9th to 12th grades	0.131	0.138	17,005	0.144	0.154	18,379
9th and 12th grades	0.130	0.135	8,649	0.144	0.151	9,335
B. Individual Level Data						
B.1. Probabiliy of moving to a school with ... than school of origin						
less college-bound students	0.514	0.500	72,749	0.546	0.498	78,289
lower SAT average	0.377	0.485	64,714	0.491	0.500	67,097

Notes: All the differences between the before and after means are statistically significant at the 1% level, apart from the within-county segregation index that is statistically significant at the 5% level. 'College-bound students' measures the proportion of students taking either SAT or ACT at a given school.

Table 2: Fixed effect estimation, 9th to 12th grades, school years from 1994 to 2000 (excl. 1997)

Dep. Var.: M^r_{ys}: Local segregation index with respect to *region*				
	(1)	(2)	(3)	(4)
$G12 \times POST$	-0.004*	-0.004*	-0.004*	-0.004*
	(0.002)	(0.002)	(0.002)	(0.002)
$G11 \times POST$			-0.004*	-0.004*
			(0.002)	(0.002)
$G10 \times POST$			-0.003	-0.003
			(0.002)	(0.002)
Constant	0.135***	0.135***	0.136***	0.136***
	(0.001)	(0.001)	(0.001)	(0.001)
Fixed effects:				
School-Grade	yes	yes	yes	yes
Region-Year	no	yes	no	yes
Year	yes	no	yes	no
Mean of Dep. Var.	0.137	0.137	0.138	0.138
Observations	17,984	17,984	35,384	35,384
School-grade	3,722	3,722	7,274	7,274

Notes: * significant at 10%, ** significant at 5%, *** significant at 1%. Robust standard errors in parentheses. The masked observations were converted to zero. The variable $Gy \times POST = 1$ if $y = \{10, 11, 12\}$ and $t > 1997$ and 0 otherwise.

Table 3: Placebo analysis: Fixed effect estimation, 9th to 12th grades, school years from 1990 to 1996 (excl. 1993)

Dep. Var.: M^r_{ys}: Local segregation index with respect to *region*				
	(1)	(2)	(3)	(4)
$G12 \times T93$	0.002	0.002	0.002	0.002
	(0.002)	(0.002)	(0.002)	(0.002)
$G11 \times T93$			0.001	0.001
			(0.002)	(0.002)
$G10 \times T93$			0.001	0.001
			(0.002)	(0.002)
Constant	0.125***	0.126***	0.127***	0.127***
	(0.001)	(0.001)	(0.001)	(0.001)
Fixed effects:				
School-grade	yes	yes	yes	yes
region-year	no	yes	no	yes
Year	yes	no	yes	no
Mean of Dep. Var.	0.127	0.127	0.128	0.128
Observations	16,435	16,435	32,441	32,441
School-grade	3,301	3,301	6,454	6,454
r-squared (within)	0.001	0.012	0.000	0.008

Notes: * significant at 10%, ** significant at 5%, *** significant at 1%. Robust standard errors in parentheses. The masked observations were converted to zero. The variable $Gy \times T93 = 1$ if $y = \{10, 11, 12\}$ and $t \geq 1993$ and 0 otherwise.

Table 4: Linear Probability Model, 9th to 12th grades, school years from 1994 to 2000 (excl. 1997)

Dep. Var.:	Probability of moving to a school with **less college-bound** students than school of origin			Probability of moving to a school with **lower SAT average** than school of origin		
	Full Sample	Within Districts	Across Districts	Full Sample	Within Districts	Across Districts
	(1)	(2)	(3)	(4)	(5)	(6)
$G11$	0.028***	0.079***	0.008	0.016**	0.023	0.012**
	(0.005)	(0.014)	(0.005)	(0.006)	(0.020)	(0.005)
$G12$	0.064***	0.148***	0.024***	0.020***	0.026*	0.019***
	(0.006)	(0.016)	(0.006)	(0.005)	(0.015)	(0.006)
$G11 \times POST$	0.025**	0.074**	0.004	-0.013	-0.048	0.000
	(0.012)	(0.031)	(0.007)	(0.015)	(0.052)	(0.007)
$G12 \times POST$	0.031***	0.067***	0.009	0.023***	0.066***	0.010
	(0.008)	(0.021)	(0.008)	(0.008)	(0.023)	(0.008)
Constant	0.454***	0.462***	0.446***	0.501***	0.552***	0.475***
	(0.010)	(0.024)	(0.009)	(0.011)	(0.026)	(0.010)
Mean Dep. Var.	0.530	0.611	0.502	0.435	0.488	0.418
Observations	151,038	39,341	111,697	131,811	32,072	99,739
R-squared	0.007	0.036	0.003	0.082	0.117	0.068

Notes: * significant at 10%, ** significant at 5%, *** significant at 1%. Robust standard errors clustered at the school of origin level in parentheses. The control variables are year, ethnic group, economic disadvantaged status, grade, grade offered. 'College-bound students' measures the proportion of students taking either SAT or ACT at a given school.

Table 5: Testing the unbiasedness assumption

Dep. Var.:	MAJ_i (1)	MAJ_i (2)	$MAJ_i - \widehat{MAJ}_i$ (3)	MAJ_i (4)	$MAJ_i - \widehat{MAJ}_i$ (5)
MAJ_s	0.996***	0.996***		0.994***	
	(0.002)	(0.002)		(0.002)	
$MAJ_{s'}$			0.026***		0.025***
			(0.002)		(0.002)
$MAJ_s \times POST$				0.004**	
				(0.002)	
$MAJ_{s'} \times POST$					0.001
					(0.001)
Constant	0.024***	0.026***		0.028***	
	(0.001)	(0.002)		(0.002)	
Fixed effects					
Year	no	yes	no	yes	no
Grade	no	yes	no	yes	no
Observations	1,464,216	1,464,216	1,464,216	1,464,216	1,464,216

Notes: * significant at 10%, ** significant at 5%, *** significant at 1%. The dependent variable MAJ_i is equal to 1 if student moving from school s to s' is from majority group (i.e., white or Asian) and 0 otherwise. The dependent variable $MAJ_i - \widehat{MAJ}_i$ corresponds to the residuals from the previous column. Robust standard errors clustered at the school of origin level in parentheses.

Table 6: Robustness checks: unbiasedness assumption

Dep. Var.:	MAJ_i: Majority status of student moving from school s to s'					
	(1)	(2)	(3)	(4)	(5)	(6)
MAJ_s	1.004***	0.945***	1.005***	0.950***	1.007***	0.951***
	(0.002)	(0.012)	(0.002)	(0.012)	(0.002)	(0.013)
Constant	0.019***	0.053***	0.019***	0.048***	0.019***	0.048***
	(0.002)	(0.011)	(0.002)	(0.012)	(0.002)	(0.012)
Fixed effects						
Year	yes	yes	yes	yes	yes	yes
Grade	yes	yes	yes	yes	yes	yes
Origin-destination school	no	yes	no	yes	no	yes
Observations	1,253,180	1,253,180	1,214,427	1,214,427	1,181,042	1,181,042
Sample restriction	Only pairs of schools with 20+ movers		Only pairs of schools with 50+ movers		Only pairs of schools with 100+ movers	

Notes: * significant at 10%, ** significant at 5%, *** significant at 1%. Robust standard errors clustered at the school of origin level in parentheses.