

School Competition, Classroom Formation, and Academic Quality

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US Public Schools Are Highly Segregated Along Racial Lines

As of May 2021, **45%** of white K-12 students attend a school where they account for **75%** or more of the student body.

U.S. Government Accountability Office 2022

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Does classroom segregation respond to **competitive incentives**?
How does this affect **educational outcomes**?

Parents Care About Classroom Assignments

Parents may submit to the principal **written requests** for assignment or reassignment of their children so long as the parents provide a compelling reason for the request. The **principal shall consider** parental requests in assigning students to classes.

Policy Code, Montgomery County Schools, NC

CLASSROOM MANAGEMENT

Principal Hotline: I'm Buried in Parent Requests. What Do I Do?

I've heard "I don't want my child with that teacher" 100 times already this summer.



Illustration credit: Glenn Trumbull



Education
Next San Francisco's Detracking Experiment

Whether **detracking** can assist in the quest for greater equity is an open question. It could, in fact, **exacerbate inequities** by favoring high achieving children from upper-income families—who can afford private sector workarounds—or with parents savvy enough to **negotiate** the bureaucratic hurdles SFUSD has erected to impede acceleration.

EducationWeek

Florida Law Lets Parents Request Classroom Transfers For Their Children

"(...) I've **never known a principal** who hasn't honored a parent request."

Teacher quote, in St. John (2014), *Understanding the Factors that Influence the Grouping and Assignment of Students to Elementary Classrooms*

"Working-class and poor parents (...) had much more **distance or separation** from the school than did middle-class mothers. (...) Other working-class and poor parents also appeared **baffled, intimidated, and subdued** in parent-teacher conferences."

Annette Lareau (2011), *Unequal Childhoods*

This Might Lead To Efficiency And Equity Loss

- ▶ Students (parents) value classroom demographics Glazerman 1998; Saporito and Lareau 1999; Nechyba 2000; Schneider and Buckley 2002; Rothstein 2006; Hastings et al. 2009; Chakrabarti and Roy 2014; Glazerman and Dotter 2017; Allende 2019; Campos 2024
 - ▶ Proxy for achievement and behavior; commonality of views; residential patterns Castillo and Petrie 2010; Davidson, Penner, Penner, Pharris-Ciurej, Porter, Rose, Shem-Tov, Yoo 2022; Billingham and Hunt 2016; Lareau 2000, 2011
- ▶ Schools compete for *marginal* student Spence, 1975; Bau, 2022 Enrollment Incentives
 - 1. Indulging parental preferences may raise level of classroom segregation within school
 - 2. Schools' incentives to compete on directly productive investments may be reduced
 - ▶ Part of learning benefits of competition may be lost

This Paper: Question One

- Does classroom segregation respond to **competitive incentives** in public education?

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 - ▶ Classroom segregation increases by up to a third – driven by higher **dispersion**
 - ▶ Academic quality increases by a fourth of a standard deviation
 - ▶ Schools that increase classroom segregation relatively more raise academic quality less, and vice versa (i.e., competitive responses are **negatively correlated**)

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- ▶ **Banning** classroom segregation raises aggregate academic quality and reduces racial test score gap and segregation
 - ▶ **Test score impact** a fifth as large as upon replacing 5% least effective teachers Chetty et al.

2014; Gilraine et al. 2020

Literature Contributions

- ***Unintended consequences of competition in education*** Nechyba 2000; Epple, Newlon & Romano 2002; Figlio & Page 2002; Epple, Figlio, & Romano 2004; McMillan 2004; MacLeod & Urquiola 2013, 2015; Akyol & Krishna 2017; Altonji, Huang, & Taber 2015; Boleslavsky & Cotton 2015; Bordon, Fu, Gazmuri, & Houde 2016; Singleton 2019 - Rothstein 2006; Abdulkadiroğlu et al. 2020; Ainsworth et al. 2022
 - ▶ **This Paper:** Extend to **public** schooling markets via discretionary classroom formation
- **School choice and competition with social interactions** Walters 2018; Singleton 2019; Allende 2019; Neilson 2021; Dinerstein & Smith 2021; Gilraine, Singleton, & Petronijevic 2023 - Fan 2013; Ryan 2023 - Brock & Durlauf 2001, 2002, 2005, 2006; Blume et al. 2015; Diamond 2016; Bayer & Timmins 2018; Davis, Gregory, & Hartley 2023 - Fu & Mehta 2018 - Agostinelli, Luflade, & Martellini 2023
 - ▶ **This Paper:** Embed **structure** of peer interactions within school in demand and supply
- **Quantitative analysis of K-12 horizontal differentiation** Bau 2022; Gilraine, Singleton, & Petronijevic 2021; Ferreyra & Kosenok 2018; Figlio & Page 2002
 - ▶ **This Paper:** Document that horizontal differentiation reduces **vertical competition**
- **Charlotte reform** Hastings and Weinstein 2008; Hastings et al. 2009; Billings et al. 2014; Deming et al. 2014; Bibler & Billings 2020
 - ▶ **This Paper:** Identify and document **competitive responses**

Roadmap

Context & Reduced-Form Evidence

Empirical Model

Estimation

Results

Conclusion

Roadmap

Context & Reduced-Form Evidence

Empirical Model

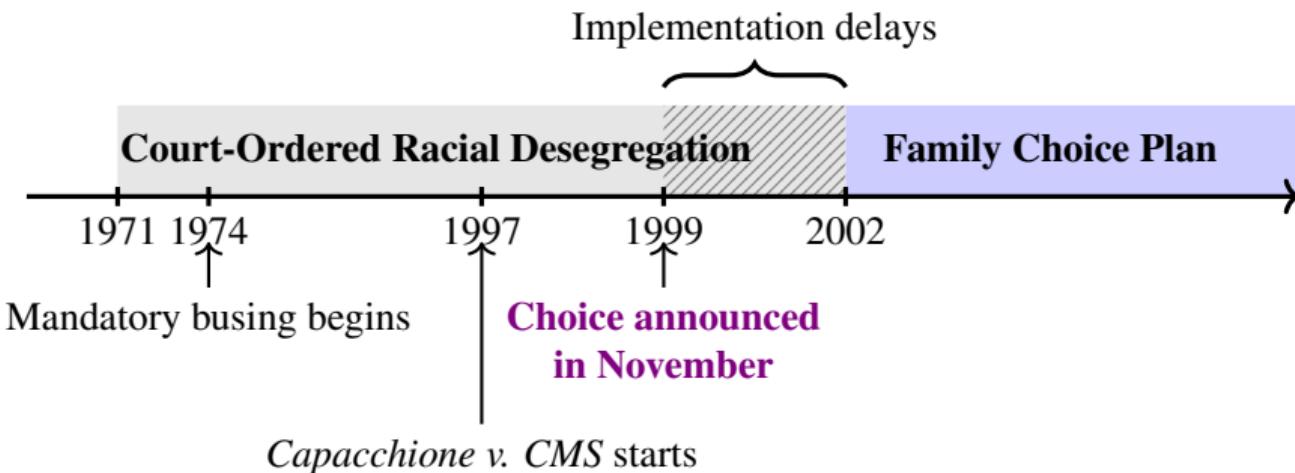
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School Choice Is Introduced In Charlotte-Mecklenburg Schools (CMS)

- ▶ **27K** G3-5 students enrolled across **87** campuses; **51%** non-white; **44%** low SES
- ▶ Assignment of students to public schools is deeply reformed:



Data

- ▶ Administrative records from the North Carolina Education Research Data Center, 1998-2005: Focus on elementary traditional public schools
- ▶ At the individual level:
 - ▶ Demographics (race and binary measure of economic disadvantage)
 - ▶ Residential address (at the block group level)
 - ▶ School and grade of enrollment
 - ▶ Test scores
- ▶ Individuals can be linked to classrooms
- ▶ Measure classroom segregation through (variation of) dissimilarity index, academic quality through value-added Measurement

Empirical Strategy

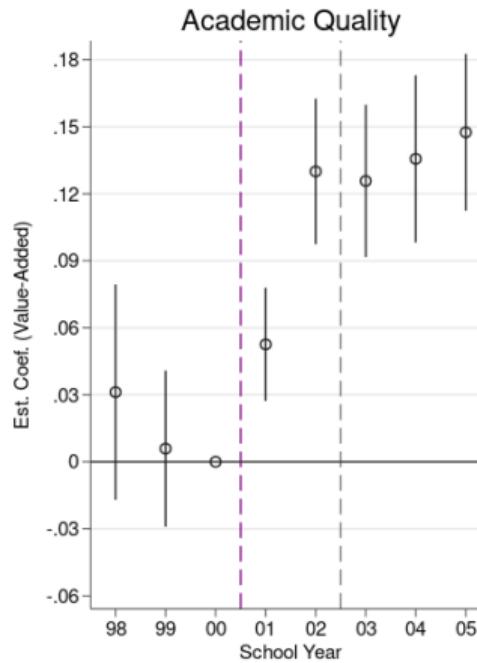
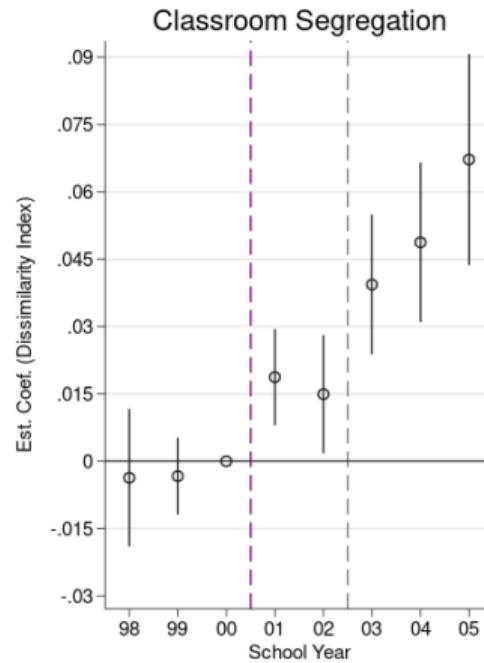
Estimate event study specification at school s by year t level:

$$y_{st} = \alpha + \sum_{k=1998}^{1999} \beta_k (1[t=k] \times Treated_s) + \sum_{k=2001}^{2005} \gamma_k (1[t=k] \times Treated_s) + \delta X_{st} + \phi_s + \phi_t + \epsilon_{st}$$

- ▶ Event: reform *announcement* Figlio & Hart 2014; Gilraine, Petronijevic, & Singleton 2021
- ▶ y_{st} : classroom segregation or value-added
- ▶ $Treated_s$: two alternative definitions
 - ▶ Binary: CMS v. other large urban districts in North Carolina
 - ▶ Continuous: within CMS, physical proximity to nearest competitor
- ▶ X_{st} enrollment size and composition; ϕ_s, ϕ_t fixed effects

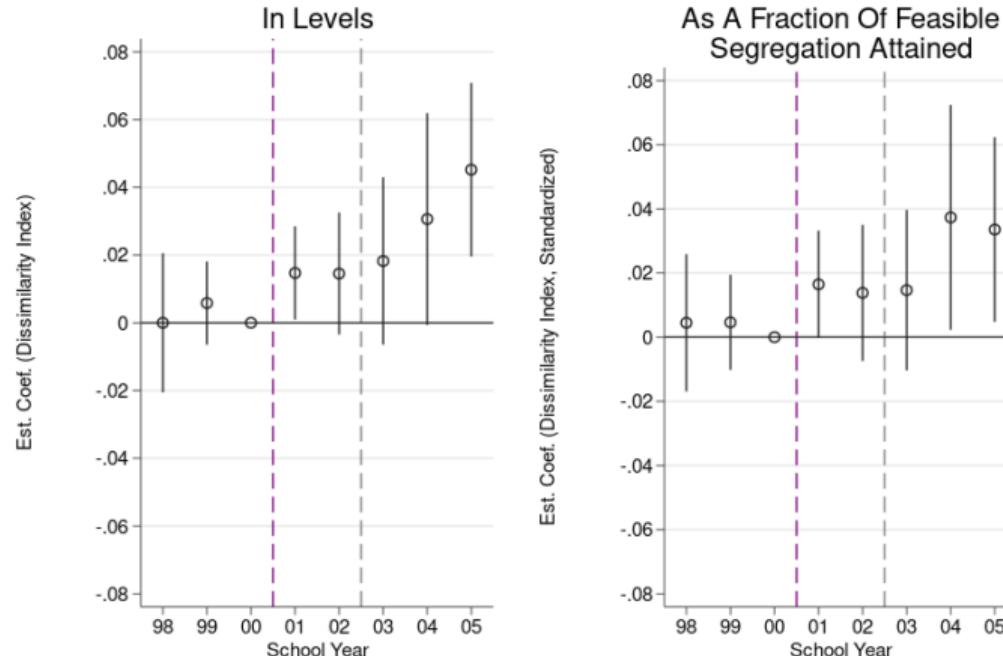
Fact 1: Classroom Segregation Responds To Competitive Incentives

CMS v. Other Large Districts

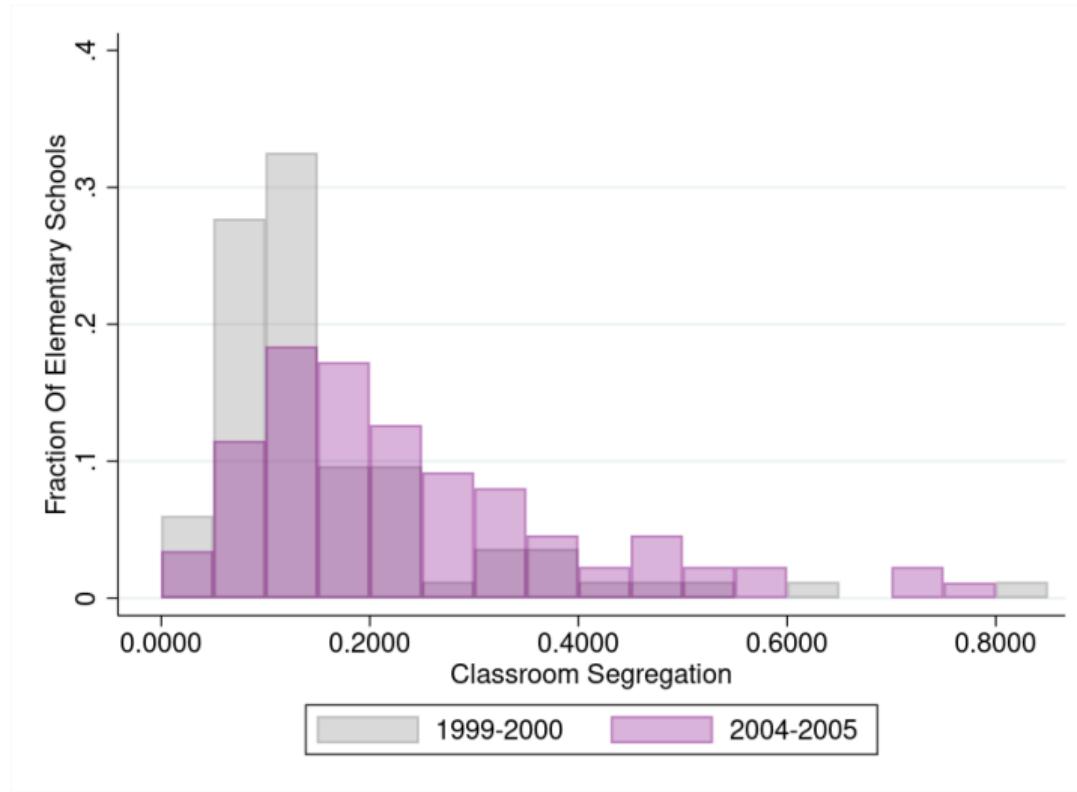


Fact 2: Larger Increase Where Competitive Pressure Is Greater

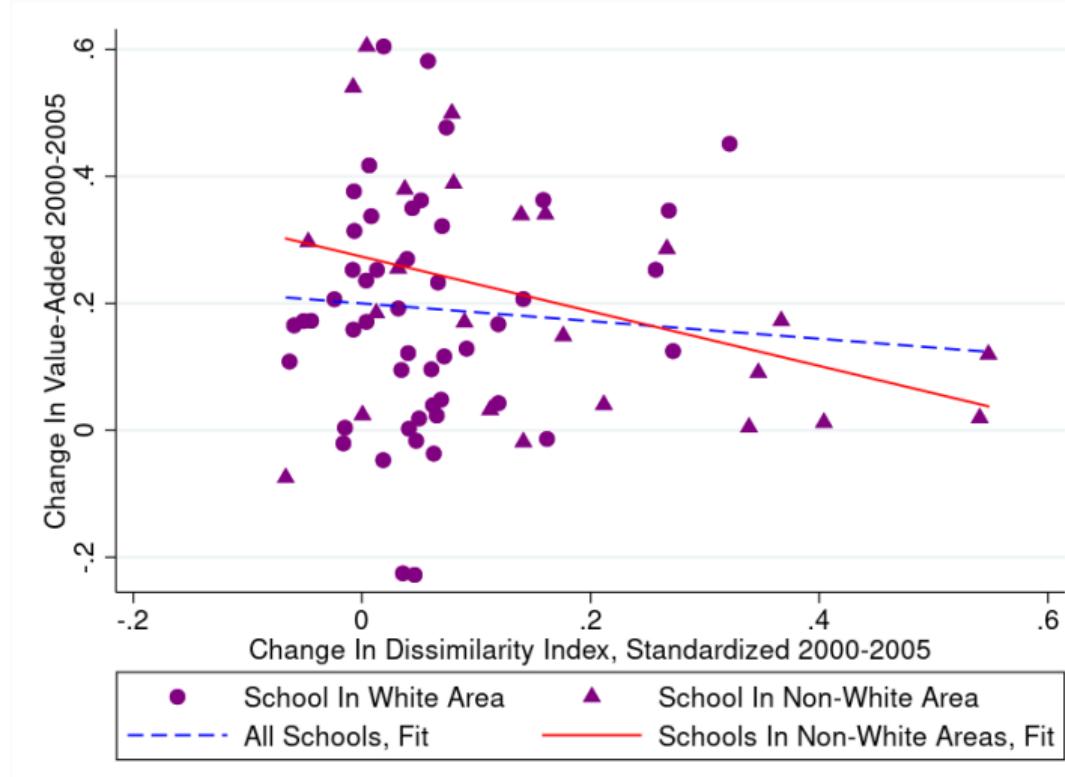
Classroom Segregation Within CMS



Fact 3: Rise Driven By Right Tale Of Classroom Segregation Distribution



Fact 4: Correlation Between Segregation And Quality Responses



Correlation coefficient: -0.14 for all schools; -0.43** for schools in non-white areas.

2000-2001

Key Take-Aways

Data Pattern	Model Ingredient
Classroom segregation and value-added both increase	Parents value both dimensions
Schools with closer competitors increase segregation more	Parents value proximity to home (i.e., schools compete spatially)
Classroom segregation distribution spreads out	Heterogeneous preferences for classroom segregation
Negative correlation between segregation and quality responses	Segregation substitutes for quality
Correlation stronger in minority-white nbhd	Preferences for classroom segregation depend on school composition

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Empirical Model

In each year (t):

1. Schools (s) choose academic quality q and classroom segregation D simultaneously
(full information static Nash)
2. Households (i) choose school that maximizes indirect utility

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$$U_{ist} = \beta_i^q q_{st} + \beta_i^D D_{st} + \beta_i^W \overline{W}_{st}(q_t, D_t) + \beta_i^{DW} \left(D_{st} \times \overline{W}_{st}(q_t, D_t) \right) + \beta_i^M Magnet_{st} + \xi_{st}$$
$$- \gamma_i Distance_{ist} + \gamma_i^M Distance_{ist} \times Magnet_{st} + \gamma_i^T Distance_{ist} \times Post_t \times Transportation_{ist}$$
$$+ \eta_i Default_{ist} + \eta_i^P Default_{ist} \times Post_t + \tilde{v}_{ist}$$

Empirical Model

In each year (t):

- Schools (s) choose academic quality q and classroom segregation D simultaneously
(full information static Nash)

$$\arg \max_{\{q_{st}, D_{st}\}} \left\{ E_{st}(q_t, D_t) - C_{st} \left(q_{st}, D_{st}, E_{st}(q_t, D_t), W_{st}(q_t, D_t) \right) \right\}$$

$$0 \leq D_{st} \leq 1$$

Cost function comprises marginal cost of academic quality, quadratic in academic quality, quadratic in classroom segregation, and compositional shifter

Cost function

- Households (i) choose school that maximizes indirect utility

Equilibrium

- ▶ First-order conditions for classroom segregation and academic quality
- ▶ Rational expectation condition: $\bar{W}_{st} = W_{st} \quad \forall s$
- ▶ How will supply of academic quality respond to ban on classroom segregation?
 - ▶ Marginal student preferences (horizontal differentiation v. vertical competition)
D'Aspremont et al. 1979; Tirole 1988
 - ▶ Non-linearity in cost function McMillan 2004

Equilibrium

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Parameters To Be Estimated

- ▶ Linear demand parameters θ_1 : do not vary across households
- ▶ Non-linear demand parameters θ_2 : observed and unobserved heterogeneity
- ▶ Supply parameters θ_3 : marginal cost of academic quality; quadratic fixed cost of academic quality and classroom segregation; compositional shifter

Estimation Strategy

Using data from before *and* after introduction of choice, Estimation sample

1. Estimate θ_2 via Simulated Maximum Likelihood Integration

- ▶ Identification: availability of student-level data Berry & Haile 2020; Grieco, Murry, Pinske, & Sagl 2023
- ▶ At $\hat{\theta}_2$, back out mean utilities $\hat{\delta}(\theta_1)$ that match market shares (BLP inversion) Berry et al. 1995

2. Estimate θ_1 and θ_3 via Generalized Method of Moments

- ▶ **Endogeneity problem.** Example: classroom segregation choices may be correlated with supply-side factors ω_{st}^D that schools face but are unobserved to econometrician.
- ▶ Rely on within-market variation in spatial concentration as instrument for schools' responses: estimated parameter rationalizes event-study results Gilraine, Petronijevic, & Singleton 2023

Identifying Assumption

Roadmap

Context & Reduced-Form Evidence

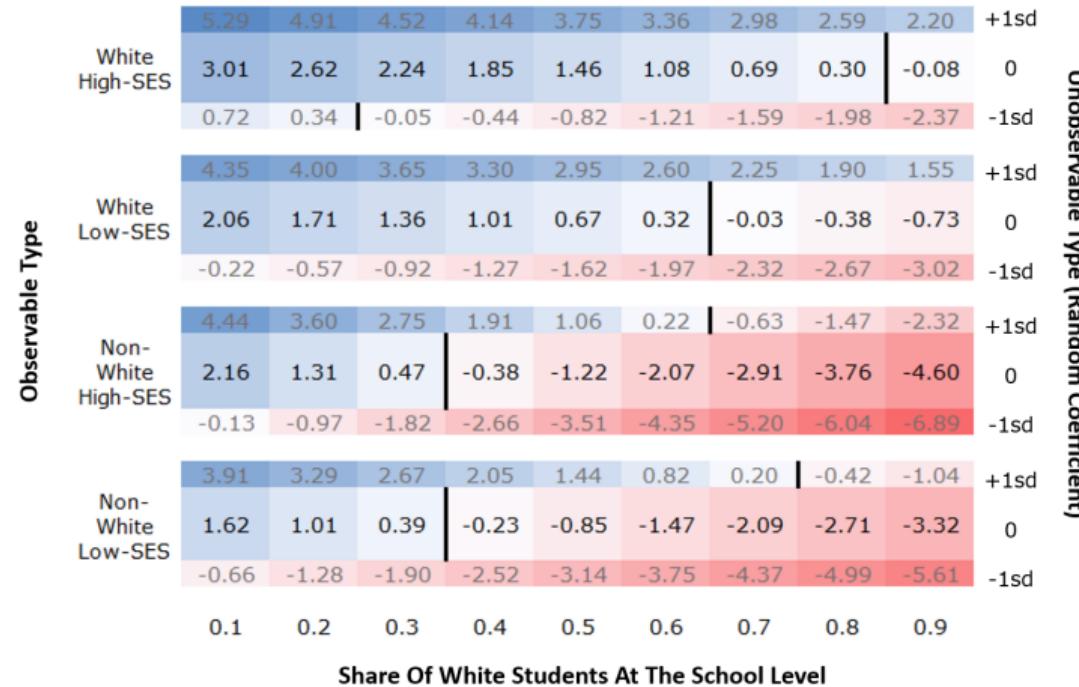
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Model Estimates: Preferences For Classroom Segregation



Counterfactual: Ban On Classroom Segregation

Effect Of Mandating Integrated Classrooms On	Change w.r.t. Baseline
Academic quality	+0.012 σ <small>Distribution</small>
Average test score	+0.004 σ
Average p.v. lifetime earnings <small>Chetty et al. 2014, Gilraine et al. 2020</small>	+\$1,620
Racial test score gap	-2%
Racial segregation across schools (dissimilarity)	+0.1 p.p.
Total segregation (tentative estimate)	-10%

[Tracking literature](#) [Overlap](#) [Decomposition](#)

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Concluding Remarks

- ▶ Study schools' joint decision over classroom segregation and academic quality
- ▶ Find substantial heterogeneity in household preferences for classroom segregation
- ▶ Banning discretion on classroom formation leads to gains in aggregate quality
- ▶ To de-tracking experiments: Gains depend on market structure and parents' responsiveness to academic quality Akyol & Krishna 2017; Bau 2022; Ainsworth et al. 2023 Policies
- ▶ Bridge to literature on parents' behavioral responses Cunha, Heckman, & Schennach 2010; Fu & Mehta 2018; Attanasio, Meghir, & Nix 2018; Kinsler & Pavan 2021; Del Boca, Flinn, Verriest, & Wiswall 2023

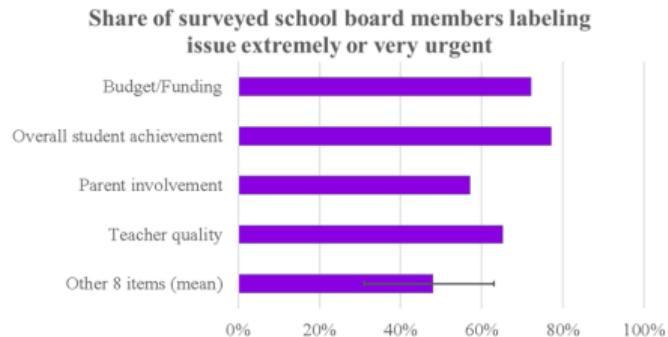
Public Schools Care About Enrollment

- ▶ Size

- ▶ Funding

- ▶ Composition

- ▶ Funding
 - ▶ Parental involvement
 - ▶ Achievement
 - ▶ Appeal to teachers



Adapted from: National School Board Association & K12 Insight 2018 Survey

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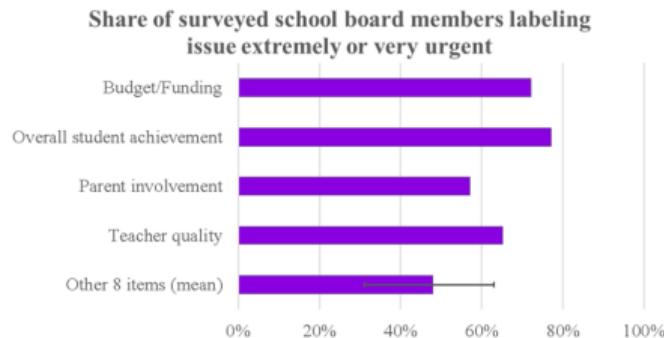
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“By introducing choice and competition (...) intra- and interdistrict **public school choice** (...) policies transform a top-down accountability system (...) into a bottom-up system wherein schools attempt to **attract and retain students** whose parents enjoy a wide range of educational options.”

W. G. Howell, in Howell and Peterson 2006

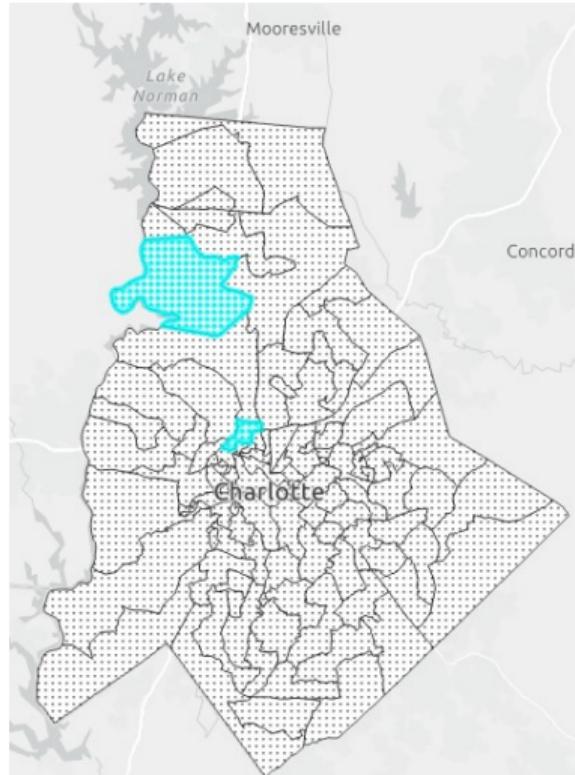
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Classroom Formation In North Carolina Is A Discretionary Process

- ▶ No specific state or district guidelines discipline the process
 - ▶ Similar practices in other states Hopkins 1999; Burns & Mason 2002
- ▶ Elementary schools mix automation and discretion Henderson 2011
 - ▶ Classroom assignments deviate from random Bosworth & Li 2013; Horvath 2015
- ▶ Principals overwhelmed by parental requests Web anecdotes
 - ▶ Demographics and *class* correlate with parental involvement Kim 2009, Lareau 2011

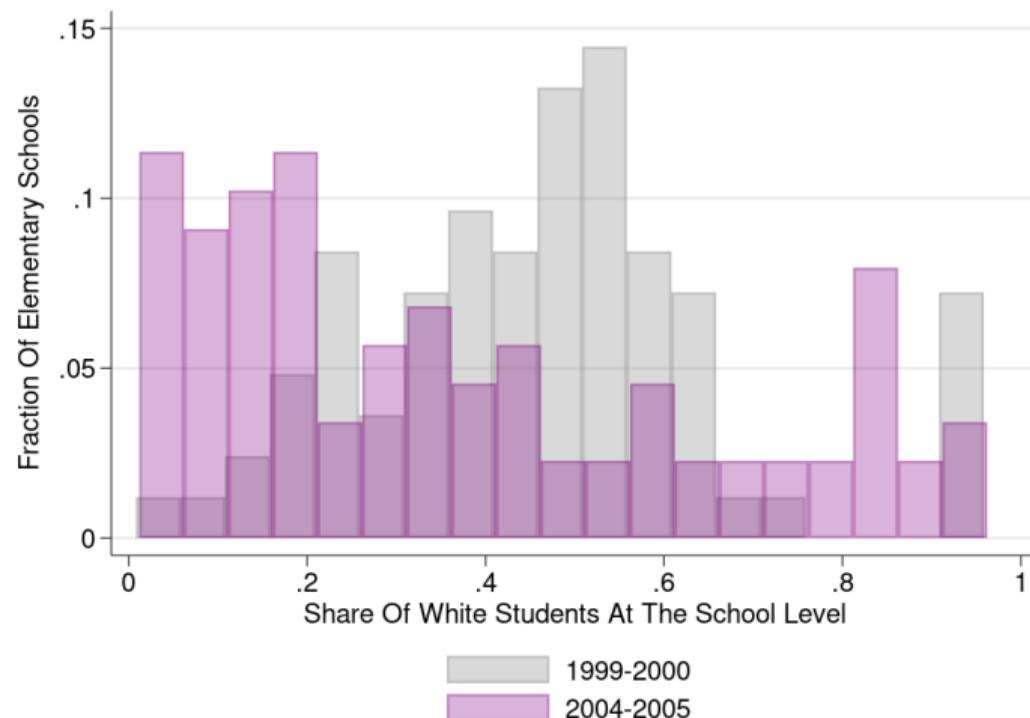
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Example Of Satellite Zone In 2000: Creek Elementary



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Students Re-Sort Across Schools Along Racial Lines



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Measuring Classroom Segregation (I)

For school s in year t , compute average dissimilarity index across grades g Duncan and Duncan 1955

$$D_{stg}^A = \frac{1}{2} \sum_c \left| \frac{w_{stgc}}{W_{stg}} - \frac{n_{stgc}}{N_{stg}} \right|$$

- ▶ c classroom; w number of white students; n number of non-white students; capital denotes total; white category includes Asian students Card and Giuliano 2016
- ▶ Intuitive: Share of non-white students that must be transferred to different classrooms for non-white students to be distributed like their white grade-mates
- ▶ Limitation: Hard to compare across schools with different compositions

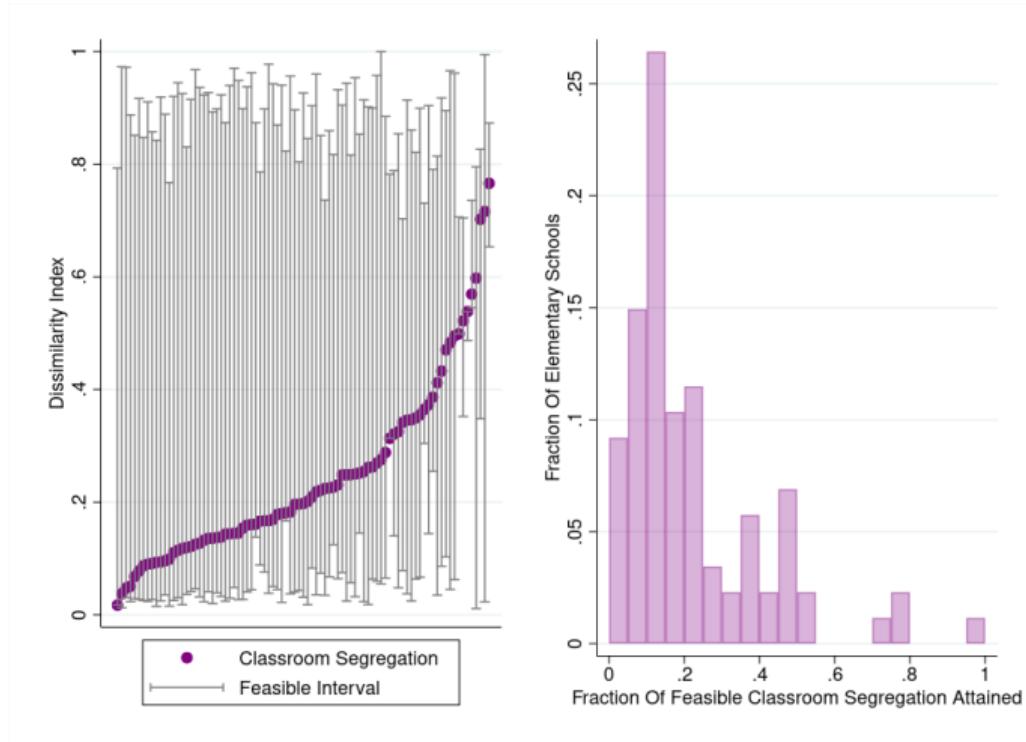
Measuring Classroom Segregation (II)

- ▶ Fraction of *feasible* classroom segregation attained:

$$D_{st} = \frac{D_{st}^A - D_{st}^{A,min}}{D_{st}^{A,max} - D_{st}^{A,min}}$$

- ▶ $D_{st}^{A,min}$: computed under *least segregated* classroom configuration (simulated)
- ▶ $D_{st}^{A,max}$: computed under *most segregated* classroom configuration (simulated)
- ▶ Class sizes and school racial composition anchored to real data

Classroom Segregation Varies Across Schools



Correlation

Support

Dense set

Estimating Academic Quality

Standard Value-Added Model Neilson 2021, Allende 2018, Bau 2022, Gilraine, Petronijevic, & Singleton 2023

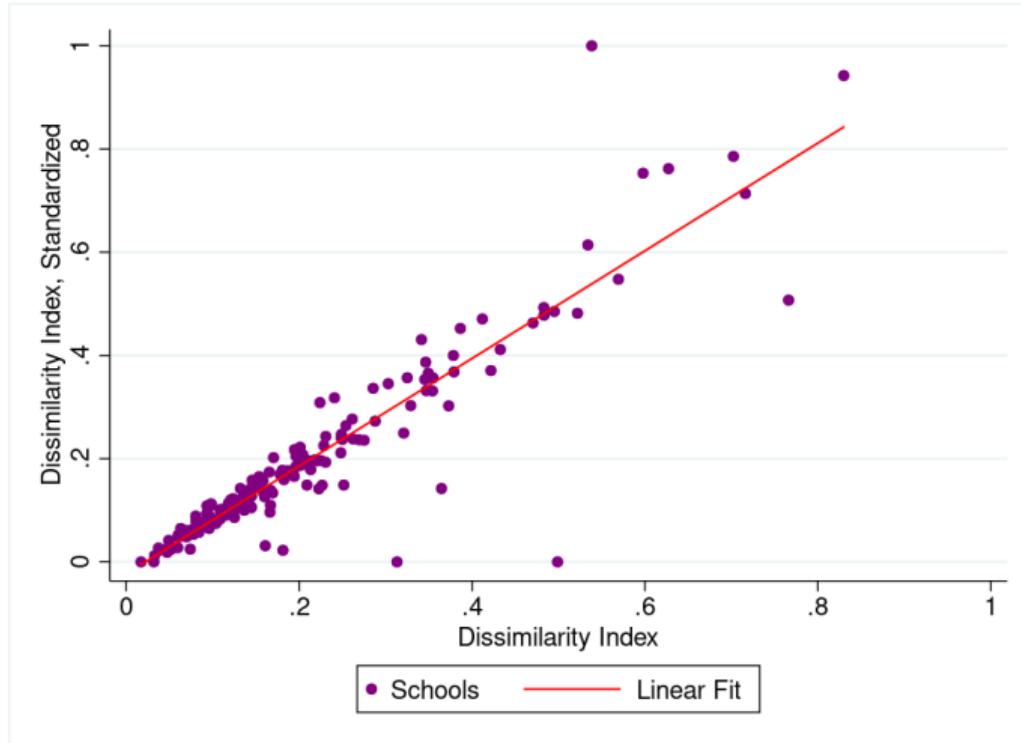
$$Y_{isgct} = X'_{isgct}\beta + \bar{X}'_{sgt}\gamma + \bar{X}'_{scgt}\delta + \omega_{gt} + q_{st} + \epsilon_{ist}$$

- ▶ i student; s school; g grade; c classroom; t year
- ▶ Y standardized end-of-grade math test score; X individual characteristics (including lagged test score); \bar{X} averaged individual characteristics; ω_{gt} grade-by-year dummies
- ▶ q_{st} school-by-year fixed effects: school's "treatment effect" on test score growth

Chetty et al. 2014; Deming 2014; Angrist et al. 2017; Raudenbush & Willms 1995; Rockoff & Turner 2016; Ellison & Swanson 2016

[Details](#) [Shrinkage](#) [Distribution](#) [Back](#)

Measures Of Classroom Segregation Are Positively Correlated



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Support Size Is Correlated With School Composition

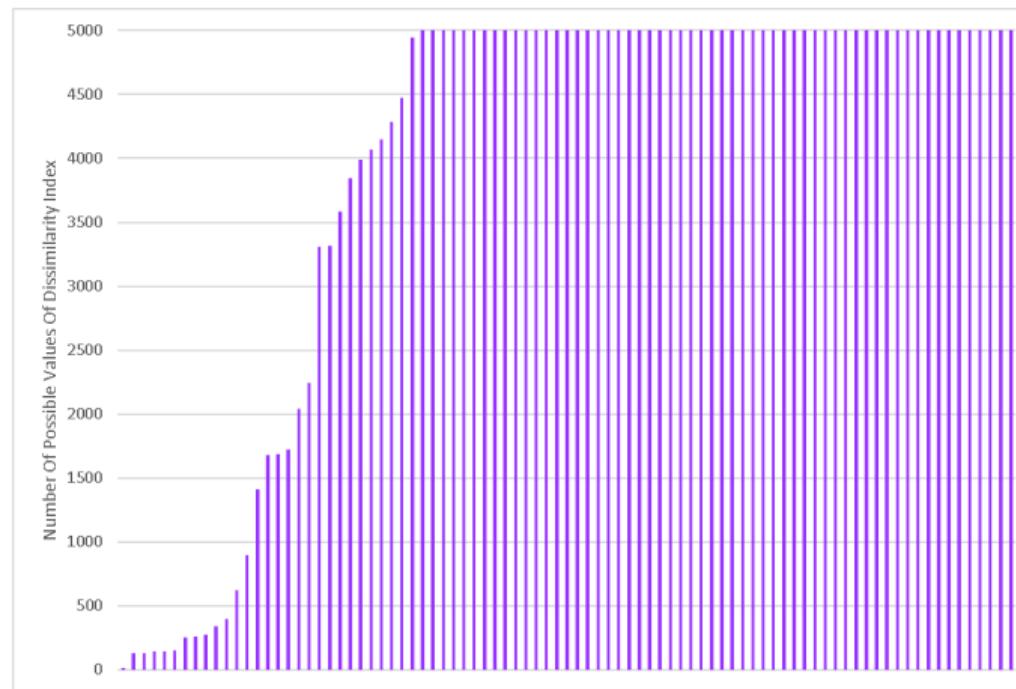
VARIABLES	(1) Minimum	(2) Maximum	(3) Range
Enrollment	0.000 (0.000)	0.001*** (0.000)	0.001*** (0.000)
Share White	-0.157*** (0.026)	0.005 (0.019)	0.162*** (0.036)
Observations	336	336	336
R-squared	0.104	0.206	0.149

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

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Sets Of Feasible Segregation Values Are Dense



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Details On Value-Added Estimation

Want a measure of academic quality that is:

- ▶ Orthogonal to student sorting → Flexibly control for student's lagged achievement
Chetty et al. 2014; Deming 2014; Angrist et al. 2017
 - ▶ Vector of individual covariates also includes race, gender, measures of economic disadvantage, English learner, disability, and Gifted & Talented status
- ▶ Purged from returns to classroom composition → Flexibly control for classroom composition and average lagged achievement (interacted with individual covariates)

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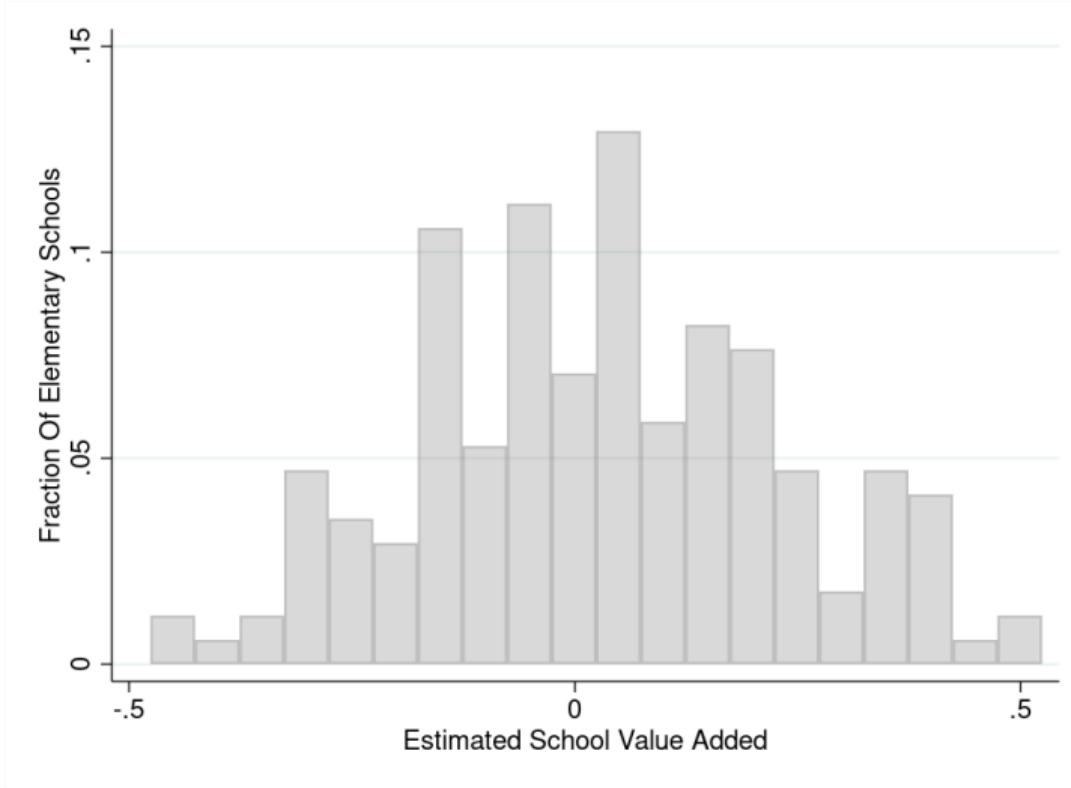
Empirical Bayes Estimator Of Value-Added

$$q_{st} = \tilde{q}_{st} \frac{\sigma_s^2}{\sigma_s^2 + \left(\frac{\sigma_\epsilon^2}{N_{st}} \right)}$$

- ▶ \tilde{q}_{st} school-year fixed effect in Value-Added Model (VAM)
- ▶ N_{st} number of students in school s and year t
- ▶ σ_ϵ^2 variance of ϵ_{ist} in VAM (estimate via ML and plug-in)
- ▶ σ_s^2 variance of \tilde{q}_{st} (estimate via ML and plug-in)

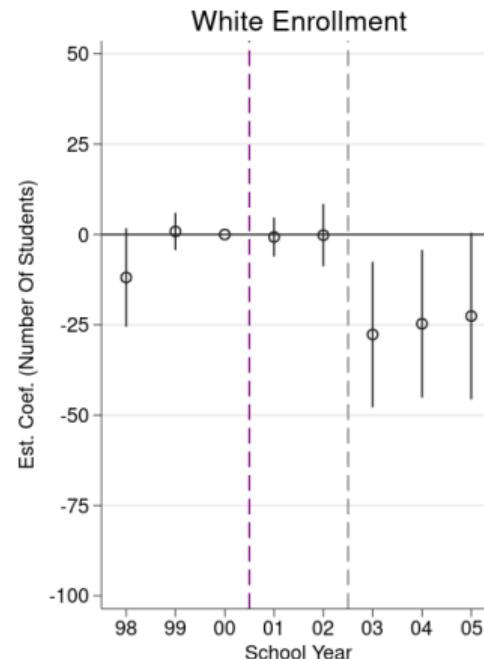
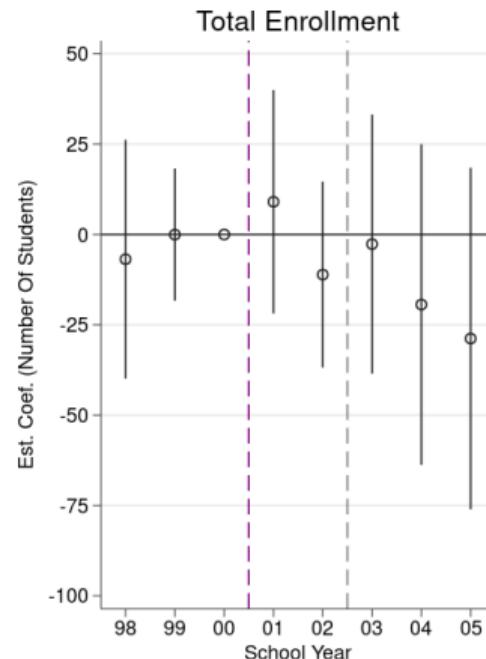
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Estimated Distribution Of Value-Added



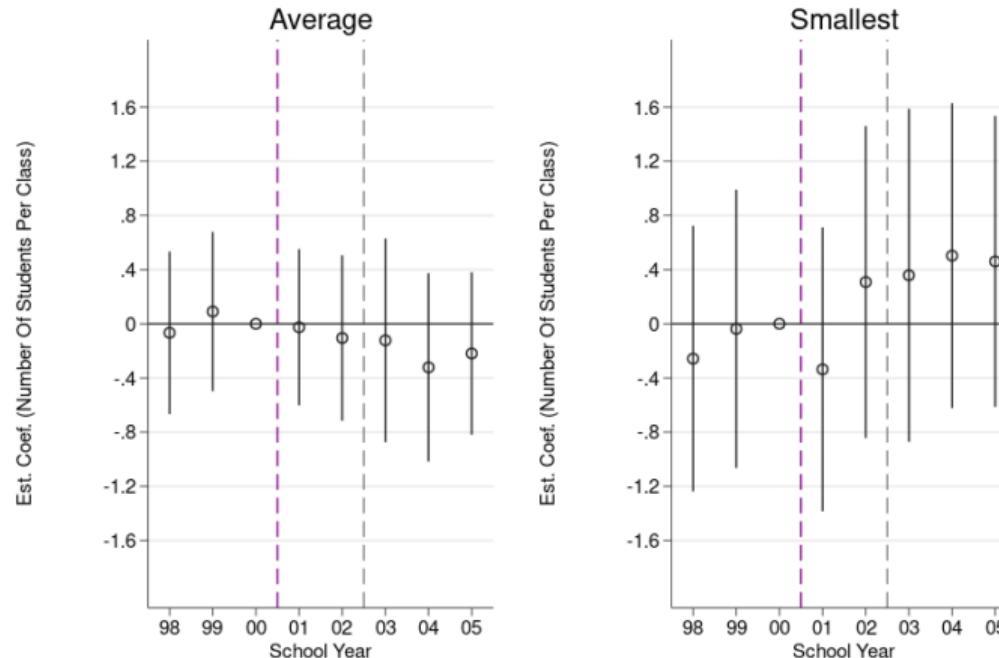
Enrollment Size And Composition Do Not Respond To Announcement

Enrollment Within CMS



Class Size Does Not Respond To Announcement

Class Size Within CMS



Racial Segregation V. Ability Tracking

DEPENDENT VARIABLE	White × Post	Achievement × Post
Share of white classmates	0.007*** (0.002)	0.002 (0.001)
Classmates' average lagged test score	0.012* (0.006)	0.005 (0.003)

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Quotes

Literature

Quotes From CMS Parents' Letters (*Capacchione v. CMS*)

- ▶ “(...) your classes were **slowed down** with **these other** students trying to get them up to the same level.” *Michael Grant, father, speaking of bused low-income minority students.*
- ▶ **Q:** “My question is (...) whether **exposure to people of another race in the classroom** (...) has an **educational value** to it.” **A:** “No.” *Deposition of Bill Capacchione.*
- ▶ “A school system should provide an educational venue for kids consistent with **what they need**. My kid didn’t get any of that because of his **skin color**.” *Larry Gavreau, father whose son was denied access to Magnet IB due to racial quota.*

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Parent Evaluation Of School Characteristics

- ▶ Mixed evidence on parental evaluation of school value-added
 - ▶ Families place substantial weight on it

Campos and Kearns 2022; Beuermann et al. 2023; Gilraine et al. 2023
 - ▶ Peer characteristics matter more

Rothstein 2006; Abdulkadiroğlu et al. 2006; Ainsworth et al. 2022
- ▶ School choice literature under social interactions: parents value school demographics

Hastings et al. 2009; Allende 2019

 - ▶ Evidence that peer racial composition matters – in some cases more than average achievement

Glazerman 1998; Saporito and Lareau 1999; Schneider and Buckley 2002; Glazerman and Dotter 2017
 - ▶ Valued both directly and as proxy for peers' achievement

Billingham and Hunt 2016

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Student-Teacher Match Quality Does Not Respond To Competition

VARIABLES	(1)	(2)
	Teacher VA Advantage With White Students	1(Teacher VA Advantage With White Students > 0)
1(Student is White)	0.006 (0.005)	-0.006 (0.013)
1(Student is White)	-0.008 (0.011)	0.041 (0.026)
x 1(Post-reform)		
School FE	Y	Y
Grade FE	Y	Y
Year FE	Y	Y
Observations	19,994	19,994
R-squared	0.186	0.169

Preference Heterogeneity

Allow for unobservable heterogeneity in preferences for q , D , and W :

$$\begin{pmatrix} \beta_i^q \\ \beta_i^D \\ \beta_i^W \end{pmatrix} = \begin{pmatrix} \bar{\beta}^q \\ \bar{\beta}^D \\ \bar{\beta}^W \end{pmatrix} + \begin{pmatrix} \beta_z^q \\ \beta_z^D \\ \beta_z^W \end{pmatrix} Z_i + \begin{pmatrix} \nu_i^q \\ \nu_i^D \\ \nu_i^W \end{pmatrix}$$

Where Z_i denotes student i 's observable (i.e., race-by-SES) type

McFadden 1973; McFadden & Train 2000; Nevo 2000

Preferences over other dimensions only vary across observable types

Parametrization

Back

Enrollment Probabilities

With \tilde{v}_{ist} following an extreme value type I distribution,

$$p_{ist} = \frac{\exp(V_{ist})}{\sum_{j \in \Omega} \exp(V_{ijt})} = \frac{\exp(\delta_{st}(\theta_1) + u_{ist}(\theta_2))}{\sum_{j \in \Omega} \exp(\delta_{jt}(\theta_1) + u_{ijt}(\theta_2))}$$

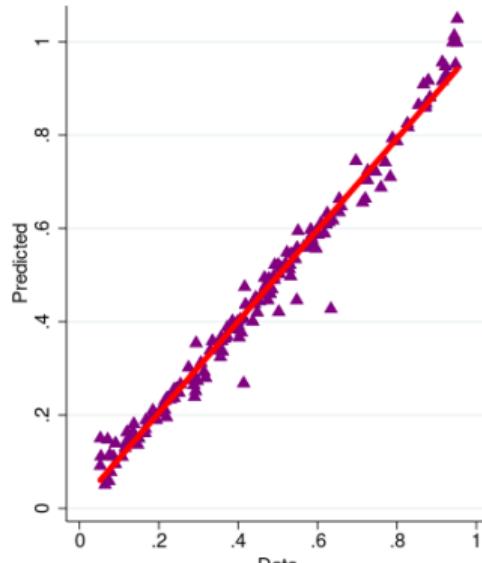
- ▶ Choice set Ω includes all elementary public schools in CMS
- ▶ θ_1 linear preference parameters $\rightarrow \delta_{st}$ “mean utility”
- ▶ θ_2 non-linear preference parameters $\rightarrow u_{ist}$ “idiosyncratic utility”

[Decomposition](#) [Back](#)

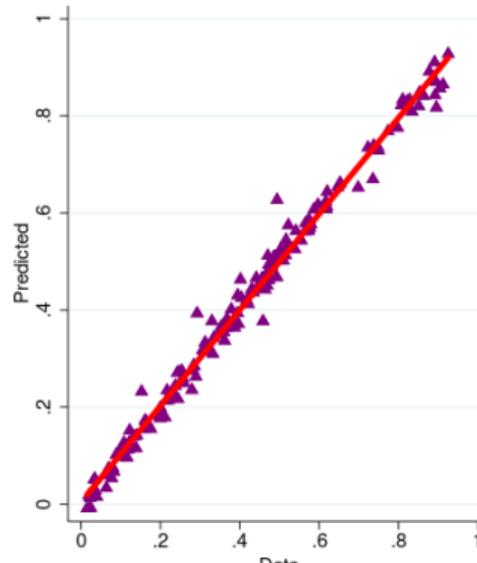
Expected Share Of White Classmates: Linear Fit

Average Share Of White Classmates

For White Students



For Non-White Students



▲ Schools — Linear Fit

▲ Schools — Linear Fit

Parametrization

$$\nu_i^q \sim \ln\mathcal{N}(\mu^q, \sigma^q)$$

$$\begin{pmatrix} \nu_i^D \\ \nu_i^W \end{pmatrix} \sim \mathcal{N}(0, \Sigma^{DW})$$

\tilde{v}_{ist} follows an extreme value type I distribution

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Enrollment Probabilities: Decomposition

$$p_{ist} = \frac{\exp(V_{ist})}{\sum_{j \in \Omega} \exp(V_{ijt})} = \frac{\exp(\delta_{st} + u_{ist})}{\sum_{j \in \Omega} \exp(\delta_{jt} + u_{ijt})}$$

$$\delta_{st}(\theta_1) = \bar{\beta}^q q_{st} + \bar{\beta}^D D_{st} + \bar{\beta}^W \bar{W}_{st} + \bar{\beta}^{DW} D_{st} \times \bar{W}_{st} + \xi_{st}$$

$$\begin{aligned} u_{ist}(\theta_2) = & (\beta_z^q Z_i + \nu_i^q) q_{st} + (\beta_z^D Z_i + \nu_i^D) D_{st} + (\beta_z^W Z_i + \nu_i^W) \bar{W}_{st} + \beta_z^{DW} Z_i (D_{st} \times \bar{W}_{st}) - \\ & \gamma_i Distance_{ist} + \gamma_i^M Distance_{ist} \times Magnet_{st} + \gamma_i^T Distance_{ist} \times Post_t \times Transportation_{ist} \\ & + \eta_i Default_{ist} + \eta_i^P Default_{ist} \times Post_t \end{aligned}$$

Back

Cost Function

$$C_{st} \left(q_{st}, D_{st}, E_{st}, W_{st} \right)$$
$$= \underbrace{\left(\phi W_{st} + \mu q_{st} + \omega_{st}^q \right) E_{st} - \underbrace{\zeta W_{st}}_{\text{Compositional Premium}}}_{\text{Cost of Producing Academic Quality}} + \underbrace{\kappa_1 q_{st} + \frac{\kappa_2}{2} q_{st}^2}_{\text{Fixed Cost}} + \underbrace{\omega_{st}^D \cdot D_{st} + \frac{\alpha}{2} D_{st}^2}_{\text{Cost of Classroom Segregation}}$$

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Equilibrium (Unconstrained)

First order conditions ($\kappa_2 = 0$):

$$q_{st} = -\frac{1}{\epsilon_{st}^q} \left(1 + \frac{\kappa_1}{\mu} \frac{1}{E_{st}} - \frac{\zeta}{\mu} \frac{dW_{st}}{dq_{st}} \frac{1}{E_{st}} \right) + \frac{1 - w_{st}}{\mu} - \frac{\omega_{st}^q}{\mu}$$

$$D_{st} = \frac{1}{\alpha} \frac{\epsilon_{st}^D}{\epsilon_{st}^q} \left(\mu E_{st} + \kappa_1 - \zeta \frac{dW_{st}}{dq_{st}} \right) + \frac{\zeta}{\alpha} \frac{dW_{st}}{dD_{st}} - \frac{\omega_{st}^D}{\alpha}$$

Rational expectation condition:

$$\bar{W}_{st} = W_{st} = \frac{\sum_i \left(p_{ist}(q_t, D_t) \times 1(White_i) \right)}{\sum_i p_{ist}(q_t, D_t)}$$

Semi-Elasticities

$$\epsilon_{st}^q = \frac{1}{E_{st}} \frac{dE_{st}}{dq_{st}} \quad \epsilon_{st}^D = \frac{1}{E_{st}} \frac{dE_{st}}{dD_{st}}$$

$$\frac{dE_{st}(\mathbf{q}, \mathbf{D}, W)}{dq_{st}} = \underbrace{\frac{\partial E_{st}(\mathbf{q}, \mathbf{D}, W)}{\partial q_{st}}}_{\text{Partial effect}} + \sum_j \underbrace{\frac{\partial E_{st}(\mathbf{q}, \mathbf{D}, W)}{\partial W_{jt}} \frac{dW_{jt}}{dq_{st}}}_{\text{Compositional effect}}$$

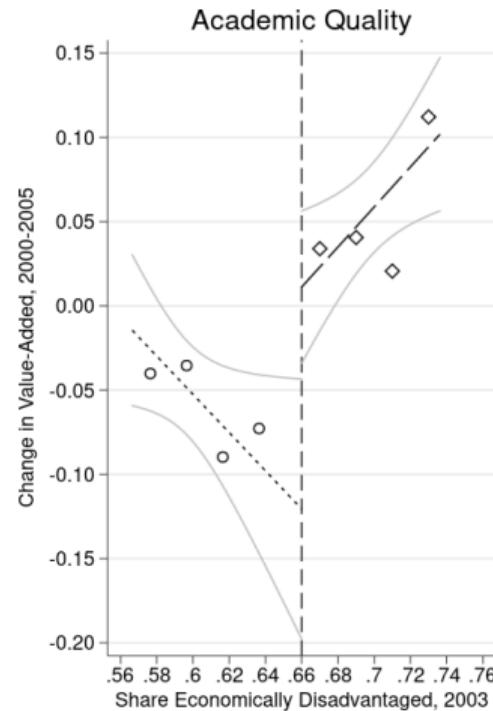
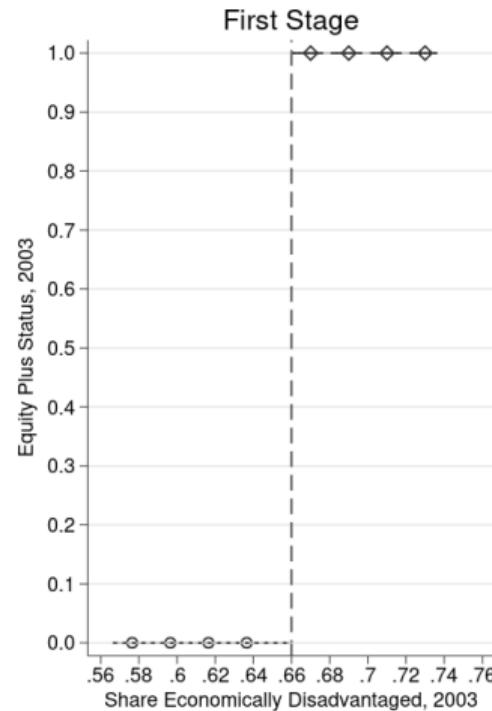
$$\frac{dE_{st}(\mathbf{q}, \mathbf{D}, W)}{dD_{st}} = \underbrace{\frac{\partial E_{st}(\mathbf{q}, \mathbf{D}, W)}{\partial D_{st}}}_{\text{Partial effect}} + \sum_j \underbrace{\frac{\partial E_{st}(\mathbf{q}, \mathbf{D}, W)}{\partial W_{jt}} \frac{dW_{jt}}{dD_{st}}}_{\text{Compositional effect}}$$

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The Equity Plan

- ▶ Shifts resources (e.g., extra teachers, bonuses, bond funds for renovation) toward schools with $\geq 66\%$ low-income students
- ▶ Approved in 2000 in anticipation of student re-sorting
- ▶ Works as cost-shifter: among comparably underprivileged schools, eligible ones achieve larger gain in value-added

Regression Discontinuity Evidence That Academic Quality Is Costly



Estimation Sample

Students	1999-2000		2004-2005	
	Full	10% Random	Full	10% Random
% White high-SES	41.97	42.92	35.91	37.88
% White low-SES	7.32	6.06	6.78	7.25
% Non-white high-SES	14.44	14.29	14.84	15.13
% Non-white low-SES	36.27	36.73	42.47	39.74
% Attending zoned school (for at least some residential draws)	81.97	82.68	57.03	58.20
<i>White</i>	82.11	82.20	68.73	72.22
<i>Non-white</i>	81.83	83.15	48.32	46.67
Distance to school of attendance (in miles)				
<i>Q1</i>	1.68	1.67	1.28	1.28
<i>Median</i>	2.89	2.73	2.77	2.69
<i>Q3</i>	4.20	4.21	7.17	6.92
Number of students	16,452	1,617	18,626	1,890
Number of student-by-address observations	240,391	23,899	74,638	6,887

[Back To Timeline](#)[Back To Estimation](#)[Schools](#)

Descriptive Statistics For Schools

Schools	1999-2000	2004-2005
Estimated value-added	-0.071 (0.179)	0.127 (0.176)
Classroom segregation	0.166 (0.136)	0.244 (0.159)
% Feasible classroom segregation attained	0.162 (0.157)	0.221 (0.187)
Share of white students at school level	0.459 (0.201)	0.367 (0.284)
Market share	0.012 (0.004)	0.011 (0.005)
Number of schools	83	88

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Simulated Maximum Likelihood: Technical Details

- ▶ Integrate out 3D unobserved heterogeneity via sparse grid quadrature Heiss and Winschel 2008
- ▶ For students with missing addresses:
 - ▶ Post-reform: assign random draws and attach weights drawn from pre-policy type-specific density across block groups
 - ▶ Pre-reform: for those enrolled at zoned school, draws are all block groups within catchment area (uniform weights)

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Instrument Relevance

Outcome Variable	# Excluded Instruments	F-Statistic
Δq	7	19.23
ΔD	8	13.38
$\widehat{\delta}$	3	29.84

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Moments

$$E\left[\Delta\omega^D(\theta_1, \theta_3) \middle| \mathcal{Z}^{\Delta D}\right] = 0$$

- Competitive pressure; Differentiation at baseline

Gandhi & Houde, 2019; Gilraine, Petronijevic, & Singleton 2023

$$E\left[\Delta\omega^q(\theta_1, \theta_3) \middle| \mathcal{Z}^{\Delta q}\right] = 0$$

$$E\left[\xi_t(\theta_1) \middle| \mathcal{Z}_t^\xi\right] = 0$$

Moments

$$E \left[\Delta\omega^D(\theta_1, \theta_3) \middle| \mathcal{Z}^{\Delta D} \right] = 0$$

- ▶ Competitive pressure; Differentiation at baseline Gandhi & Houde, 2019; Gilraine, Petronijevic, & Singleton 2023

$$E \left[\Delta\omega^q(\theta_1, \theta_3) \middle| \mathcal{Z}^{\Delta q} \right] = 0$$

- ▶ Equity Plus; Differentiation at baseline RD Carneiro, Koussihouèdé, Lahire, Meghir, & Mommaerts 2020

$$E \left[\xi_t(\theta_1) \middle| \mathcal{Z}_t^\xi \right] = 0$$

Moments

$$E \left[\Delta\omega^D(\theta_1, \theta_3) \middle| \mathcal{Z}^{\Delta D} \right] = 0$$

- ▶ Competitive pressure; Differentiation at baseline Gandhi & Houde, 2019; Gilraine, Petronijevic, & Singleton 2023

$$E \left[\Delta\omega^q(\theta_1, \theta_3) \middle| \mathcal{Z}^{\Delta q} \right] = 0$$

- ▶ Equity Plus; Differentiation at baseline RD Carneiro, Koussihouèdé, Lahire, Meghir, & Mommaerts 2020

$$E \left[\xi_t(\theta_1) \middle| \mathcal{Z}_t^\xi \right] = 0$$

- ▶ Baseline nbhd demographics; Teacher body, lagged Berry et al. 1995; Neilson 2021; Petrie, Ponder, & Seo 2022

Step Two: Estimator

$$\hat{\theta}_{1,3} = \arg \min_{\theta_{1,3}} \left(g_N(\theta_{1,3})' W_N g_N(\theta_{1,3}) \right)$$

where

$$g_N(\theta_{1,3}) = \frac{1}{N} \begin{bmatrix} \mathcal{Z}^{\Delta D} & 0 & 0 \\ 0 & \mathcal{Z}^{\Delta q} & 0 \\ 0 & 0 & \mathcal{Z}^\xi \end{bmatrix} \begin{bmatrix} \Delta \omega^D \\ \Delta \omega^q \\ \xi \end{bmatrix}$$

N : number of moment conditions; W_N : weighting matrix.

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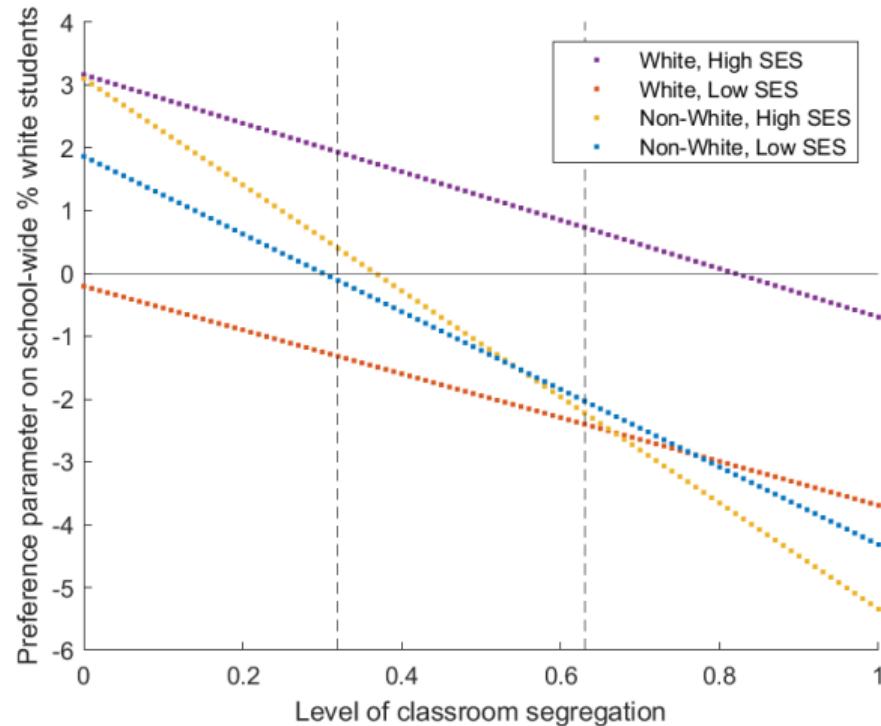
Selected Demand Estimates

	q	D	W	DxW
White High-SES (Linear, Step 1)	5.3989 (0.4518)	3.3940 (0.4437)	3.1848 (0.1724)	-3.3875 (0.2951)
White Low-SES (Interaction, Step 2)	-1.3494 (0.0013)	-0.9833 (0.0058)	-3.3682 (0.0012)	0.3711 (0.0020)
Non-White High-SES (Interaction, Step 2)	-0.6041 (0.0027)	-0.3919 (0.0009)	-0.0643 (0.0044)	-4.5862 (0.0012)
Non-White Low-SES (Interaction, Step 2)	-2.2873 (0.0016)	-1.1513 (0.0022)	-1.3007 (0.0008)	-2.3239 (0.0042)

Back To β_i^q

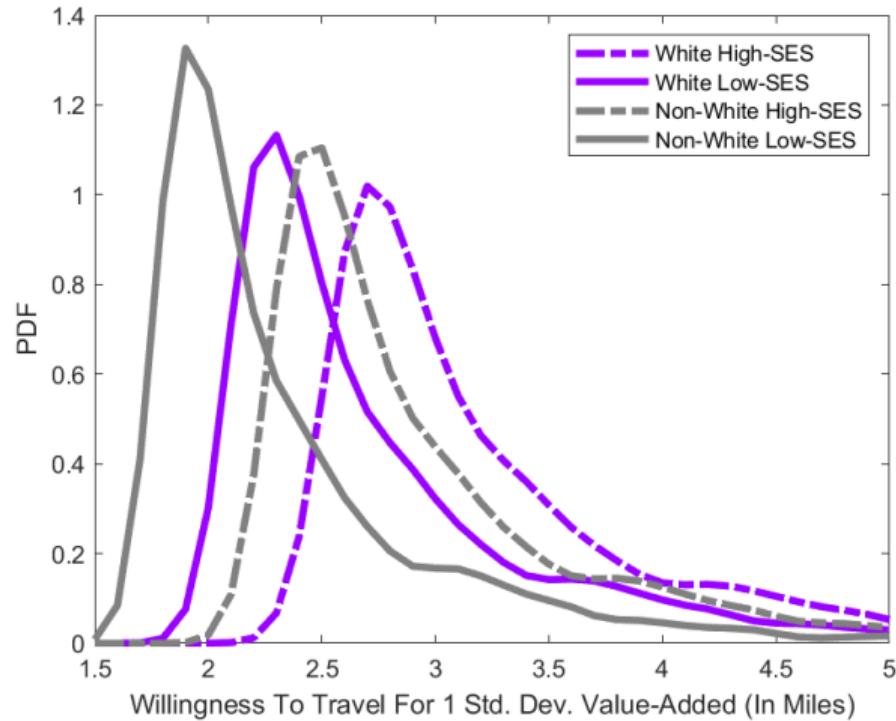
Back To β_i^D

Model Estimates: Preferences For School-Wide White Share



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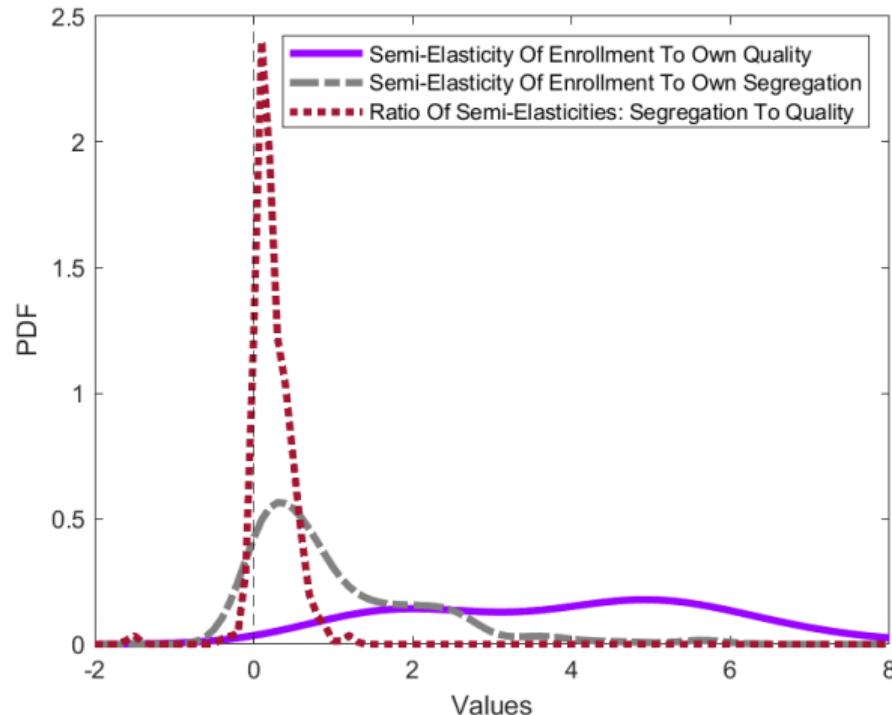
Model Estimates: Preferences For Academic Quality



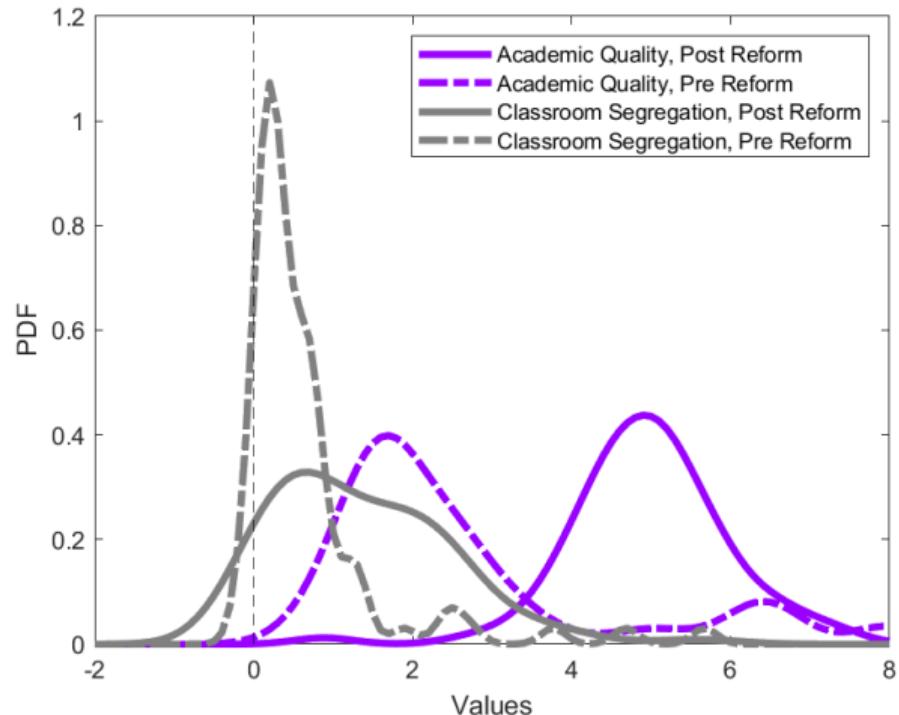
Estimates

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Model Estimates: Semi-Elasticities Of Enrollment



Model Estimates: Semi-Elasticities Of Enrollment Pre v. Post Reform

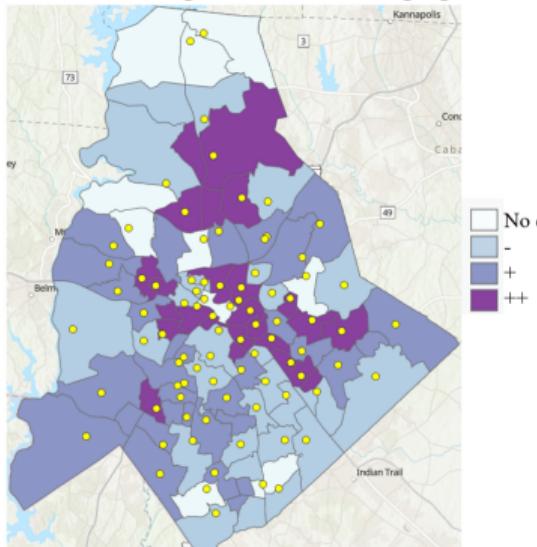


Ratio

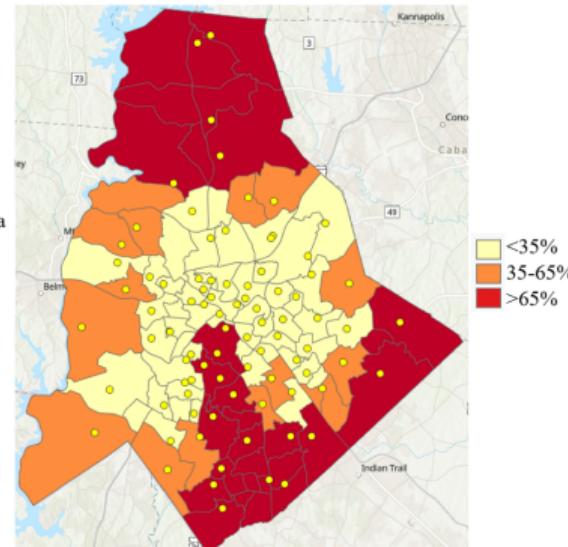
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Simulated Changes In Classroom Segregation Around The Reform

Predicted Change In Classroom Segregation



Share Of White Students Enrolled In 2005

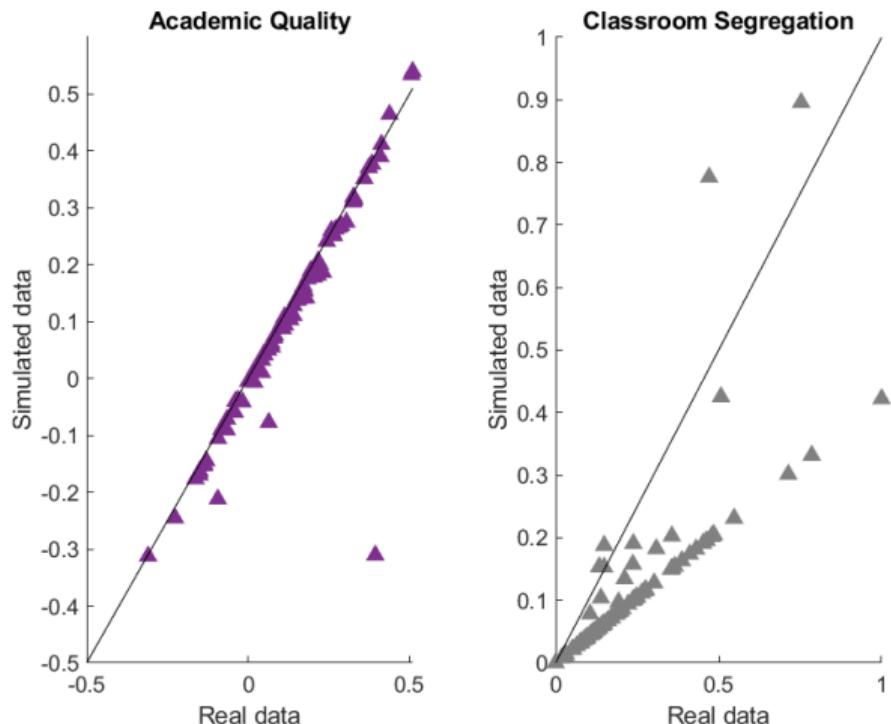


[Model Fit I](#)

[Model Fit II](#)

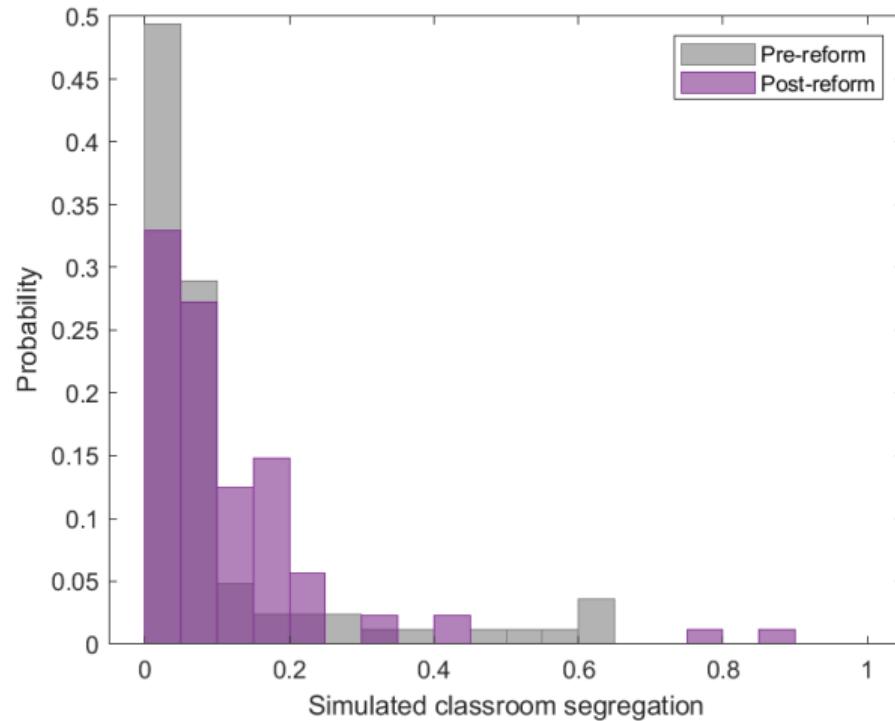
[Back](#)

Model Fit



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Simulated Distribution Of Classroom Segregation



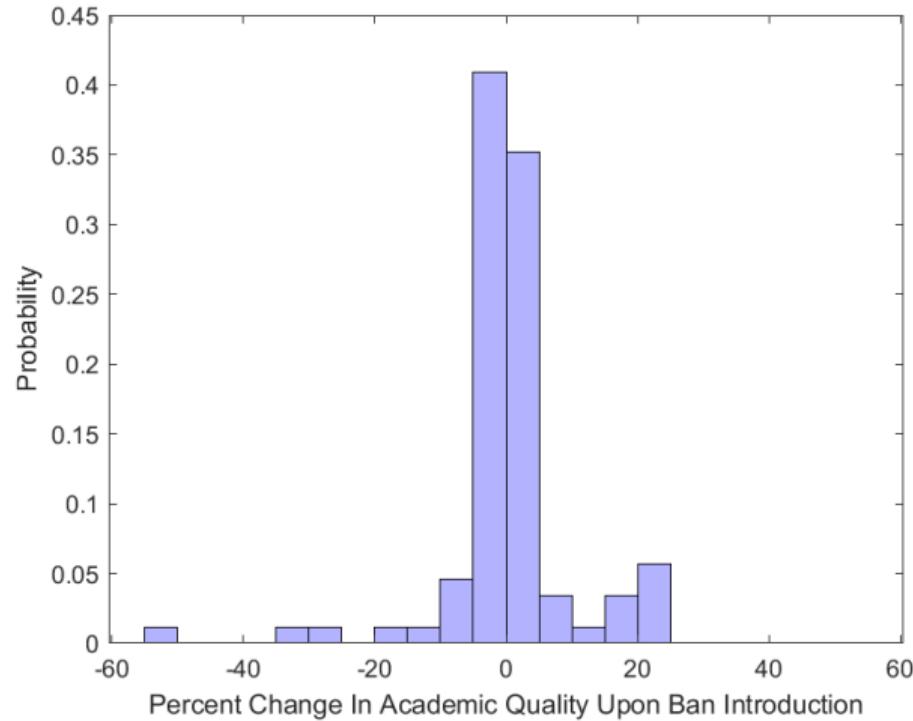
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Decomposition Of Competitive Incentives

Scenario	Parameters	Quality (Average)	Segregation (Average)
Full model	Estimates	0.1043	0.1168
Cost of segregation doubles	$\alpha = \hat{\alpha} \times 2$	0.0449 (-57%)	0.0313 (-73%)
Cost of academic quality homogeneous across students	$\zeta = 0$	0.0274 (-73%)	0.0397 (-66%)

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Counterfactual: Ban On Classroom Segregation



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Mixed Evidence On Productive Returns To Tracking In US Elementary

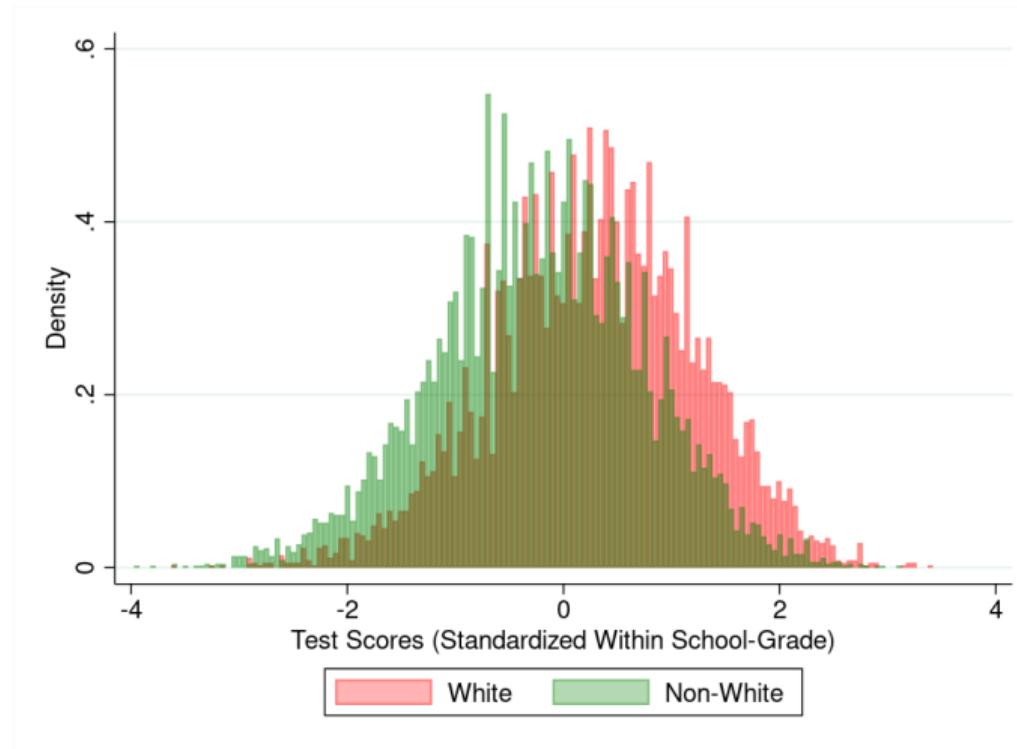
- ▶ No consensus in the literature on whether tracking leads to significant achievement gains (Betts, 2011; Sacerdote, 2011).
- ▶ No or negative effects: Antonovics et al., 2022 (*NBER WP*); Bui, Craig, Imberman, 2014 (*AEJ Policy*)¹
- ▶ Benefits high-achievers only: Card and Giuliano, 2016 (*AER*)²
- ▶ Benefits low-achievers only: Figlio and Page, 2002 (*NBER WP*)³
- ▶ Benefits all students: Collins and Gan, 2013 (*NBER WP*)
- ▶ More nuanced: Burke and Sass, 2013 (*JOLE*)
 - ▶ Low- and high-ability students better off with middle-ability, who gain from high-ability.
Largest effect for low-ability. [Back](#)

¹G&T.

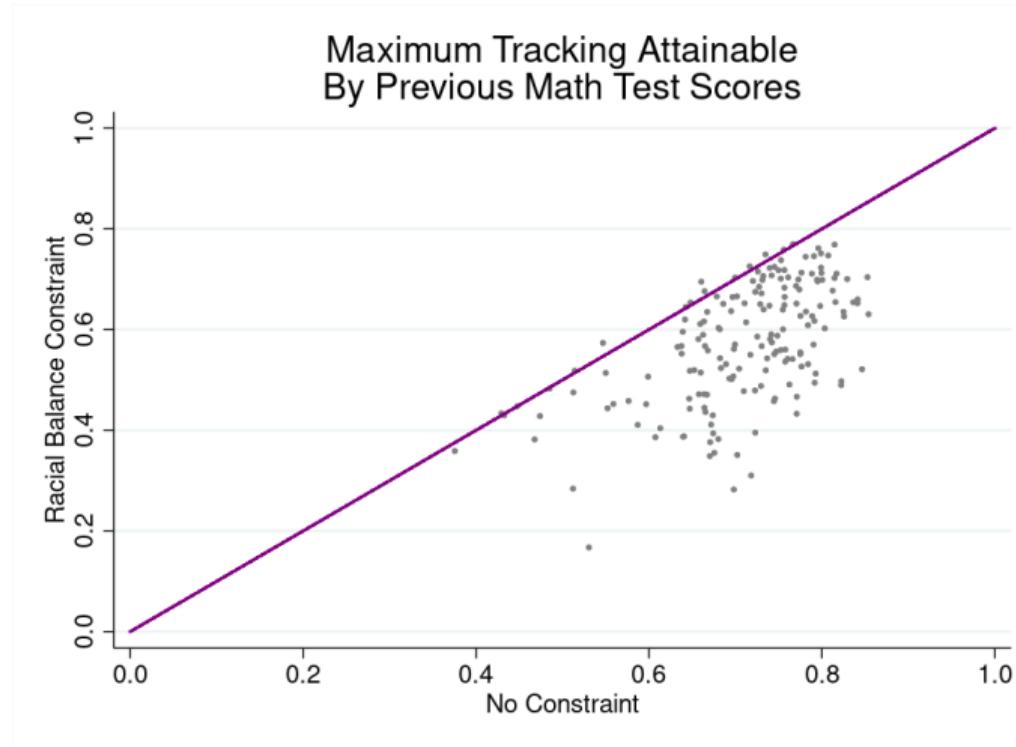
²G&T. Limited to minorities. Effect **not** mediated by teacher quality or peer composition channels.

³Includes compositional effect of tracking.

Correlation Between Race and Achievement (I)



Correlation Between Race and Achievement (II)



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Policies Across The Nation

The New York Times Dec. 8, 2021

De Blasio to Phase Out N.Y.C. Gifted and Talented Program

The mayor unveiled a plan to replace the highly selective program, which has become a **glaring symbol of segregation** in New York City public schools, for incoming students. It will be up to his successor to implement it.

AP

Nov. 10, 2021

Schools debate: Gifted and talented, or racist and elitist?

(...) would be among the most significant developments yet in a push that extends from Boston to Seattle and that has stoked passions and pain over **race**, inequality and access to a decent education.

Forbes

Dec. 6, 2021

Gifted Education Is Under Attack

(...) the education chair of the NAACP's Seattle chapter thundered, "We want the [gifted] program just abolished. Period. [It] is fundamentally flawed, and it's **inherently racist**."

THE HECHINGER REPORT

Oct. 17, 2020

Is it time to stop segregating kids by ability in middle school math?

A New York school district limits tracking amid concerns that **students of color are overrepresented in lower-level math** and that kids in higher-level math aren't benefiting. Parents are pushing back.



GBH

Oct. 8, 2021

Boston Public Schools Suspends Test For Advanced Learning Classes; Concerns About Program's Racial Inequities Linger

E

Education Next

Mar. 29, 2022

San Francisco's Detracking Experiment

Course enrollments are a means to an end—student learning—not an end unto themselves.

(...) **Black-White and Hispanic-White achievement gaps** have widened, not narrowed, the exact opposite of the district's intention and of the story the district was selling to the public. (...)

The New York Times Nov. 10, 2021

Should California De-Track Math?

The most populous state is considering big changes to math instruction.

But proponents of changes point to a **persistent racial gap** in both math achievement and access to calculus, which has long been an informal gatekeeper for acceptance to selective colleges.

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