Family Preferences and Horizontal Differentiation in Urban School Choice Markets

Shwetha Raghuraman

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Background and Motivation

- Urban school districts in the United States allow a high degree of school choice
  - Choice among schools of varying quality
- But schools may also differ along horizontal dimensions, such as curricular theme
- New York City high school program themes ▸ More details
  - Arts and Design; Business, Hospitality, and Services; Computing and Engineering; Media; Military and Law Enforcement; Multicultural; Public Service, Law, and Social Justice; and Science
  - Humanities and Interdisciplinary
- Do families care about these themes when choosing high school programs? Do we see sorting across themes along demographic lines?

Research Questions and Empirical Approach

1. How much weight do families place on curricular theme versus other characteristics when choosing schools, and how does this differ by race, income, and baseline achievement?

    - Data: Rank-ordered applications to centralized assignment system for NYC high schools
    - Present descriptive evidence on application and enrollment behavior with respect to theme
    - Estimate a structural model of high school program application choice, allowing me to identify theme preference

Research Questions and Empirical Approach

1. How much weight do families place on curricular theme versus other characteristics when choosing schools, and how does this differ by race, income, and baseline achievement?

2. Does curricular differentiation increase or decrease segregation and student welfare?

    - Measure contribution of theme preference to segregation and applicant utility by using model to simulate counterfactual high school enrollments if all programs are general (i.e. not differentiated by theme)

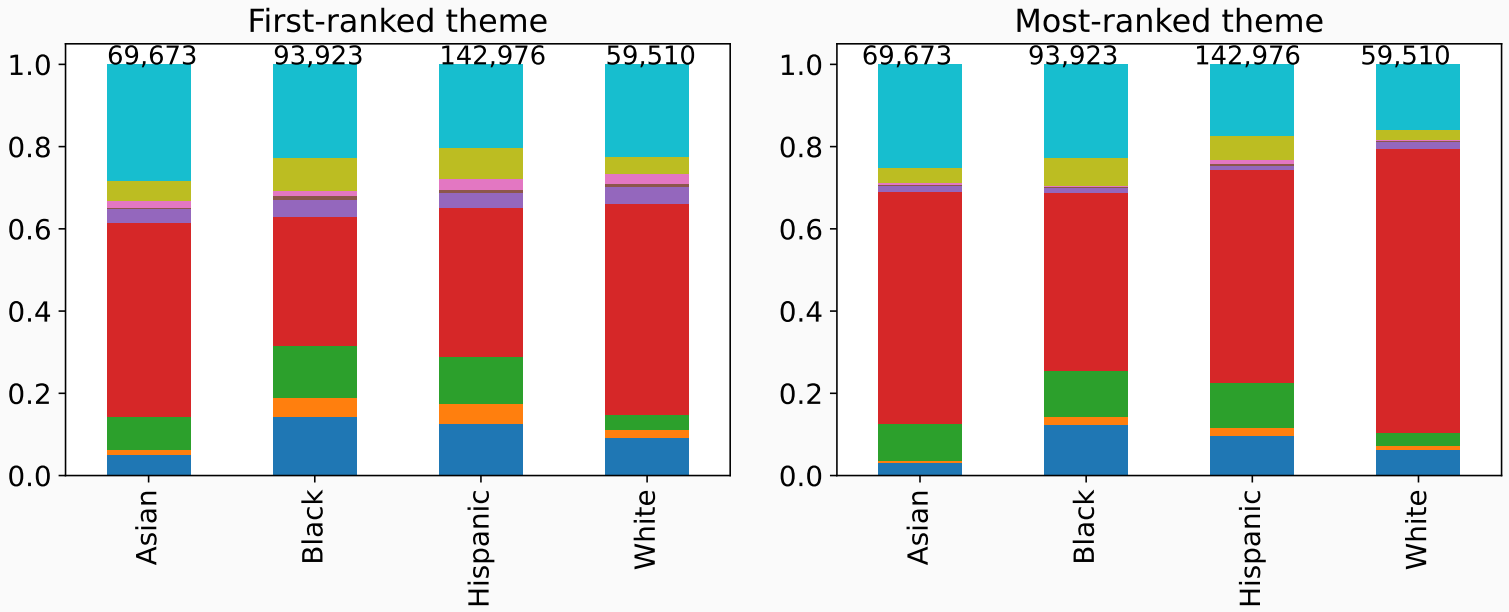
Setting: Centralized NYC High School Match

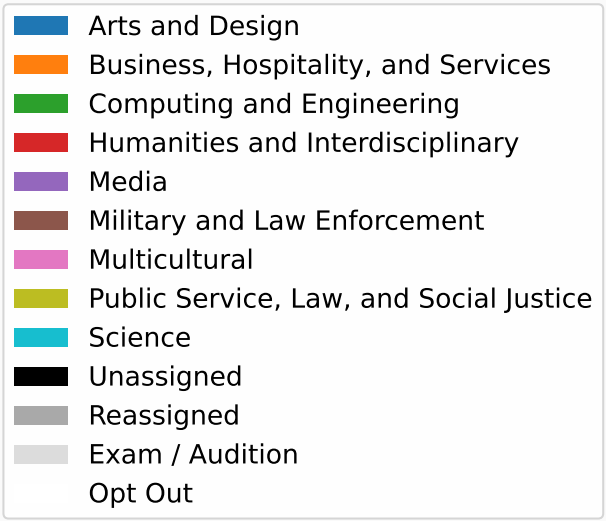
- Students receive high school program directory
- Applicants rank up to 12 high school programs in order of preference
- Schools have criteria for ranking students by priority levels (ties broken by score or lottery)
- Students receive a single offer from a Deferred Acceptance algorithm ▸ Description of algorithm
- This application system serves schools enrolling 70% of high schoolers in NYC

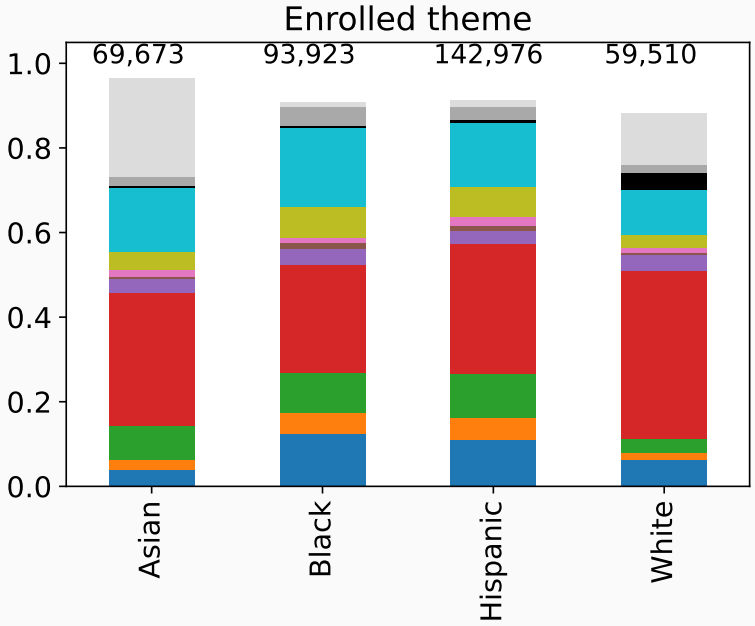
Administrative Data From NYC Department of Education

- Data on high school match and student demographics
  - High school applications of NYC public school 8th grade cohorts from 2011-12 to 2017-18 (N = 366,082)
  - Applicant's rank-ordered list of programs, priority / rank at each program applied, offer
  - Applicant high school enrollment, demographic characteristics, baseline test scores, residential census tract
- Programs: public program directory including program characteristics, including theme and admit method
- Public transit travel times

Application and Enrollment Behavior by Race







▸ Application summary statistics

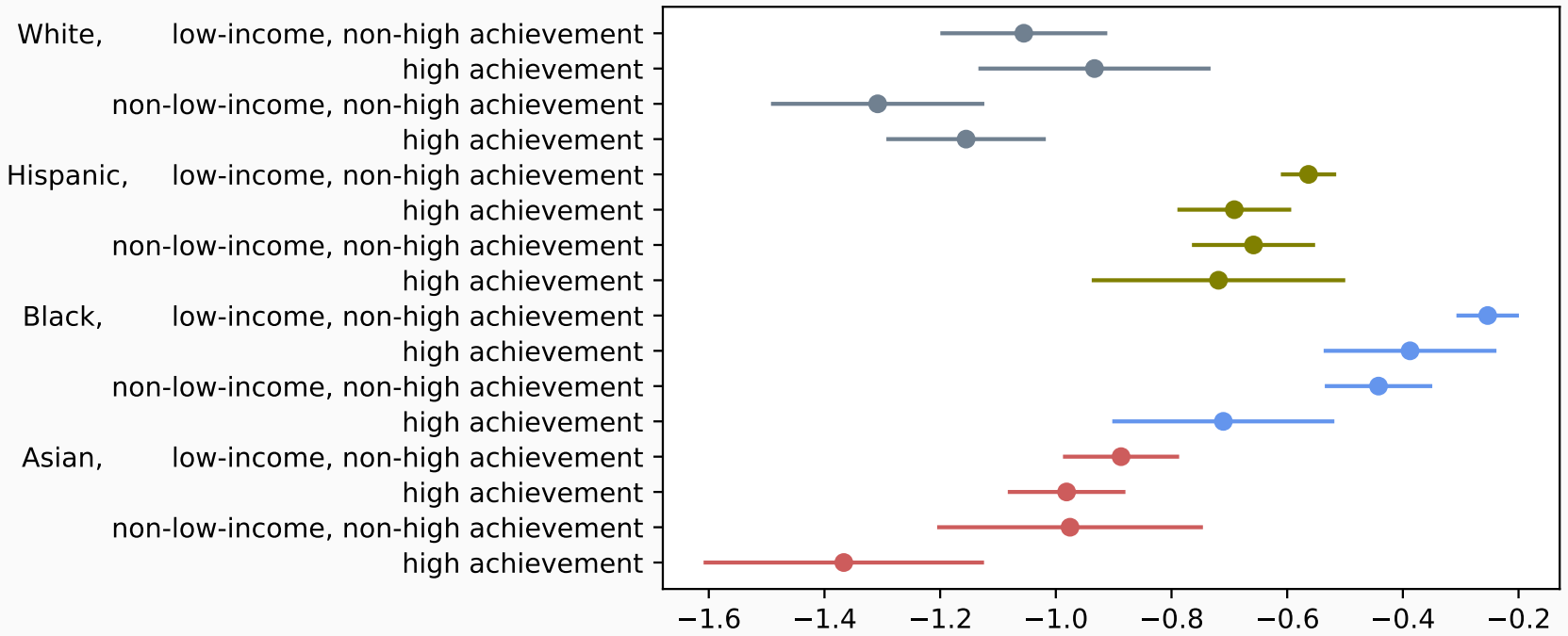
Estimating Theme Preference Using Structural Model

1. Model: applicants form lists sequentially, ranking their preferred program among those worth ranking
2. Identify applicant preferences over programs (program utilities) from observed choice of rank-ordered list
3. Identify contribution of each program characteristic to utility from estimated utilities and applicant and program characteristics
   - Theme preference coefficients = mean unexplained utility for programs in each theme
     - Controls include: public transit travel time, lagged student characteristics (proportion high achieving, proportion same-race), school size, school 4-year graduation rate, school effective leadership rating, ...
     - Estimate theme preference coefficient, relative to Humanities and Interdisciplinary, for each race x income x baseline achievement subgroup

▸ Model of application choice ▸ Parametrization of indirect utility ▸ Identifying theme preference

Preference for Themed Programs, Relative to Humanities and Interdisciplinary Programs ϕ_{cell}

All applicant groups prefer Humanities and Interdisciplinary relative to themed programs, White and Asian applicants especially so.

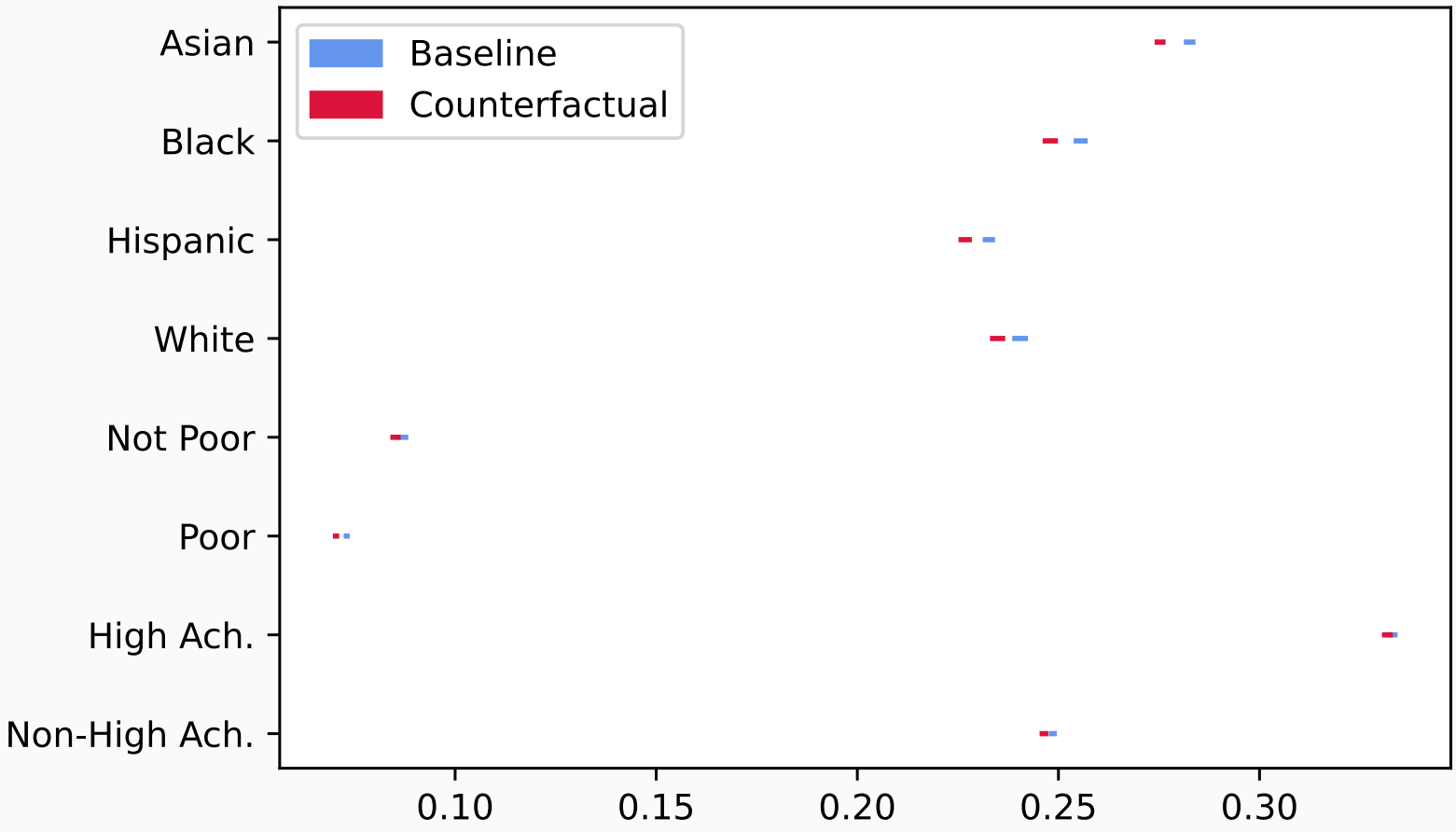


▸ Full set of theme coefficient estimates ▸ Other parameter estimates ▸ Favorite themes

Simulate Counterfactual Assignment in Which Programs Are Not Differentiated by Theme

- Recompute program utilities, removing the estimated theme preference, relative to Humanities and Interdisciplinary, component
- Simulate application, assignment, and enrollment
- Measure segregation and enrolled program utility in the counterfactual assignment and enrollments versus the baseline
    - Comparisons tell us the contribution of curricular differentiation to segregation; whether students prefer curricular differentiation

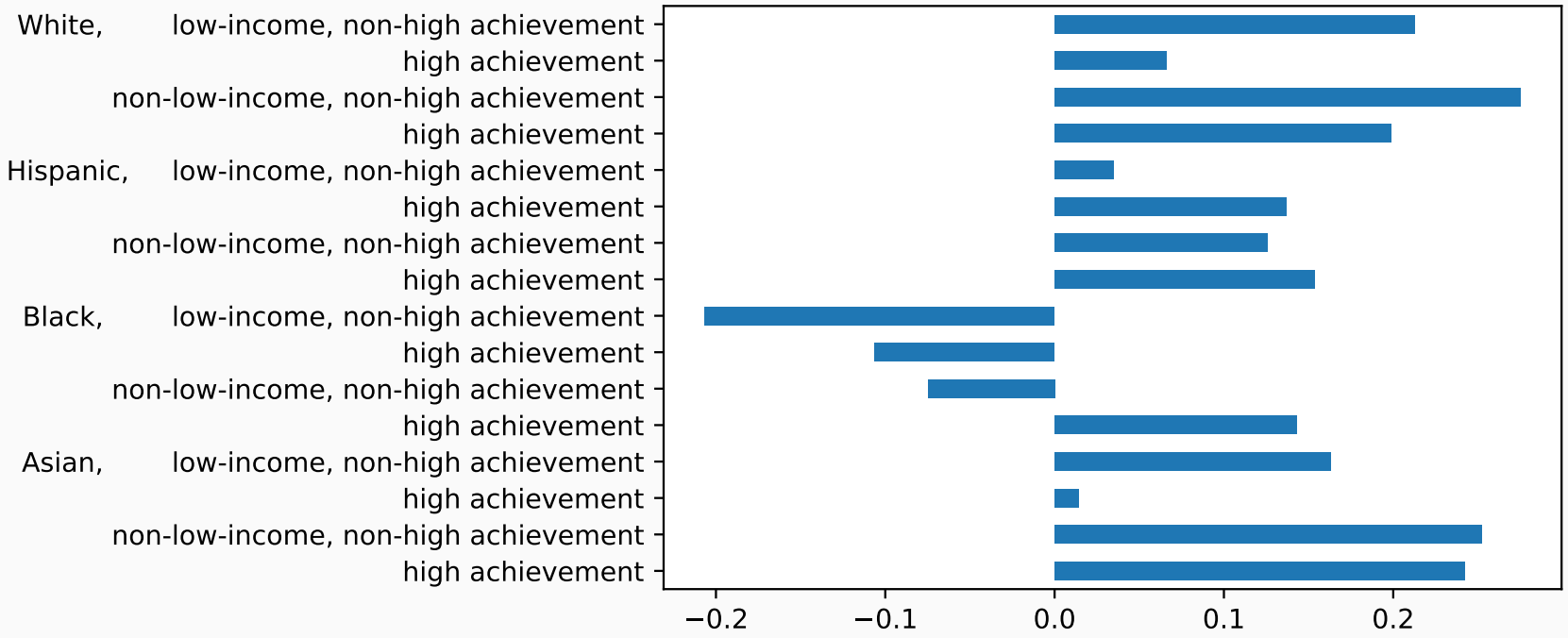
Counterfactual Results: Curricular Differentiation Slightly Increases Racial Segregation.



▸ Segregation measure

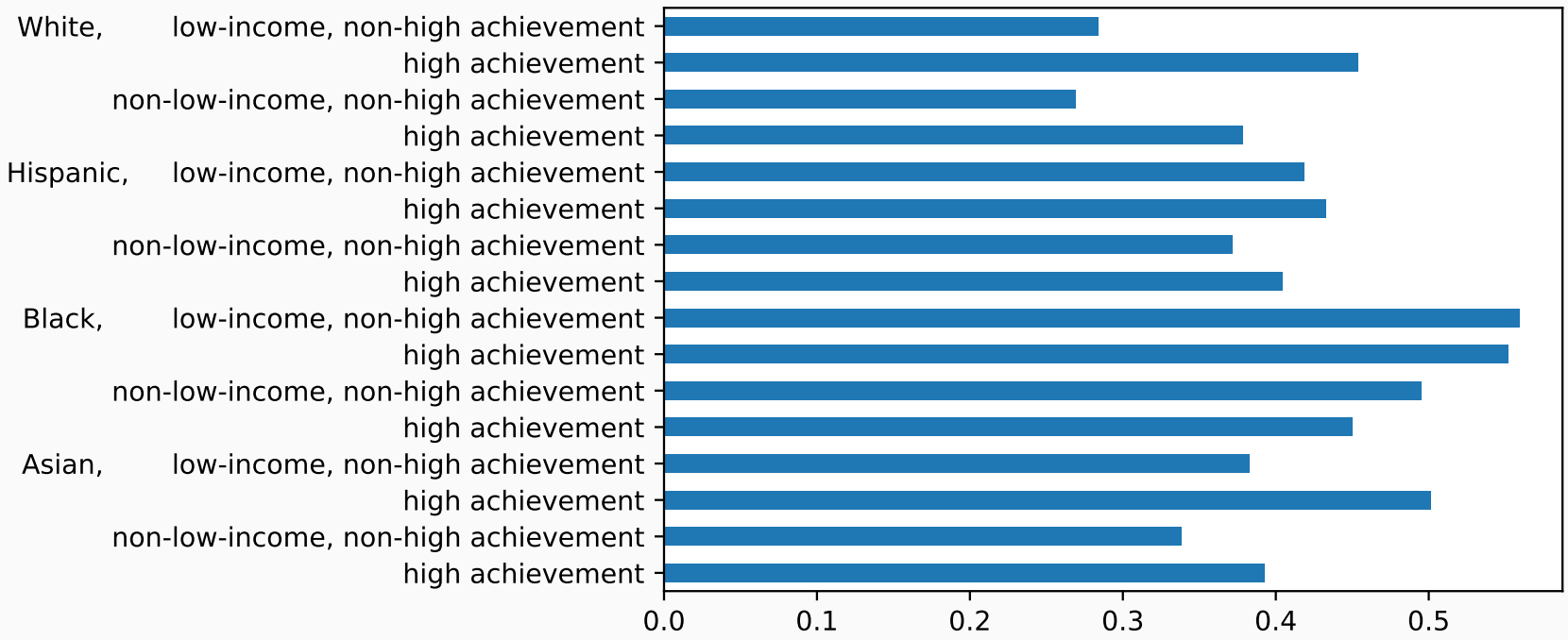
Counterfactual Results: Mean Change in Assigned Program Utility from Removing Curricular Differentiation

White, non-low income, high baseline achievement students are better off by 4.6 minutes of public transit travel time. Black, low income, non-high baseline achievement students are worse off by 3.4 minutes of public transit travel time.



Counterfactual Results: Proportion of Applicants Worse Off Without Curricular Differentiation

About half of all Black applicants prefer their status quo assignment to the counterfactual. Even in other groups that prefer the counterfactual enrollment on average, a substantial minority prefer the status quo with themes.



Conclusion and Policy Implications

- Applicants care about theme, but curricular differentiation does not substantially contribute to segregation
- Applicants on average may prefer general programs, but substantial minority of students worse off without specialized programs
    - NYC: $\uparrow$ Humanities and Interdisciplinary capacity while retaining specialized theme program capacity
- Findings on theme preferences + ongoing work on theme enrollment effects on outcomes provide important evidence on trade-offs involved in offering curricular differentiation

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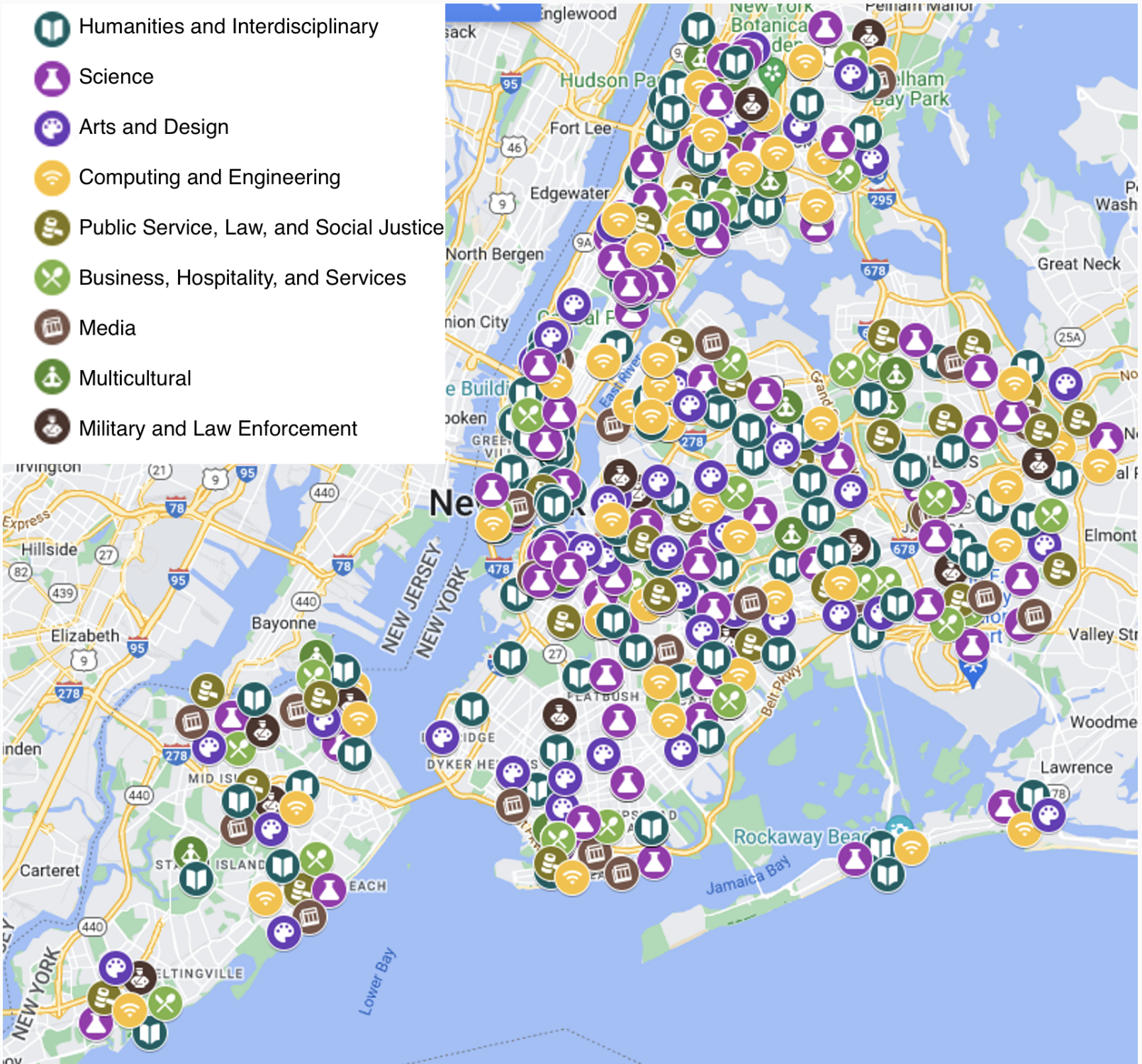
Appendix

NYC High School Program Themes

Theme	N
Arts and Design	168
Business, Hospitality, and Services	65
Computing and Engineering	129
Humanities and Interdisciplinary	251
Media	40
Military and Law Enforcement	15
Multicultural	33
Public Service, Law, and Social Justice	74
Science	160
All	935

Back


Humanities and Interdisciplinary
Science
Arts and Design
Computing and Engineering
Public Service, Law, and Social Justice
Business, Hospitality, and Services
Media
Multicultural
Military and Law Enforcement
Englewood
Hudson Pa
Fort Lee
Edgewater
North Bergen
Great Neck
Irvington
Hillside
Elizabeth
Bayonne
NEW JERSEY
NEW YORK
Carteret
Lower Bay
Jamaica Bay
Rockaway Beach
Lawrence
Valley Str
Woodme
Elmont
Belt Pkwy
FLATBUSH
DYKER HE

Deferred Acceptance Algorithm

Until every student is assigned, or has exhausted their ranked list:

- Each student proposes to their best choice. School assigns all of their seats in priority order. Ties are broken by lottery number or score. Students are rejected if there are no seats left.

- The previous step is repeated, with rejected students now proposing to their next best school (students assigned in the last round propose to the same school).

Unassigned students participate in a supplementary round, and remaining students are manually placed. Back

NYC HS Application Summary Stats

- Median list length: 7
- Median theme concentration: .5
- Median distinct themes: 3
- 83% rank fewer than 12 programs
- 92% receive an assignment in the main round
- 46% are assigned their first choice in the main round
- 80% ultimately enroll in their main round offer
- Most programs are filled to capacity and are observed rejecting people

Back

Segregation Index (Massey and Denton 1988)

Same-group exposure $SGE_{i,unit}$: proportion in same race, income, or achievement group as applicant i in their *unit*. Then, the cross-program segregation index is:

$$SI = \frac{1}{N} \sum_{i}^{N} \frac{SGE_{i,program} - SGE_{i,city}}{1 - SGE_{i,city}}$$

▸ Back to counterfactual cross-program segregation

Model of Applicant Behavior: Limited Rationality (Idoux 2021)

- Checking optimality of chosen list under full rationality is intractable
- Assume applicants choose a program for each rank sequentially, among programs worth ranking ($v_{ij} \times p_{ijk} \geq c_i$)
- Applicants myopic, don't consider how choice for one list slot affects consideration sets for list slots further down
- Mirrors DOE's instructions to choose programs in order of preference, but include a mix of high-demand, middle-demand, and low-demand programs
- Implies a set of bounds on indirect utilities and application costs

Back

Parametrization of Indirect Utility

$$v_{ij} := \delta_{cell(i),j} + \theta_{boro(i),boro(j)} + \mathbf{X_{ij,t(i)-1}}\beta_{\mathbf{cell(i)}} - d_{ij} + \gamma_{cell(i),ms(i),t(i),theme(j)} + \epsilon_{ij}$$

- $cell(i)$: the race x income x achievement demographic cell of student i
- $\delta_{cell(i)j}$: demographic cell x program FE
- $\theta_{boro(i),boro(j)}$: residential borough x program borough FE
- $\mathbf{X_{ij,t(i)-1}}$: lagged time-varying program characteristics
  - prop. high baseline achievement peers, prop. same-race peers
- d_{ij} : public transit travel time from i's census tract to program j
- $\gamma_{\mathbf{cell(i),ms(i),t(i)}} \sim MultivariateNormal(\mathbf{0}, \mathbf{\Sigma_\gamma})$: cell x middle school cohort-level unobserved theme preference
- $\epsilon_{ij} \sim N(0, \sigma_\epsilon)$: i.i.d. error term

Normalize outside option $v_{i0} = 0$, coefficient on distance $= -1$ Back

Learning About Theme Preference From Program Preference

- Estimate cell x program FE $\delta_{cell,j}$
- Decompose into component explained by program observables $\mathbf{X_j}$ (school size, 4-year grad rate, effective leadership rating, program prop. low-income), and theme component
- Theme preference coefficients $\alpha_{cell,theme}$

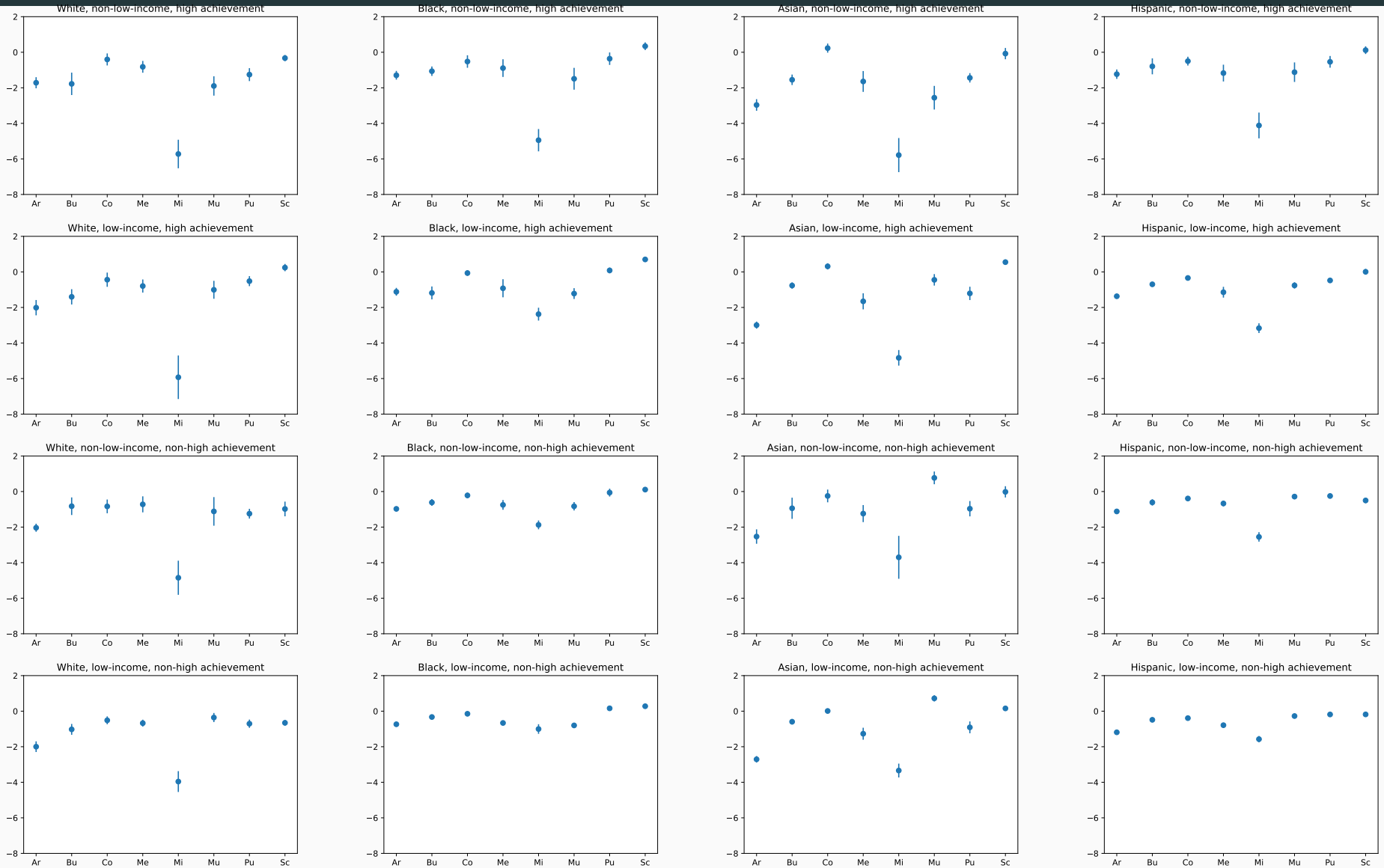
$$\delta_{cell,j} = \alpha_{cell,theme(j)} + \boldsymbol{\eta}\mathbf{X_j} + \rho_{cell} + \upsilon_{cell,j}$$

- Coefficient for any theme, relative to humanities and interdisciplinary ϕ_{cell}

$$\delta_{cell,j} = \phi_{cell}[theme(j) \neq Hum.] + \boldsymbol{\eta}\mathbf{X_j} + \rho_{cell} + \xi_{cell,j}$$

▸ Back

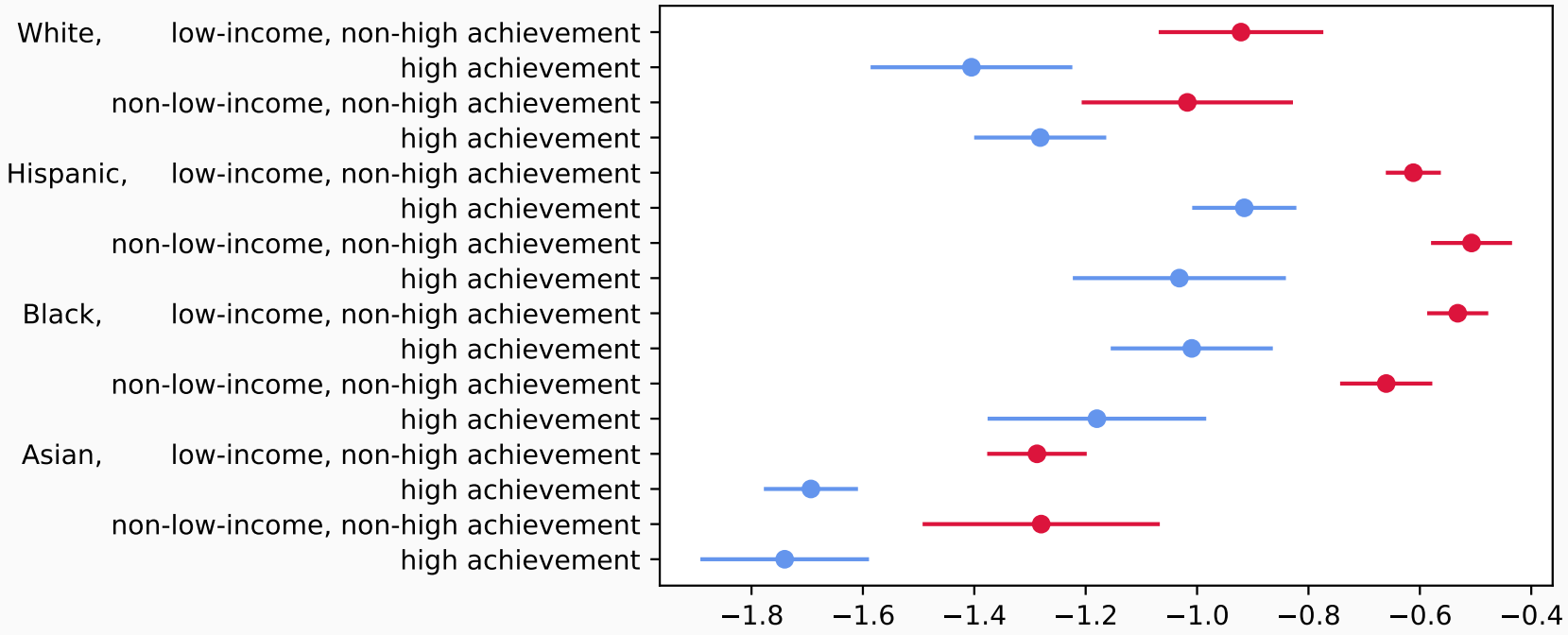
Theme Coefficient Estimates $\alpha_{cell,theme}$



Notes: From left to right, the plotted themes are Arts and Design; Business, Hospitality, and Services; Computing and Engineering; Media; Military and Law Enforcement; Multicultural; Public Service, Law, and Social Justice; and Science. Estimates relative to Humanities and Interdisciplinary.

▸ Back

Preference for Other Themed Programs, Relative to Humanities and Interdisciplinary and Science Programs ϕ_{cell}



▸ Back to estimates

Results: Top Three Themes

Cell	1st favorite theme	2nd favorite theme	3rd favorite theme
Asian, non-low-income, high achievement	Computing and Engineering	Humanities and Interdisciplinary	Science
Asian, non-low-income, non-high achievement	Multicultural	Humanities and Interdisciplinary	Science
Asian, low-income, high achievement	Science	Computing and Engineering	Humanities and Interdisciplinary
Asian, low-income, non-high achievement	Multicultural	Science	Computing and Engineering
Black, non-low-income, high achievement	Science	Humanities and Interdisciplinary	Public Service, Law, and Social Justice
Black, non-low-income, non-high achievement	Science	Humanities and Interdisciplinary	Public Service, Law, and Social Justice
Black, low-income, high achievement	Science	Public Service, Law, and Social Justice	Humanities and Interdisciplinary
Black, low-income, non-high achievement	Science	Public Service, Law, and Social Justice	Humanities and Interdisciplinary
Hispanic, non-low-income, high achievement	Science	Humanities and Interdisciplinary	Computing and Engineering
Hispanic, non-low-income, non-high achievement	Humanities and Interdisciplinary	Public Service, Law, and Social Justice	Multicultural
Hispanic, low-income, high achievement	Science	Humanities and Interdisciplinary	Computing and Engineering
Hispanic, low-income, non-high achievement	Humanities and Interdisciplinary	Science	Public Service, Law, and Social Justice
White, non-low-income, high achievement	Humanities and Interdisciplinary	Science	Computing and Engineering
White, non-low-income, non-high achievement	Humanities and Interdisciplinary	Media	Business, Hospitality, and Services
White, low-income, high achievement	Science	Humanities and Interdisciplinary	Computing and Engineering
White, low-income, non-high achievement	Humanities and Interdisciplinary	Multicultural	Computing and Engineering

▸ Back

Other Parameter Estimates

- Substantial unobserved preference heterogeneity: estimate taste shock variance $\sigma_\epsilon = 7.4$
- Marginal cost mean $c = 0.009$, marginal cost variance $\sigma_c = 0.00004$
- Unobserved preference for Military and Law Enforcement or Multicultural theme positively correlated within cell x middle school cohort, negatively correlated with unobserved preference for other themes

▸ Cell x middle school cohort unobserved theme preference covariance Σ_γ estimates

- Peer preferences vary by demographic group

▸ Peer preference coefficient β estimates

▸ Back

Scalar Parameter Estimates

Taste shock variance σ_ϵ	**Marginal cost mean c**	**Marginal cost variance σ_ζ**
7.329041	0.008879	0.000043
(0.016837)	(0.000018)	(0.000000)

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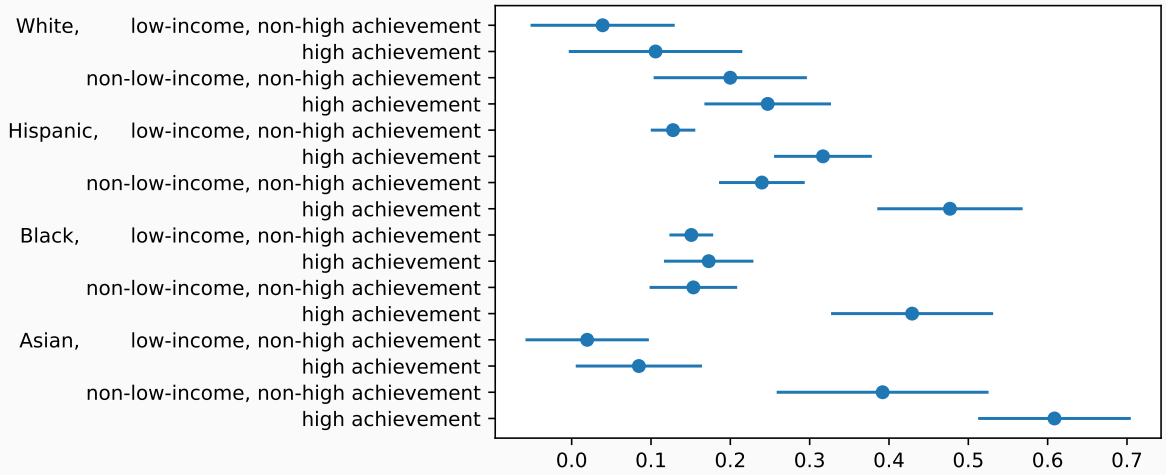
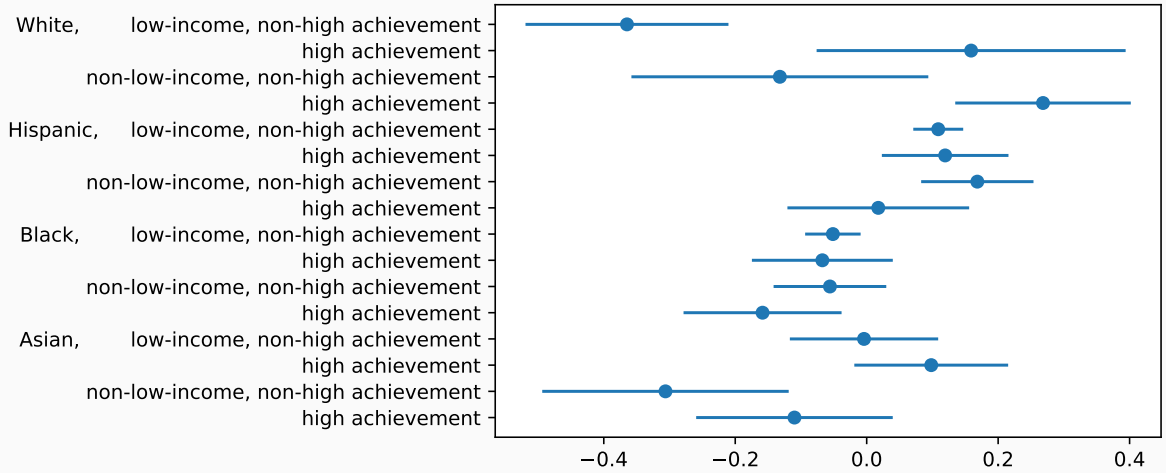
Results: Peer Preference Coefficients

$\beta_{\text{cell,prop. high-achieving peers assigned program } j \text{ in year } t-1}$



$\beta_{\text{cell,prop. same-race peers assigned program } j \text{ in year } t-1}$



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Middle School Cohort Unobserved Theme Preference Covariance Matrix Σ_γ

	Arts and Design	Business, Hospitality, and Services	Computing and Engineering	Humanities and Interdisciplinary	Media	Military and Law Enforcement	Multi-cultural	Public Service, Law, and Social Justice	Science
Arts and Design	2.34	0.25	0.24	0.63	0.39	-3.61	-0.47	0.01	0.33
	(0.05)	(0.03)	(0.03)	(0.03)	(0.02)	(0.15)	(0.04)	(0.03)	(0.03)
Business, Hospitality, and Services	0.25	0.71	0.32	0.50	0.11	-2.55	0.02	0.29	0.40
	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)	(0.10)	(0.02)	(0.01)	(0.02)
Computing and Engineering	0.24	0.32	1.15	0.53	0.18	-3.05	-0.27	0.34	0.65
	(0.03)	(0.02)	(0.03)	(0.02)	(0.02)	(0.10)	(0.02)	(0.01)	(0.02)
Humanities and Interdisciplinary	0.63	0.50	0.53	1.33	0.14	-4.21	-0.01	0.25	0.96
	(0.03)	(0.02)	(0.02)	(0.03)	(0.02)	(0.12)	(0.03)	(0.02)	(0.02)
Media	0.39	0.11	0.18	0.14	0.55	-1.47	-0.07	0.10	0.09
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.09)	(0.02)	(0.01)	(0.02)
Military and Law Enforcement	-3.61	-2.55	-3.05	-4.21	-1.47	20.05	-0.24	-1.64	-3.71
	(0.15)	(0.10)	(0.10)	(0.12)	(0.09)	(0.64)	(0.10)	(0.08)	(0.10)
Multicultural	-0.47	0.02	-0.27	-0.01	-0.07	-0.24	1.28	-0.17	-0.08
	(0.04)	(0.02)	(0.02)	(0.03)	(0.02)	(0.10)	(0.04)	(0.02)	(0.02)
Public Service, Law, and Social Justice	0.01	0.29	0.34	0.25	0.10	-1.64	-0.17	0.53	0.34
	(0.03)	(0.01)	(0.01)	(0.02)	(0.01)	(0.08)	(0.02)	(0.01)	(0.01)
Science	0.33	0.40	0.65	0.96	0.09	-3.71	-0.08	0.34	1.12
	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)	(0.10)	(0.02)	(0.01)	(0.02)

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