ICFES Referrals

10-minute internal presentation for data analysis

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Selection into the experiment

○ Better students self select

	Admin Data	Sample	p
Reading score	62.651	65.183	0.000
Math score	63.973	67.477	0.000
GPA	3.958	4.012	0.000
Low-SES	0.343	0.410	0.000
Med-SES	0.505	0.499	0.763
High-SES	0.153	0.091	0.000
Observations	4,417	734	5,151

Selection into the experiment

- Better students self select
- Low and High SES self select

	Admin Data	**Sample**	**p**
Reading score	62.651	65.183	0.000
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Balance between treatments

○ Successful randomization

|	**Baseline**	**Bonus**	**p**
Reading score	64.712	65.693	0.134
Math score	67.366	67.597	0.780
GPA	4.003	4.021	0.445
# connections	173.40	176.88	0.574
Tie strength	3.939	3.719	0.443
Low-SES	0.419	0.401	0.615
Med-SES	0.492	0.506	0.714
High-SES	0.089	0.094	0.824
Observations	382	352	734

Network size and tie strength by semester

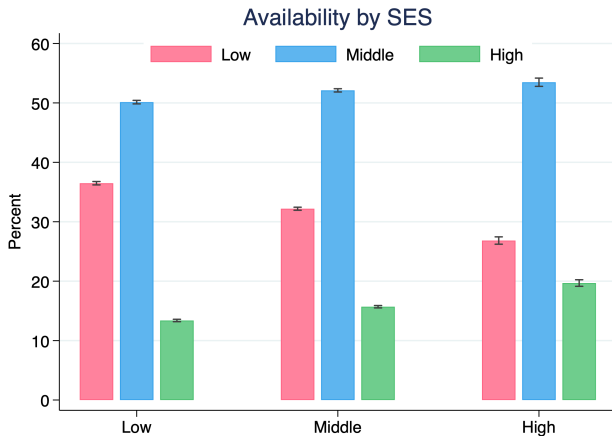○ Classes together increases over time
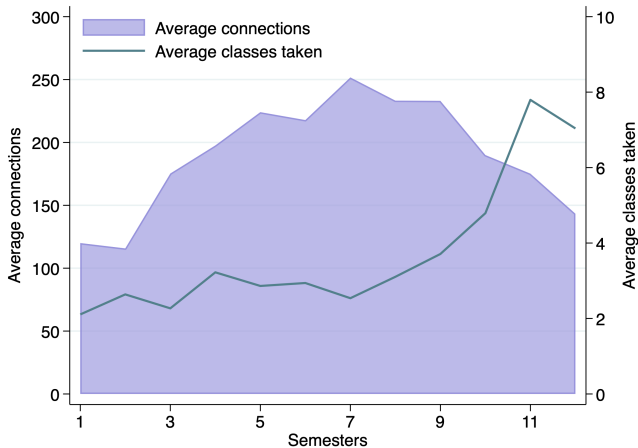
Network size and tie strength by semester

- Classes together increases over time

- Connections peak around 7 semesters and decline as students graduate
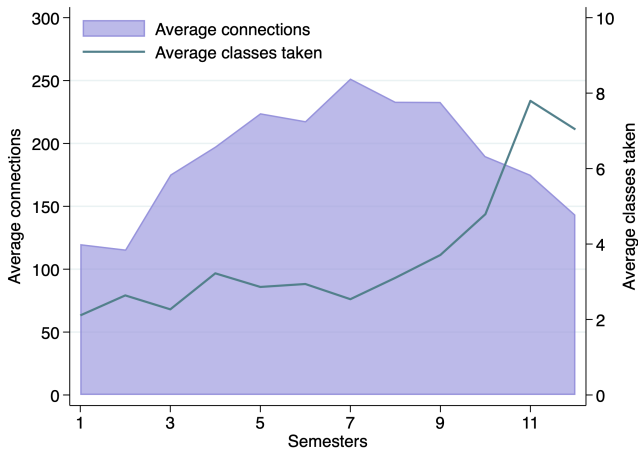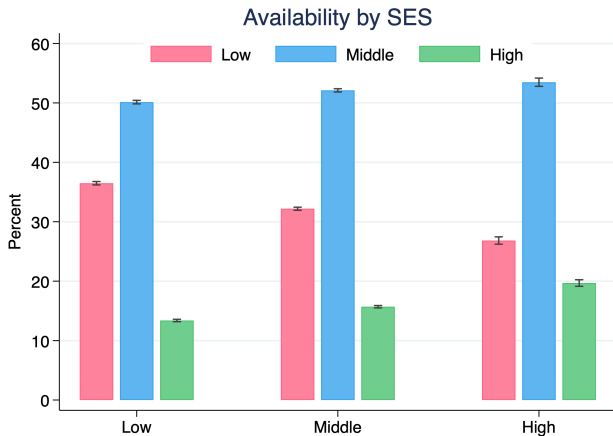
Referrer network composition by SES

○ Monotonic increase in availability across SES

Availability by SES

Referrer network composition by SES

- Monotonic increase in availability across SES
- All differences are statistically significant ($p < 0.001$)

Availability by SES

Referrer network performance by SES

- Subject specific network-level standardization

Network Performance by SES

Referrer network performance by SES
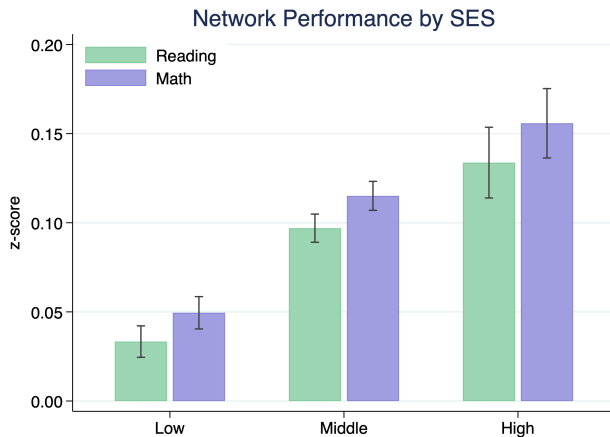
- Subject specific network-level standardization
- Performance increases with SES across math and reading

Network Performance by SES
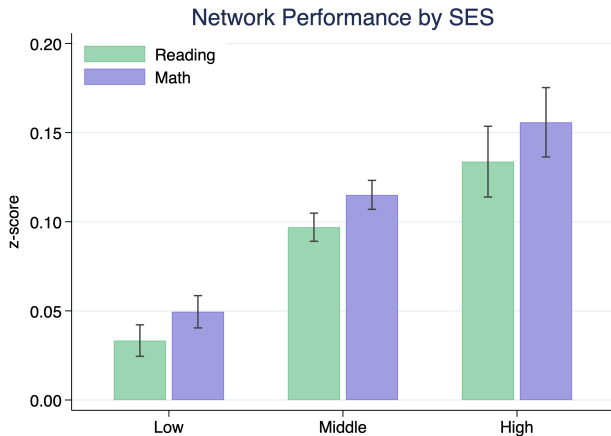
Referrer network performance by SES

- Subject specific network-level standardization
- Performance increases with SES across math and reading
- All differences are statistically significant ($p < 0.005$)
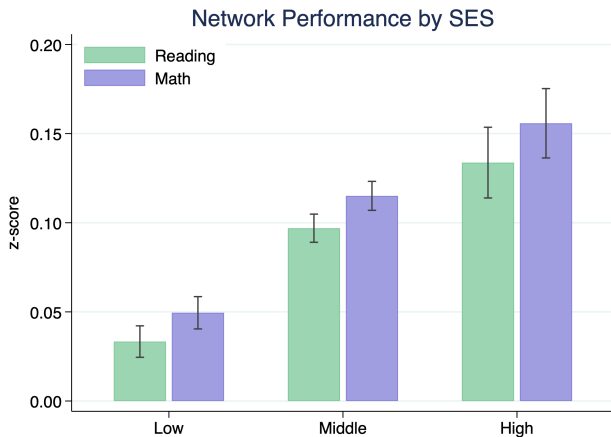
Network Performance by SES

Referrals for Reading

◦ Referrals have higher reading
  scores and much higher tie
  strength on aggregate (all
  $p < 0.001$)
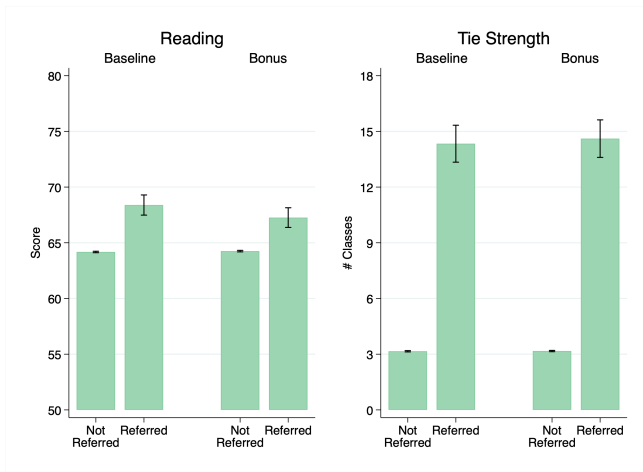
Referrals for Reading

- Referrals have higher reading scores and much higher tie strength on aggregate (all $p < 0.001$)

- No treatment effect on reading score or on on tie strength (all $p > 0.08$)
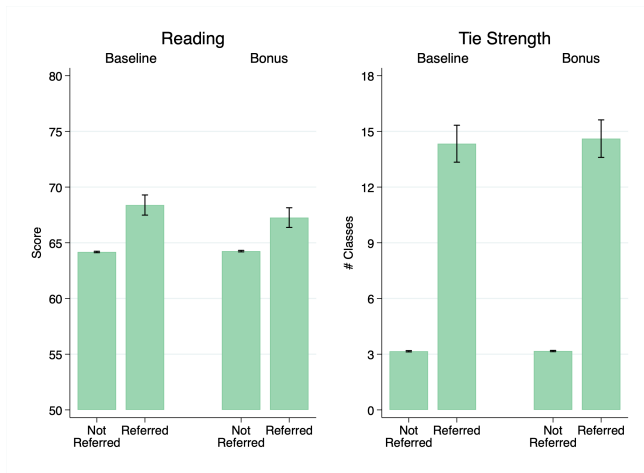
Referrals for Math

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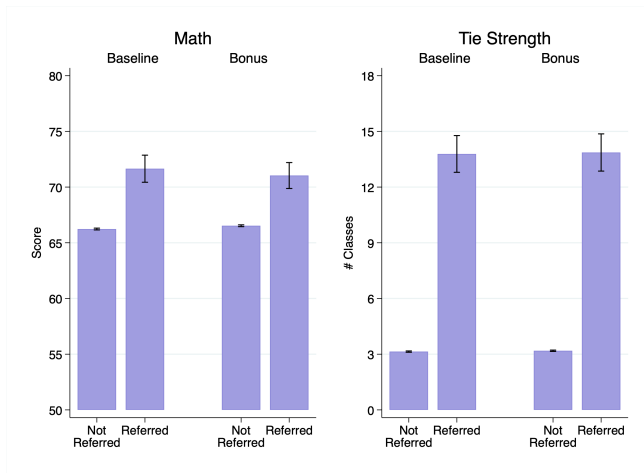
Referrals for Math

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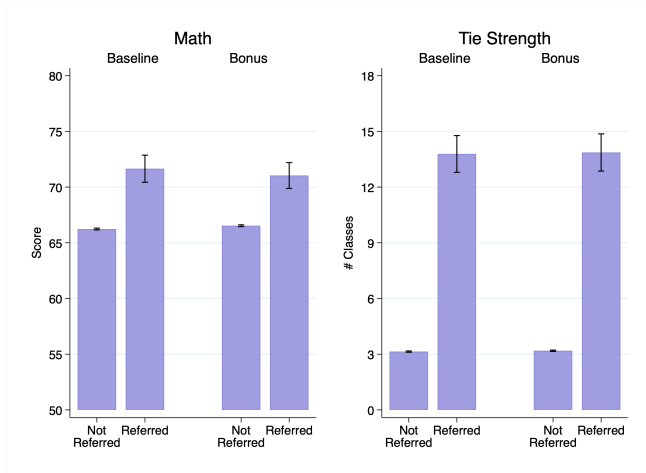
Baseline referrals

Baseline Referral Rates by SES

Baseline Referral Performance
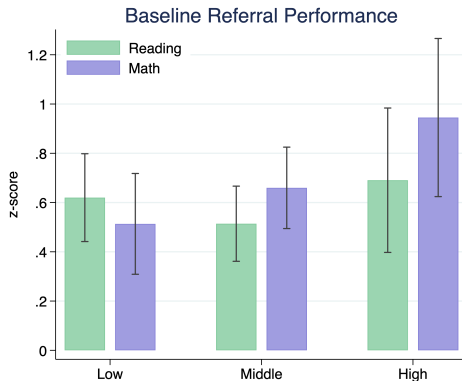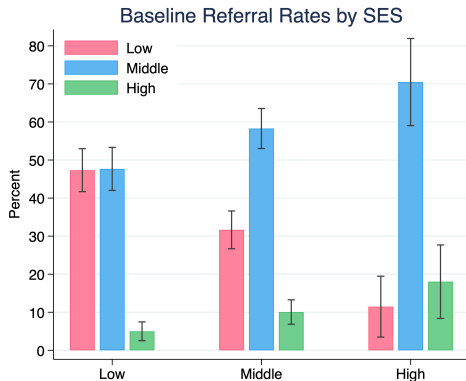
◦ Large monotonic differences in referral shares as SES increases (all $p < 0.1$)

Baseline referrals

Baseline Referral Rates by SES

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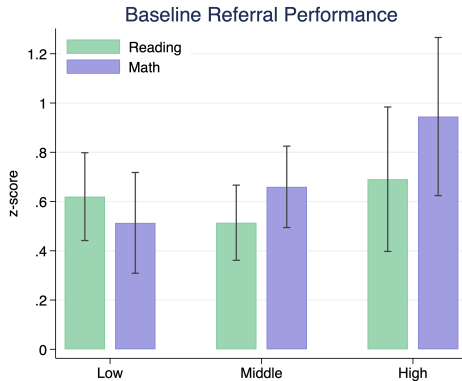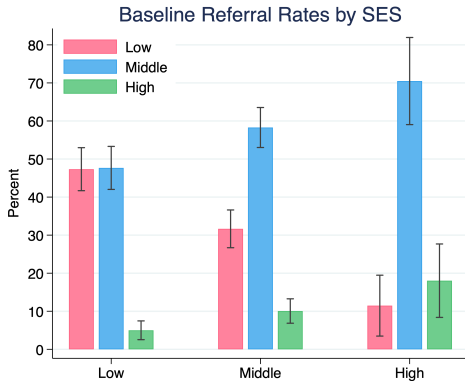
- ◦ Large monotonic differences in referral shares as SES increases (all $p < 0.1$)
- ◦ Small differences in math and reading performance across SES (all $p > 0.08$)

Treatment effects on referrals

Bonus on Referral Rates by SES

Bonus on Referral Performance by SES
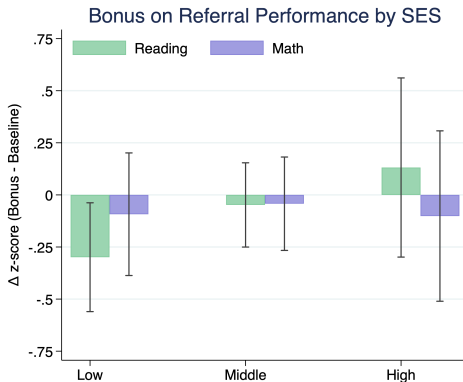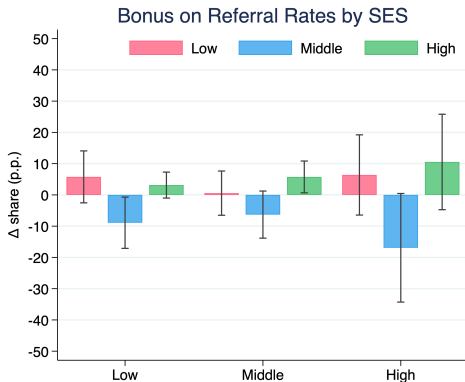
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Treatment effects on referrals

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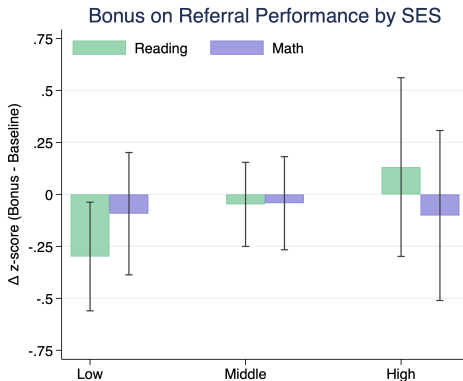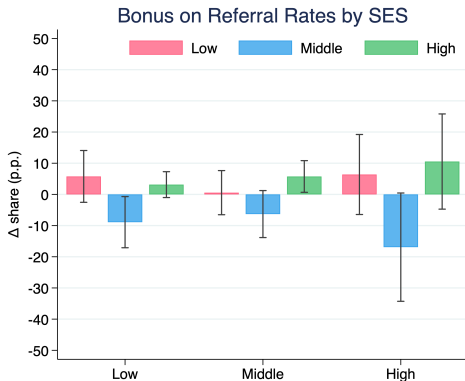
◦ No meaningful changes in referral shares with bonus

◦ No meaningful changes in reading and math performance with bonus

Treatment effect on referral tie strength

Referral Ties by SES at Baseline

Bonus on Referral Ties by SES
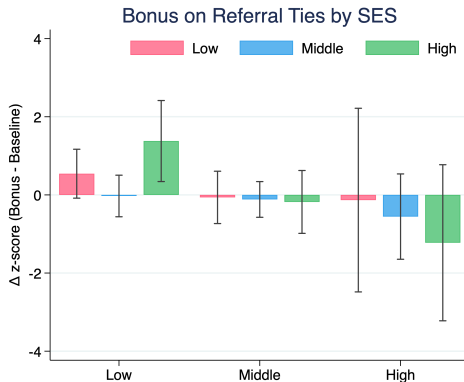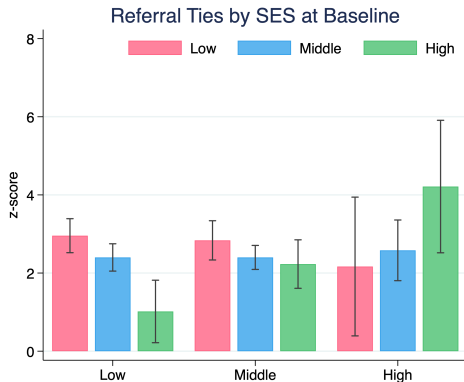
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Treatment effect on referral tie strength

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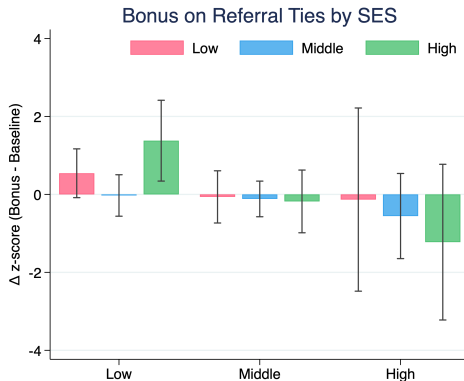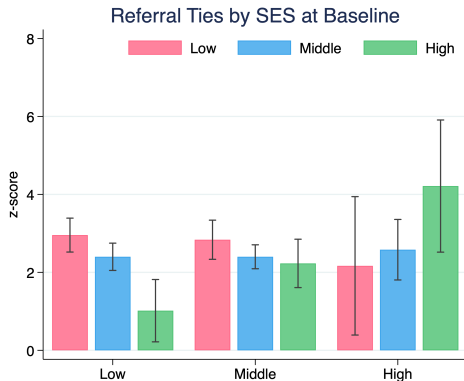
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Regression Analysis

Empirical specification

◦ Model the referral choice using a mixed multinomial logit model for each referrer's choice set (average 175 potential nominees) [McFadden and Train, 2000]

Empirical specification

- Model the referral choice using a mixed multinomial logit model for each referrer's choice set (average 175 potential nominees) [McFadden and Train, 2000]

- The probability that student i refers student $j \in N_i$ is given by

$$\frac{e^{\beta_i x_{ij}}}{\sum_{j=1}^{N_i} e^{\beta_i x_{ij}}}$$

where x_{ij} is the vector of characteristics of j (low-SES, test score, tie strength) and β_i is a vector of individual-specific parameters comprising of a constant and a random component

Is there a Low-SES bias in Reading referrals?

- Reading score and tie strength are strong predictors of referrals

	(1)	(2)	(3)
Low-SES	0.199**	0.041	0.042
	(0.083)	(0.100)	(0.100)
Reading Score		0.561***	0.509***
		(0.044)	(0.048)
Tie		0.951***	0.941***
		(0.031)	(0.032)
Score × Tie			0.029
			(0.018)
Observations	128,847	128,847	128,847
Individuals	673	673	673

Is there a Low-SES bias in Reading referrals?

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- No evidence for a Low-SES bias in referrals when controlling for referral score and tie strength

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Is there a Low-SES bias in Math referrals?

○ Math score and tie strength are strong predictors of referrals

	(1)	(2)	(3)
Low-SES	0.220***	0.049	0.050
	(0.083)	(0.097)	(0.098)
Math Score		0.653***	0.538***
		(0.040)	(0.041)
Tie		0.887***	0.854***
		(0.029)	(0.030)
Score × Tie			0.088***
			(0.019)
Observations	128,150	128,150	128,150
Individuals	669	669	669

Is there a Low-SES bias in Math referrals?

- Math score and tie strength are strong predictors of referrals

- Significant but small interaction between math score and tie strength

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Do grades predict Reading referrals?

- GPA correlates weakly with reading score ($\rho = 0.18$)

	(1)	(2)	(4)
GPA	0.759***	0.640***	0.578***
	(0.044)	(0.059)	(0.070)
Reading Score		0.407***	0.344***
		(0.048)	(0.068)
Tie Strength		0.936***	0.911***
		(0.031)	(0.032)
Score $\times$ Tie			0.010
			(0.022)
Score $\times$ GPA			0.017
			(0.056)
GPA $\times$ Tie			0.028
			(0.026)
Score $\times$ Tie $\times$ GPA			0.030*
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Do grades predict Math referrals?

- Significant but small interactions between tie strength and both performance variables

	(1)	(2)	(4)
GPA	0.765***	0.621***	0.500***
	(0.044)	(0.059)	(0.068)
Math Score		0.531***	0.400***
		(0.044)	(0.065)
Tie Strength		0.871***	0.808***
		(0.029)	(0.030)
Score $\times$ Tie			0.068***
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Is there in-group homophily in Reading referrals?

◦ Restrict sample by SES of referrer

	Low-SES (1)	Med-SES (2)	High-SES (3)
Homophily	0.300**	0.203	-0.354
	(0.152)	(0.125)	(0.344)
Reading Score	0.433***	0.353***	0.674***
	(0.074)	(0.067)	(0.170)
Tie	0.860***	0.991***	1.061***
	(0.043)	(0.048)	(0.134)
GPA	0.648***	0.667***	0.477**
	(0.094)	(0.081)	(0.228)
Observations	54,611	64,596	9,640
Individuals	275	340	58

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	Low-SES (1)	Med-SES (2)	High-SES (3)
Homophily	0.282*	0.161	-0.030
	(0.146)	(0.125)	(0.358)
Math Score	0.500***	0.516***	0.810***
	(0.069)	(0.064)	(0.128)
Tie	0.823***	0.892***	1.046***
	(0.040)	(0.044)	(0.141)
GPA	0.580***	0.675***	0.519**
	(0.093)	(0.083)	(0.219)
Observations	55,531	62,492	10,127
Individuals	283	327	59

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Empirical Specification

OLS Model:

$$\text{Score}_{ij} = \beta_0 + \beta_1 \cdot X_i + \beta_2 \cdot \text{Mean Score}_j + \beta_3 \cdot \text{SD Score}_j + \varepsilon_{ij}$$

- Score_{ij}: Test score of the nominee from referrer i in subject j

Features:

Empirical Specification

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Features:

- Sample restricted to nominated students only
- Controls for network-level performance differences
- Standard errors clustered at individual level

Do Low-SES refer better?

- No evidence that Low-SES refer better in reading or math

	Reading (1)	Math (2)
Med-SES	-1.213**	-0.816
	(0.607)	(0.731)
High-SES	0.438	0.937
	(1.085)	(1.287)
Mean Score	1.250***	1.399***
	(0.096)	(0.074)
SD Score	0.233	0.163
	(0.409)	(0.318)
Constant	-13.062	-21.571***
	(8.006)	(6.373)
Observations	673	669

Do Low-SES refer better?

- No evidence that Low-SES refer better in reading or math

- Better referrals depend on average network performance

	Reading (1)	Math (2)
Med-SES	-1.213**	-0.816
	(0.607)	(0.731)
High-SES	0.438	0.937
	(1.085)	(1.287)
Mean Score	1.250***	1.399***
	(0.096)	(0.074)
SD Score	0.233	0.163
	(0.409)	(0.318)
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	(8.006)	(6.373)
Observations	673	669

Is there performance homophily in referrals?

- Significant but small effect of own test score on referral score

	Reading (1)	Math (2)
Own Score	0.177***	0.176***
	(0.035)	(0.036)
Mean Score	1.020***	1.186***
	(0.101)	(0.082)
SD Score	0.056	0.155
	(0.398)	(0.310)
Constant	-9.126	-19.835***
	(7.835)	(6.240)
Observations	673	669

Is there performance homophily in referrals?

- Significant but small effect of own test score on referral score

- Very large difference between the average network test score versus referrer performance (about 6 times)

|	Reading (1)	Math (2)
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Mean Score	1.020***	1.186***
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SD Score	0.056	0.155
	(0.398)	(0.310)
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Is there performance homophily in referrals?

- Significant but small effect of own test score on referral score
- Very large difference between the average network test score versus referrer performance (about 6 times)
- Performance homophily is nearly not as important as network composition

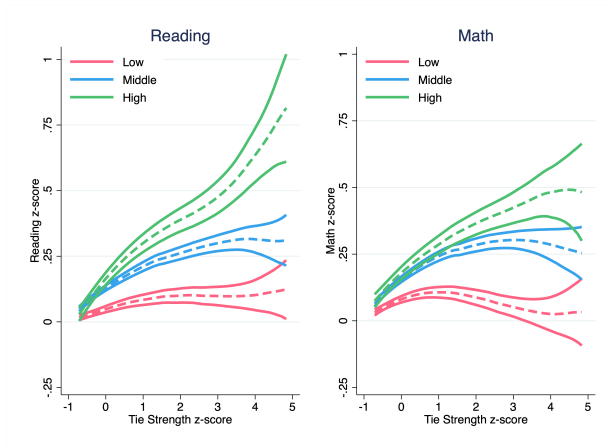|	Reading (1)	Math (2)
Own Score	0.177***	0.176***
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Prelude

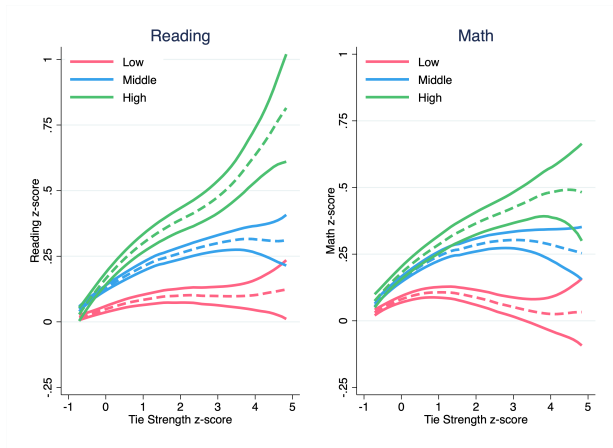○ No evidence for a Low-SES bias in referrals
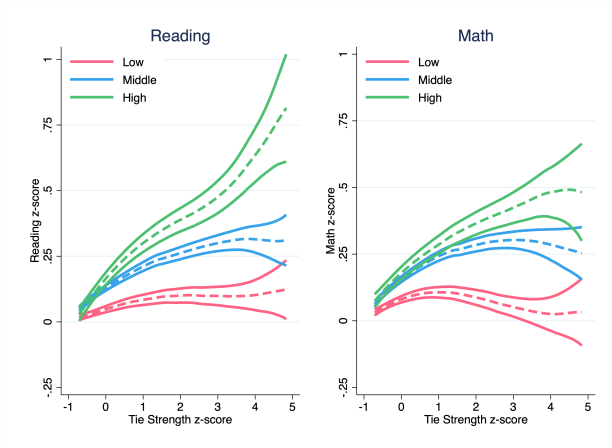
Prelude

○ No evidence for a Low-SES bias in referrals

○ Referrers pick nominees based on performance and tie strength

Prelude

- No evidence for a Low-SES bias in referrals
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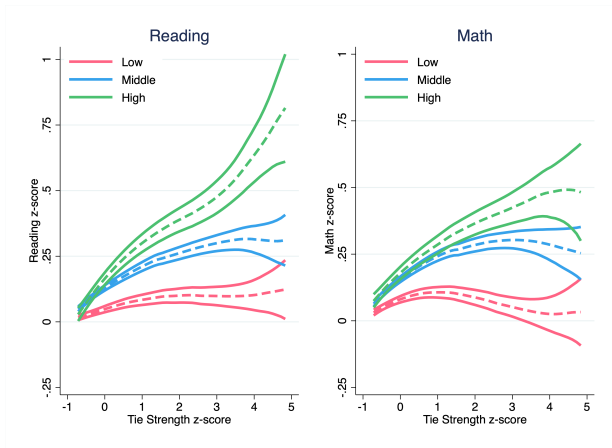- Referral performance depends heavily on referrer network composition

Prelude

- No evidence for a Low-SES bias in referrals
- Referrers pick nominees based on performance and tie strength
- Referral performance depends heavily on referrer network composition
- Which SES group has the better network?

Empirical Specification

OLS Model:

$$\text{Mean Score}_{ij} = \beta_0 + \beta_1 \cdot \text{Score}_{ij} + \beta_2 \cdot \text{SES}_i + \varepsilon_{ij}$$

- Mean Score$_{ij}$: Average network test score of referrer i in subject j

Features:

Empirical Specification

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Features:

- Sample restricted to referrers only
- Estimated at relevant tie-strength z-score thresholds (z_tie $\geq$ 1, 2, 3, 4)
- Standard errors clustered at individual level

Do Low-SES have worse networks in Reading?

○ Average referral tie strength is around 2.7 SD for reading

	Tie ≥ 1 (1)	Tie ≥ 2 (2)	Tie ≥ 3 (3)	Tie ≥ 4 (4)
Score	0.174***	0.204***	0.228***	0.196***
	(0.024)	(0.027)	(0.032)	(0.040)
Middle-SES	1.213***	1.132***	1.510***	1.371**
	(0.299)	(0.336)	(0.423)	(0.539)
High-SES	1.837***	1.292***	1.706***	1.941***
	(0.424)	(0.438)	(0.512)	(0.575)
Observations	506	376	278	189

Do Low-SES have worse networks in Reading?

- Average referral tie strength is around 2.7 SD for reading

- Referrer reading score has a significant but small effect at each tie strength threshold

	Tie ≥ 1 (1)	Tie ≥ 2 (2)	Tie ≥ 3 (3)	Tie ≥ 4 (4)
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- Systematic network inequality is constraining Low-SES referrals

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Do Low-SES have worse networks in Math?

◦ Average referral tie strength is around 2.5 SD for math

	Tie ≥ 1 (1)	Tie ≥ 2 (2)	Tie ≥ 3 (3)	Tie ≥ 4 (4)
Score	0.242***	0.264***	0.308***	0.304***
	(0.024)	(0.028)	(0.038)	(0.049)
Middle-SES	1.851***	1.890***	2.031***	2.328***
	(0.417)	(0.452)	(0.568)	(0.707)
High-SES	1.483***	1.332**	1.751**	1.914**
	(0.571)	(0.603)	(0.727)	(0.938)
Observations	479	358	257	176

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