Home and School in the Development of Children

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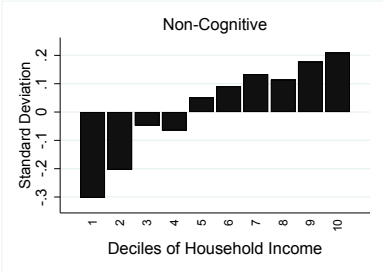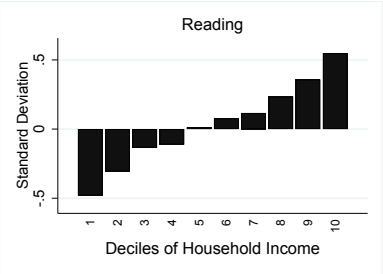
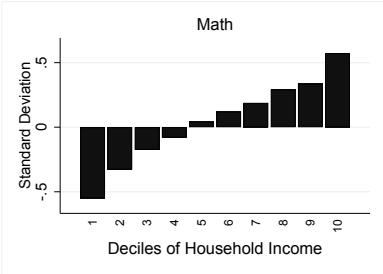[1]University of Pennsylvania

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Motivation: Test Scores Vary Widely at Kindergarten Entry

This Paper: Synthesizes Two Literatures

- Child Development Literature
  - Focuses on home

- Education Literature
  - Focuses on school

Why is this Important?

Relative importance of home and school

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- School has a 3 to 5 times larger effect on skills

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- Home has a 2 to 3 times larger effect on the skills gap

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Relative importance of home and school

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- Classroom rankings based on current models are systematically biased

Rich Data on Children, Households, and Schools

Early Childhood Longitudinal Study - Kindergarten Class of 1998-99:

- Nationally representative sample

- Clustered at classroom level

Descriptive Statistics at Kindergarten Entry

	Mean	Std. Dev.
Characteristics of Child:		
Number of children	8,656	
Age	5.68	0.36
Fraction male	0.51	
Fraction White, Non-Hispanic	0.68	
Fraction living with both biological parents	0.69	
Characteristics of Household:		
Mother's age	33.89	6.36
Mother's years of schooling	13.88	2.23
Mother's hours worked	26.13	19.01
Household income (2017 USD)	68,226	35,480
Characteristics of Classroom:		
Number of classrooms	1,118	
Class size	20.11	4.65
Instructional time (hours/week)	24.03	9.26
Characteristics of School:		
Number of schools	637	
Fraction public school	0.69	
Fraction of students receiving free or reduced price lunch	0.26	0.27

The Model: Skill Formation During Kindergarten

- Two time periods: beginning and end of kindergarten

- Three skills: math, reading, and non-cognitive

- Two investments: home and school

- Addressing imperfection and arbitrariness of measures

- Assuming school investment is common at the classroom level

- Allowing for return to school to vary by skills

School Investment has a Higher Effect on Skills

|	Math	Reading	Non-cognitive
Home	0.113		
	[0.066,0.173]		
School	0.323		
	[0.305,0.349]		

Notes: 95% confidence intervals are in brackets.
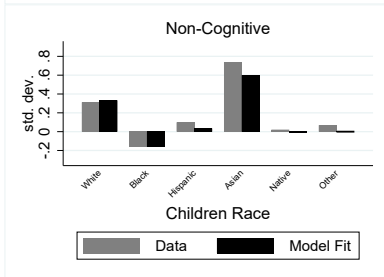
School Investment has a Higher Effect on Skills

	Math	Reading	Non-cognitive
Home	0.113	0.078	0.079
	[0.066,0.173]	[0.023,0.120]	[0.032,0.150]
School	0.323	0.390	0.524
	[0.305,0.349]	[0.367,0.417]	[0.493,0.558]

Notes: 95% confidence intervals are in brackets.

Higher School Returns for Disadvantaged Children
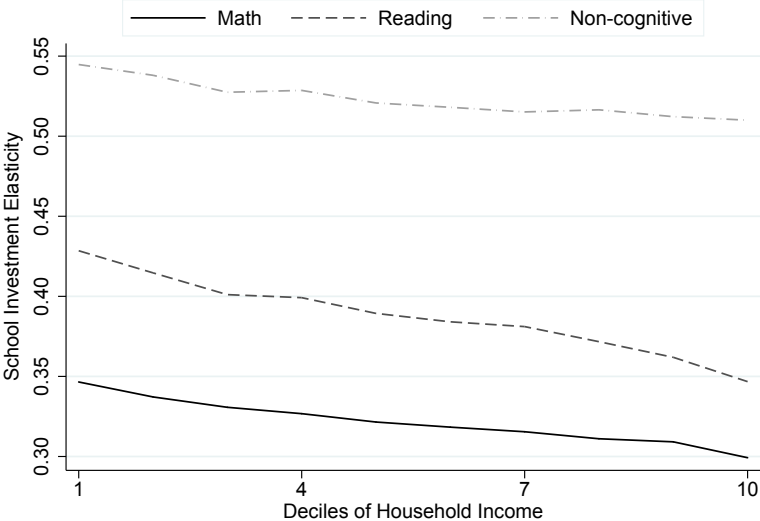
Model Fit
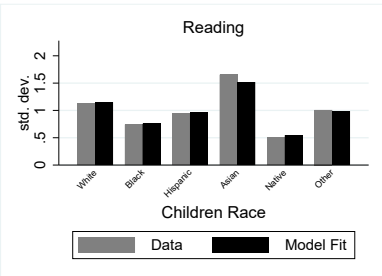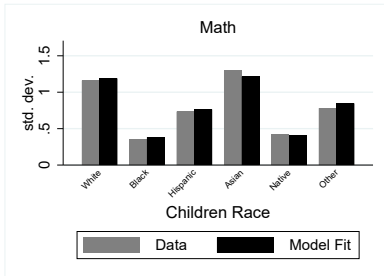
Home Investment has a Larger Effect on the Skills Gap

How would the skills gap change if we were to provide all children with:

1. the 90th percentile of school investment?
2. the 90th percentile of home investment?

	Baseline Gap	Δ	90th-pct School	Δ	90th-pct Home
Math	-0.88		
Reading	-0.69		
Non-Cognitive	-0.66		

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	Baseline Gap	Δ | 90th-pct School	Δ | 90th-pct Home
Math	-0.88	-8%	
Reading	-0.69	-5%	
Non-Cognitive	-0.66	-9%	

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How would the skills gap change if we were to provide all children with:

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2. the 90th percentile of home investment?

	Baseline Gap	Δ | 90th-pct School	Δ | 90th-pct Home
Math	-0.88	-8%	-18%
Reading	-0.69	-5%	-15%
Non-Cognitive	-0.66	-9%	-24%

Are Current Classroom Rankings Robust?
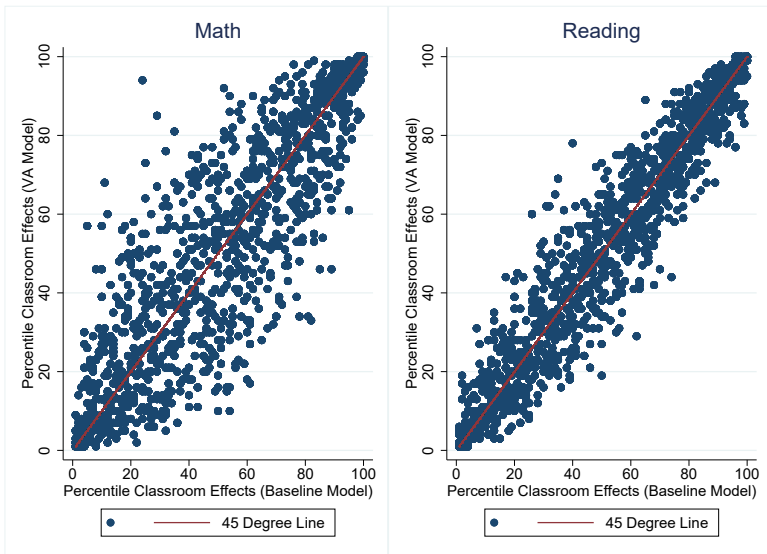
Current Classroom Rankings are Systematically Biased
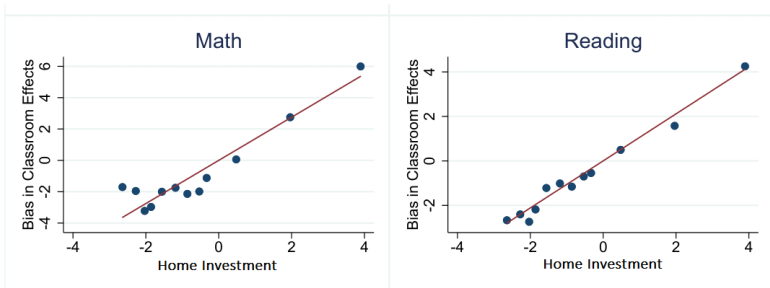
Bias is the difference between the rank of estimated classroom effect in a typical model and our model.

Conclusions

- School investment has a higher effect on skills; its effect is between 3 to 5 times larger than the home investment

- School investment has a higher return for disadvantaged children; the elasticities for children in the lowest decile of household income are between 10 and 22 percent higher than for children in the highest decile

- Home investment has a higher effect on the skills gap; its effect is between 2 to 3 times larger than the school investment

- Current models systematically predict a lower rank for classrooms with lower levels of home investment or non-cognitive skills

Thank You!

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Extra Material

Test Scores at the End of Kindergarten
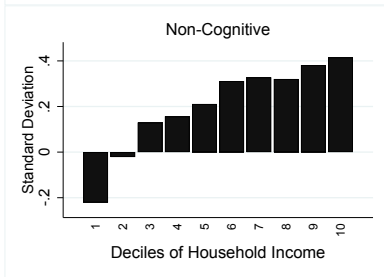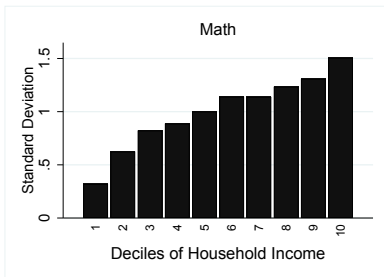
Children's Scores and Home Investments at K-Entry

	Obs	Mean	Std. Dev.	Min	Max
Test Scores:					
Math (Routing)	8656	5.11	2.94	0	16
Math (IRT)	8656	27.56	9.22	10	96
Reading (Routing)	8656	6.25	3.97	0	20
Reading (IRT)	8656	36.28	10.45	21	138
Approach to Learning	8656	3.04	0.66	1	4
Self Control	8656	3.11	0.61	1	4
Interpersonal Skills	8430	3.01	0.62	1	4
Home Investments:					
Number of Books	8656	84.77	60.30	0	200
Computer is Available (0/1)	8656	0.63	0.48	0	1
Mother's Years of Education	8656	13.88	2.23	8	20

Non-Cognitive Scores

- Approaches to Learning
    - attentiveness
    - task persistence
    - eagerness to learn
    - organization

- Self-Control
    - respecting the property rights of others
    - controlling temper
    - accepting peer ideas for group activities
    - responding appropriately to pressure from peers

- Interpersonal Skills
    - forming and maintaining friendships
    - getting along with people who are different
    - comforting or helping other children
    - expressing feelings, ideas, and opinions in positive ways

The Model Synthesizes Two Literatures

- Modeling three skills: Math, Reading, and Non-cognitive

- Notation:
  - $\theta_{j,i,t}$: child i's stock of skill j at age t
  - $\Theta_{i,t}$: collection of J skills
  - $I_{S_{j,i,t}}$: investments from school
  - $I_{H_{i,t}}$: investments from home
  - $\eta_{j,i,t}$: the error term

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- During kindergarten: $t = 0$ (K-Entry), $t = 1$ (K-Exit)

$$\ln \theta_{j,i,t+1} = \ln \Theta'_{i,t} \Gamma + \gamma_{I_S} \ln I_{S_{j,i,t}} + \gamma_{I_H} \ln I_{H_{i,t}} + \quad\quad + \eta_{j,i,t}$$

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  - $\eta_{j,i,t}$: the error term

- $\theta_{j,i,t}$, $I_{H_{i,t}}$, $I_{S_{j,i,t}}$ all latent (generic index ω)

Identification Accounts for Imperfect and Arbitrary Measures

- $\theta_{j,i,t}$, $I_{H_{i,t}}$, $I_{S_{j,i,t}}$ all latent (generic index ω)

- Skills and home investment have measures M of the form:

$$M_{\omega,i,k} = \mu_{\omega,k} + \lambda_{\omega,k} \ln \omega_i + \epsilon_{\omega,i,k}$$

  - $\mu_{\omega,k}$: the location for measure k
  - $\lambda_{\omega,k}$: the scale
  - $\epsilon_{\omega,i,k}$: the measurement error

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  - $\epsilon_{\omega,i,k}$: the measurement error

- School investment is common to all students at the *classroom* level

Iterative Estimation

- Initial period latent variables are normalized: mean 0 and variance 1

- Measurement parameters are estimated in standard way

- Model is estimated iteratively using the latent factor model

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  - given the parameters, estimate the classroom effects
  - given the estimated classroom effects, estimate the parameters
  - repeat until convergence

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  - given the parameters, estimate the classroom effects
  - given the estimated classroom effects, estimate the parameters
  - repeat until convergence

- Estimates are corrected for the measurement error

Estimates of Measurement Parameters

	Location	Scale	Signal/Noise
Skills:			
Math (Routing)	5.11	2.84	0.93
Math (IRT)	27.56	8.84	0.92
Reading (Routing)	6.25	3.94	0.98
Reading (IRT)	36.28	9.51	0.83
Approach to Learning	3.04	0.50	0.58
Self Control	3.11	0.53	0.76
Interpersonal Skills	3.01	0.56	0.81
Home Investments:			
Number of Books	84.77	29.49	0.24
Computer is Available (0/1)	0.63	0.25	0.27
Mother's Years of Education	13.88	1.38	0.38

Estimates of the Initial Conditions

	(1)	(2)	(3)	(4)	(5)	(6)
Initial Math	1.00					
Initial Reading	0.69	1.00				
Initial Non-cognitive	0.53	0.47	1.00			
Home Investment	0.53	0.42	0.33	1.00		
School Investment Math	0.04	0.07	-0.09	-0.15	1.00	
School Investment Reading	0.03	0.09	-0.07	-0.22	0.49	1.00
School Investment Non-cognitive	-0.06	-0.06	-0.08	-0.17	0.08	0.10

Home Versus School: Math Skills

	Measurement Error Correction	
	without	with
Initial Math	0.601	
	[0.580,0.619]	
Initial Reading	0.131	
	[0.110,0.153]	
Initial Non-cognitive	0.138	
	[0.123,0.158]	
Home Investment		
School Investment		
Initial Math × School Investment		
N-Children	8,656	8,656
N-Classroom	1,118	1,118

Notes: 95% confidence intervals are in brackets.

Home Versus School: Math Skills

	Measurement Error Correction	
	without	with
Initial Math	0.601	0.719
	[0.580,0.619]	[0.688,0.750]
Initial Reading	0.131	0.046
	[0.110,0.153]	[0.017,0.082]
Initial Non-cognitive	0.138	0.082
	[0.123,0.158]	[0.052,0.105]
Home Investment		
School Investment		
Initial Math × School Investment		
N-Children	8,656	8,656
N-Classroom	1,118	1,118

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Home Versus School: Math Skills

	Measurement Error Correction	
	without	with
Initial Math		
Initial Reading		
Initial Non-cognitive		
Home Investment	0.017	0.113
	[0.008,0.026]	[0.066,0.173]
School Investment	0.334	0.323
	[0.316,0.355]	[0.305,0.349]
Initial Math × School Investment		
N-Children	8,656	8,656
N-Classroom	1,118	1,118

Notes: 95% confidence intervals are in brackets.

Home Versus School: Math Skills

	Measurement Error Correction	
	without	with
Initial Math		
Initial Reading		
Initial Non-cognitive		
Home Investment		
School Investment		
Initial Math × School Investment	-0.061 [-0.080,-0.038]	-0.041 [-0.069,-0.022]
N-Children	8,656	8,656
N-Classroom	1,118	1,118

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Model Fits Untargeted Moments of the Data Well
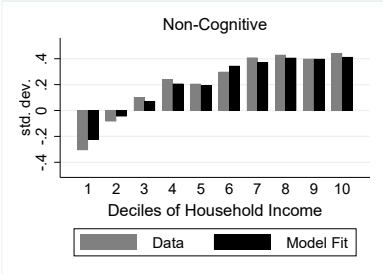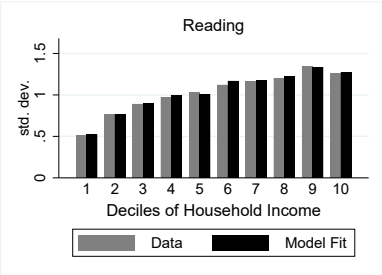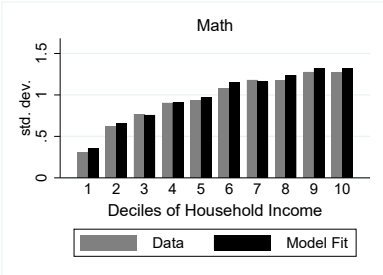
Selection on Observables Does Not Get Rejected

Residuals	Math	Reading	Non-Cognitive
Household Income (100,000 USD)	0.00	-0.00	0.02
	[-0.03,0.03]	[-0.03,0.02]	[-0.01,0.06]
N-Children	8,656	8,656	8,656

Model Replicates the Findings of STAR Experiment

	Model		STAR	
	Math	Reading	Math	Reading
A: Comparison of the Average Treatment Effect				
School Investment (SD)	0.32	0.40	0.36	0.36
B: Comparison of the Heterogeneous Treatment Effect				
Ratio of the Effect for Black to White Students	1.08	1.06	1.08	1.20

Home Investment has a Bigger Effect on the Income Gap

	Baseline Gap	Δ | 90th-pct School	Δ | 90th-pct Home
A: Measurement Error Correction and Complementarities			
Math	-0.88	-8%	-18%
Reading	-0.69	-5%	-15%
Non-Cognitive	-0.66	-9%	-24%
B: Without Measurement Error Correction and Complementarities			
Math	-0.88		
Reading	-0.69		
Non-Cognitive	-0.66		
C: Simple VA Model			
Math	-0.88		
Reading	-0.69		

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Math	-0.88	-22%	-7%
Reading	-0.69	-17%	-6%
Non-Cognitive	-0.66	-23%	-20%
C: Simple VA Model			
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Math	-0.88	-22%	-7%
Reading	-0.69	-17%	-6%
Non-Cognitive	-0.66	-23%	-20%
C: Simple VA Model			
Math	-0.88	-13%	
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