Key Players? High School Networking Effects on Earnings

Lucia Barbone Peter Dolton

PhD Conference, University of Sussex 5 December 2014

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Motivation - Non-cognitive skills

- Widely documented impact of schooling on earnings
- What are exactly the skills that one learns at school?
- Cognitive skills explain only 18% of the economic return to schooling (Bowles et al. (2001))
- The residual part has been called non-cognitive skills
- Non-cognitive skills include psychological traits and social skills

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Motivation - Non-cognitive skills

Authors	Year	Measure	Effect	Data	Sample
Barron et al.	2000	Athletic club	12-32% wage	NLSY, NLS72	Males
Postlewaite Silverman	2005	Athletic club	12% wage	NLSY79	Males
Glaeser et al.	2002	Organis Membership	Social jobs	GSS	Both
Kuhn and Weinberger	2005	Leadership Skills	4-33%	TALENT, NLS72, HSB82	White Males
Bandiera et al.	2009	Interactions	(-) product	One firm	Uni Students
Borghans et al.	2008	Interactions	16% wage	BSS, BCS70 and BIBB/IAB	Both
Krueger et al.	2008	Interactions	Sorting into jobs	US and France	Working women
Conti et al.	2010	OCEAN	(+) health	BCS70	Both
Heckman et al.	2006	Self-Esteem	+	NLSY79	Both
Drago	2011	Self-Esteem	4% wage	NLSY	White males

Networks Effects on Earnings

Motivation - Network Analysis

- Recent papers have introduced social network analysis tools as a proxy for social skills (Babcock, 2008; Hill, 2012; Conti et al., 2013)
- Networks variables are likely to suffer from an endogeneity problem
- Conti, Galeotti, Muller and Pudney (*JHR*, 2013) propose an innovative approach to tackle this issue on a partially sampled network
 - First stage estimate of Network Variables using a hypergeometric distribution
 - Second Stage using predicted values as determinant of earnings

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Previous Literature

Author	DataSet	Dependent Variable	Estimate	First Stage
Fletcher (2014)	AddHealth	Earnings	-0.004	NO
			0.007	NO
Hill (2012)	AddHealth	Earnings	0.0544**	NO
			0.0654**	NO
Babcock (2008)	AddHealth	Employment	0.0136***	NO
		College	0.0337***	NO
Conti et al. (2013)	WLS	Earnings	0.020**	YES

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Contributions and Research Question

- First stage for network variables using count data models
- Centrality as a more inclusive measure for social skills
- Dataset with both partially and fully sampled networks
- Estimations conducted using longitudinal data information
- Estimation of the importance of quality of time and ethnicity

What is the impact of social skills on personal earnings in adult life? Which network measure is the most appropriate to proxy for these social skills?

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Data

AddHealth dataset: Longitudinal Study of Adolescents in the US

- Wave I, II survey (1994/95) with nominations information
- School Administrator Survey
- Wave IV Survey 2008 with earnings information

Strengths of Dataset

- Detailed information on friendships
- Nominations question asking for best friends
- 10 Fully Sampled Schools Each school is a network

Weaknesses of Dataset

- No Class Level Information
- Respondents asked to nominate 5 male and 5 female friends. Only 3% nominates 10 friends.

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Summary Statistics

	Mean	St.Dev.
Wave 1		
Age	16	1.5
Female	0.48	0.5
White	0.6	0.489
Black	0.123	0.33
Asian	0.154	0.361
Other	0.116	0.321
Not in clubs	0.358	0.479
Not fit	0.079	0.269
Wave 4		
Earnings	39097	21735
BA	0.205	0.404
More than BA	0.083	0.275
Many friends	0.344	0.475
N	1842	

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Social Networks Analysis Tools

- In-Degree: nominations one receives
- Out-Degree: nominations one gives
- Degree: the number of nominations one gives or receives
- Centrality: how central an individual is in the network

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ID	Degree	Indegree	Outdegree	Centrality
А	13	8	5	0.20
В	13	8	5	0.55
С	13	9	4	0.81

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Construction of Network Variables

$$ID_{i} = \sum_{j} X_{ji}$$
(1)

$$OD_{i} = \sum_{i} X_{ji}$$
(2)

$$= \operatorname{out} (I - \beta X)^{-1} X 1$$
(3)

$$BC = \alpha * (I - \beta X)^{-1} X 1$$
(3)

 β power weight When β is equal to 0, BC = degreeHere:

- *β* = 0.1
- $\beta = -0.1$

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 Figure:
 Network of one school - weighted by degree
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 Figure:
 Network
 of one school - weighted by centrality
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Previous Literature

Author	DataSet	Dependent Variable	Network Variable	Estimate	First Stage
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		College	Degree Centrality	0.0337***	NO
Conti et al. (2013)	WLS	Earnings	In-degree Out-degree	0.020** 0.00	YES YES
				0.00	

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Network Statistics

	Mean	Std.Dev.	Min	Max
Degree	6.2	4.22	0	24
InDegree	3.15	2.75	0	19
BC 0.1	0.774	0.662	0	4.469
BC -0.1	0.805	0.603	0	2.946

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Empirical Strategy

Two-step estimation - Earnings Estimation

$$N = \alpha_1 + X_1\beta_1 + Z\beta_2 + S\beta_3 + F\beta_4 + \varepsilon_1$$
(4)

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$$ln(earnings) = \alpha_2 + \hat{N}\gamma_1 + X_2\gamma_2 + S\gamma_3 + F\gamma_4 + \varepsilon_2$$
(5)

Where X_1, X_2, Z individual characteristics, S school characteristics, F family characteristics

- First stage estimated using
 - Degree and In-Degree: a Negative Binomial count model
 - Centrality: OLS
- Second stage estimated using OLS

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Identification

- Functional Form
- Exclusion Restrictions: Homophily terms
 - Same grade
 - Smoking
 - Drinking
 - Ethnicities
 - Activities
 - Height
- Panel

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Results - Annual Earnings

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Degree	0.057***	0.098***	0.081***	0.095***	0.072***	0.07***	0.074**	0.073***
	(0.016)	(0.025)	(0.026)	(0.032)	(0.030)	(0.03)	(0.029)	(0.032)
Indegree	0.06***	0.077***	0.064***	0.069***	0.056***	0.058***	0.06**	0.06***
	(0.008)	(0.024)	(0.024)	(0.027)	(0.024)	(0.024)	(0.026)	(0.026)
BC 0.1	0.017	0.091***	0.070**	0.064**	0.047*	0.051*	0.044	0.050*
	(0.019)	(0.027)	(0.028)	(0.030)	(0.026)	(0.028)	(0.029)	(0.028)
BC -0.1	0.01	0.094***	0.075***	0.066***	0.047*	0.053*	0.045*	0.047*
	(0.015)	(0.026)	(0.026)	(0.029)	(0.025)	(0.025)	(0.026)	(0.028)
Grade FE	No	No	Yes	Yes	Yes	Yes	Yes	Yes
School FE	No	No	No	Yes	Yes	Yes	Yes	Yes
hrs work	No	No	No	No	Yes	Yes	Yes	Yes
Psy	No	No	No	No	No	Yes	No	Yes
IQ	No	No	No	No	No	No	Yes	Yes
First Stage	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1842	1842	1808	1808	1808	1742	1723	1661
R2	0.20	0.21	0.21	0.22	0.32	0.33	0.32	0.332
	Bootstrap	pped errors i	n parenthes	es. * p < 0.0	01, ** p < 0	0.05, *** p	< 0.10	

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Bonacich Power Centrality - Interpretation

- Benefit from being connected to more important individuals in a network
 - More likely that one receives information quickly
 - More influential sending information out
- Positive β : being connected to neighbors with more connections makes one powerful
- Negative β : dependency of neighbours on the individual
- Social capital measure

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Robustness Checks and Extensions

- Wave 2 network data
- Hourly wage estimates
- Partially vs. fully sampled schools estimates: effects underestimated for 'partial' sample
- Ethnicity separated estimates: effects significant for white sample
- Quantile estimates: higher effect for low-paying jobs
- Quality of relationships
- Spatial regression

Additional

Main Findings and Summary

- 1. Degree has a limited informational content, while network centrality is a superior measure to proxy for social skills.
- 2. The use of a Negative Binomial distribution dictated by the nature of the data allows more precise estimates
- 3. Partially sampled networks bring underestimated effects.
- 4. Social skills increase earnings by around 6.5%. The effect is linked to the ethnicity and to the strength of the link between the respondents.
- 5. What matters is not the size of the network, but whether one is a Key Player



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Figure: Same Degree, Different Centralities Networks Effects on Earnings Sussex PhD Conference

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Figure: Same Degree, Different Centralities

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 Figure:
 Network of one school, nodes weighted by indegree
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 Figure:
 Network of one school, nodes weighted
 by outdegree

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Degree Distribution



Figure: Degree: Poisson, Negative Binomial and Actual

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In-Degree Distribution



Figure: In-Degree: Poisson, Negative Binomial and Actual

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The Determinants of Social Skills

	Degree	Indegree	BC 0.1	BC -0.1	
No Clubs	-0.137***	-0.224***	-0.06	-0.019	
	(0.033)	(0.053)	(0.04)	(0.041)	
Not Fit	-0.197***	-0.223***	-0.144***	-0.108***	
	(0.027)	(0.053)	(0.041)	(0.025)	
Sports	0.104*	0.081	0.136**	0.089	
	(0.061)	(0.083)	(0.042)	(0.047)	
Hang out	0.181**	0.258**	0.101	0.066	
	(0.090)	(0.114)	(0.071)	(0.057)	
Repeated	-0.120***	-0.181**	-0.063**	-0.042***	
	(0.041)	(0.073)	(0.025)	(0.012)	
Father Edu	0.031	-0.015	0.080**	0.069*	
	(0.027)	(0.026)	(0.033)	(0.033)	
Ability Grouping	-3.931***	-5.638***	-0.040	0.027	
	(1.230)	(1.323)	(0.190)	(0.135)	
School FE	Yes	Yes	Yes	Yes	
Grade FE	Yes	Yes	Yes	Yes	
Robust errors, clustered at school level in parentheses.					
* p	< 0.01 , ** μ	o < 0.05, ***	* <i>p</i> < 0.10		

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Does the Effect Vary Across Earnings Quantiles?

Degree						
Degree	0.093***	0.120**	0.075*	0.043		
	(0.036)	(0.056)	(0.042)	(0.051)		
Female	-0.330***	-0.305***	-0.276***	-0.331***		
	(0.028)	(0.053)	(0.030)	(0.039)		
Bachelor	0.241***	0.296***	0.257***	0.177***		
	(0.036)	(0.044)	(0.041)	(0.041)		
More than Bachelor	0.337***	0.403***	0.399***	0.285***		
	(0.051)	(0.087)	(0.054)	(0.064)		
Observations R2	1808 0.222	1808	1808	1808		
BC $\beta = 0.1$						
BC 0.1	0.064**	0.110**	0.054	0.047		
	(0.030)	(0.043)	(0.034)	(0.033)		
Female	-0.318***	-0.297***	-0.284***	-0.320***		
	(0.028)	(0.044)	(0.035)	(0.034)		
Bachelor	0.242***	0.274***	0.247***	0.182***		
	(0.039)	(0.054)	(0.047)	(0.044)		
More than Bachelor	0.338***	0.389***	0.379***	0.294***		
	(0.050)	(0.084)	(0.051)	(0.062)		
Observations R2	1808 0.221	1808	1808	1808		
Bootstrapped errors in parentheses. * $p < 0.01$, ** $p < 0.05$, *** $p < 0.10$						

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Ethnicity Separated Estimations

	White	NonWhite		
Degree	0.131***	-0.023		
	(0.04)	(0.042)		
Indegree	0.101***	0.021		
	(0.029)	(0.041)		
BC 0.1	0.089***	-0.071		
	(0.029)	(0.057)		
BC -0.1	0.071***	-0.048		
	(0.029)	(0.043)		
Grade FE	Yes	Yes		
School FE	Yes	Yes		
N	1097	711		
R2	0.26	0.19		
Bootstrapped errors in parentheses.				
* $p < 0.01$, ** $p < 0.05$, *** $p < 0.10$				

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Partially Sampled vs. Fully Sampled Schools

	Full	Partial			
Degree	0.098***	-0.003			
	(0.025)	(0.012)			
Indegree	0.077***	0.002			
_	(0.024)	(0.011)			
BC 0.1	0.093***	-0.005			
	(0.025)	(0.014)			
BC -0.1	0.094***	-0.004			
	(0.026)	(0.012)			
FE	No	No			
N	1842	4941			
R2	R2 0.21 0.18				
Bootstrapped errors in parentheses.					
* <i>p</i> < 0.0	* $p < 0.01$, ** $p < 0.05$, *** $p < 0.10$				

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Wave 2 Data

	(1)	(2)	(3)	(4)	(5)
Degree W2	0.092***	0.064***	0.078	-0.001	0.083**
	(0.035)	(0.022)	(0.060)	(0.035)	(0.033)
Indegree W2	0.070**	0.055***	0.055	-0.004	0.058*
	(0.018)	(0.016)	(0.054)	(0.035)	(0.032)
BC 0.1 W2	0.065**	0.023	0.039	0.054*	0.065**
	(0.027)	(0.019)	(0.031)	(0.031)	(0.026)
BC -0.1 W2	0.018	0.018	0.04	0.011	0.083**
	(0.021)	(0.021)	(0.28)	(0.031)	(0.035)
Degree W1					0.007*
					(0.004)
InDegree W1					0.015***
					(0.006)
BC 0.1 W1					-0.005
					(0.022)
BC -0.1 W1					-0.094**
					(0.042)
Grade FE	Yes	Yes	Yes	Yes	Yes
School FE	Yes	Yes	Yes	Yes	Yes
Network W1	No	Yes	No	No	Yes
First Stage	Yes	Yes	Yes	No	Yes
N	1233	1233	1233	1233	1233
R2	0.25	0.25	0.25	0.25	0.26
Bootstrapped	errors in pa	rentheses. *	<i>p</i> < 0.01	, ** p < 0	0.05, *** p < 0.10

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Quality Indices

	(1)	(2)			
	Degree	BC 0.1			
Stand Degree	0.086***				
	(0.032)				
Stand BC 0.1		0.056*			
		(0.030)			
House	-0.019	-0.015			
	(0.109)	(0.101)			
Meet	-0.018	-0.013			
	(0.077)	(0.075)			
Talk	-0.041	-0.043			
	(0.071)	(0.071)			
Phone	0.100	0.097			
	(0.081)	(0.081)			
Time	0.167**	0.167**			
	(0.080)	(0.079)			
Observations	1808	1808			
R2	0.227	0.226			
Bootstrapped errors in parentheses.					
* $p < 0.01$, ** $p < 0.05$, *** $p < 0.10$					

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Quality Based Network Measures

	(house)	(meet)	(time)	(talk)	(phone)
Degree	0.155***	0.131***	0.132***	0.141***	0.159***
	(0.043)	(0.040)	(0.039)	(0.044)	(0.041)
Indegree	0.107***	0.079**	0.095***	0.096***	0.118***
	(0.039)	(0.031)	(0.035)	(0.034)	(0.035)
BC 0.1	0.124***	0.144***	0.122***	0.128***	0.130***
	(0.043)	(0.041)	(0.036)	(0.038)	(0.039)
BC -0.1	0.109**	0.132***	0.121***	0.106***	0.117***
	(0.044)	(0.039)	(0.034)	(0.039)	(0.039)
Grade FE	Yes	Yes	Yes	Yes	Yes
School FE	Yes	Yes	Yes	Yes	Yes
First Stage	Yes	Yes	Yes	Yes	Yes
N	782	864	821	840	948
R2	0.28	0.28	0.31	0.28	0.28
Bootstrapped errors in parentheses. * $p < 0.01$, ** $p < 0.05$, *** $p < 0.10$					

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Annual Earnings, Hourly Wage and Adjacency Matrix

	Annual	Hourly	Adj (std)	Adj		
Degree	0.095***	0.067**	0.015***	0.001***		
	(0.032)	(0.029)	(0.004)	(0.0005)		
Indegree	0.069***	0.059***	0.014***	0.003***		
	(0.027)	(0.023)	(0.0039)	(0.0009)		
BC 0.1	0.064**	0.043*	0.009*	0.011**		
	(0.03)	(0.026)	(0.005)	(0.004)		
BC -0.1	0.066***	0.040*	0.013**	0.012		
	(0.029)	(0.04)	(0.006)	(0.007)		
Grade FE	Yes	Yes	Yes	Yes		
School FE	Yes	Yes	Yes	Yes		
N	1808	1808	1808	1808		
R2	0.22	0.18	0.22	0.22		
* p < 0.01, ** p < 0.05, *** p < 0.10						

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First Stage Covariates

	Network Equat	ion
Age	Ability Grouping	Only Child
Ethnicity	School Size	Living with both parents
Religion	Location	Birth Order
Gender	Private	Family Income
Not Fit	Safety	Parents' Education
Not part of Clubs	Homophily	English
Smoking	Class Size	
Hobbies	Grades	
Repeated Grade		
Height		
IQ		
Sports		
TV per day		
Breastfeed		
US		
Month Birth		
Hang Out		

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Second Stage Covariates					
Individual	School	Family			
Earnings Equation					
Ethnicity	Ability Grouping	Married			
Education	Network Density	Only Child			
IQ	Class Size	Family Income			
Voting Behaviour	School Size	Parents' Education			
Rural Area					
Age					
Gender					
Religion					
Same State					
Arrested					
US native					
US citizen					
Breastfeed					
Rural					
Friends					
Experience					
Health					
Want no children					
Month of birth					

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Survey Questions

- Please, tell me the name of your five best male friends, starting with your best male friend.
- Please, tell me the name of your five best female friends, starting with your best female friend.

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Survey Questions

- Did you go to NAME's house during the past seven days?
- Did you meet NAME after school to hang out or go somewhere during the past seven days?
- Did you spend time with NAME during the last weekend?
- Did you talk with NAME about a problem during the past seven days?
- Did you talk with NAME on the phone during the past seven days?

Variable	Mean	Std. Dev.	Min.	Max.	N
Age	15.75	1.424	12	20	1842
Female	0.488	0.5	0	1	1842
Born in the US	0.674	0.469	0	1	1842
White	0.603	0.489	0	1	1842
Black	0.127	0.333	0	1	1842
Asian	0.154	0.361	0	1	1842
Other Ethnicity	0.116	0.321	0	1	1842
Not Christian	0.028	0.164	0	1	1842
Atheist	0.113	0.317	0	1	1842
TV 5 times/week	0.521	0.5	0	1	1842
sports	0.948	0.222	0	1	1842
hobbies	0.785	0.411	0	1	1842
Not fit	0.079	0.269	0	1	1842
Does not participate in clubs	0.358	0.479	0	1	1842
Repeated	0.173	0.378	0	1	1842
Grade 7	0.052	0.222	0	1	1808
Grade 8	0.051	0.221	0	1	1808
Grade 9	0.119	0.324	0	1	1808
Grade 10	0.288	0.453	0	1	1808
Grade 11	0.26	0.439	0	1	1808
Grade 12	0.23	0.421	0	1	1808

Table: Individual Characteristics

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Table: Individual Characteristics - Wave 4

Variable	Mean	Std. Dev.	Min.	Max.	
Age W4	28.75	1.424	25	33	
Personal Earnings	39097.007	21734.302	2400	140000	
Hourly Wage	19.944	12.064	4.081	208.333	
Married	0.45	0.498	0	1	
Bachelor	0.205	0.404	0	1	
More than Bachelor	0.083	0.275	0	1	
Not Moved State	0.777	0.416	0	1	
US citizen	0.961	0.193	0	1	
Good health	0.901	0.299	0	1	
Always vote	0.254	0.435	0	1	
Many close friends	0.344	0.475	0	1	
Friends same ethnicity	0.442	0.497	0	1	
Ν	1842				

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Variable	Mean	Std. Dev.	Min.	Max.	Ν
Living with both parents	0.591	0.492	0	1	1842
Siblings	2.986	2.122	0	15	1841
Only child	0.034	0.18	0	1	1842
Twin	0.021	0.144	0	1	1842
Does not speak English at home	0.16	0.367	0	1	1842
Mother Degree	0.146	0.353	0	1	1842
Father Degree	0.149	0.356	0	1	1842
Low Income	0.041	0.198	0	1	1842
Middle Income	0.459	0.498	0	1	1842
High Income	0.5	0.5	0	1	1842

Table: Family Characteristics

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Variable	Mean	Std. Dev.	Min.	Max.
Urban	0.042	0.2	0	1
Suburban	0.528	0.499	0	1
Rural	0.43	0.495	0	1
Safe at School	0.621	0.485	0	1
Public	0.958	0.2	0	1
Private	0.042	0.2	0	1
Small School	0.201	0.401	0	1
Large School	0.799	0.401	0	1
Ability Grouping	0.863	0.344	0	1
Class size	30.169	7.841	13	38
\setminus % White	0.502	0.469	0	1
∖ % Black	0.046	0.159	0	1
\% Asian	0.048	0.112	0	0.312
N	1842			

Table: Schools Characteristics

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Schools

Small (less 400)	8
Public	8
Urban	2
Ability Grouping	4
Class Size	23
% White	0.77
% Black	0.15
% Other	0.07
Ν	10

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