

# An aspiring friend is a friend indeed:

On the mechanisms behind peer influences on human capital accumulation

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# Motivation

- Large body of literature on peer effects on achievement and performance.
  - Mixed results, context dependent ([Sacerdote, 2011](#)).
- More recently literature on human capital investment decisions – larger peer influences than test scores.
  - Post-secondary education (College) ([Altmejd et al., 2021](#); [Cools et al., 2021](#); [Abramitzky et al., 2018](#); [Barrios-Fernández, 2022](#)).
  - Secondary education (High School) ([Ballis, 2020](#); [Bobonis and Finan, 2009](#); [Pagani and Pica, 2021](#); [Joensen and Nielsen, 2018](#); [Dustan, 2018](#)).
- However, little is known about the mechanisms through which peers influence human capital accumulation decisions.
  - Understanding these mechanisms is essential to exploit such spillovers in policymakers.

# This paper

- Peer effects on students' high school completion Educational Attainment
  - How does high school completion of a students' friends impact her own likelihood of also completing high school?
- Mechanisms behind such an impact
  - Role of aspirations
- Social networks data collected from middle school students in Brazil
- Acknowledge problems emerging from the estimation of peer effects

# Data

- 2011: students in the 9<sup>th</sup> grade – last grade of middle school.
- Comprehensive questionnaire about personal profile, study habits, and expectations.
- Information on students' friendship ties in the grade:
  - Nomination of four best friends/colleagues.
  - Link answers to get network information - mapped network for (almost) all students of 9<sup>th</sup> in each school - usually more than one class.
- Merge survey with administrative data.
  - Information on students' performance.
  - Track students before and after 2011.
  - SES information.

# Identification of peer effects

$$y_{li} = \beta \frac{\sum_{j \in F_i} y_{lj}}{n_i} + \gamma x_{li} + \eta \frac{\sum_{j \in F_i} x_{lj}}{n_i} + \varepsilon_{li}$$

Let  $G$  be the adjacency matrix, where element  $g_{i,j} = 1$  if individual  $i$  sends a friendship tie to individual  $j$ , and  $g_{i,j} = 0$  otherwise.

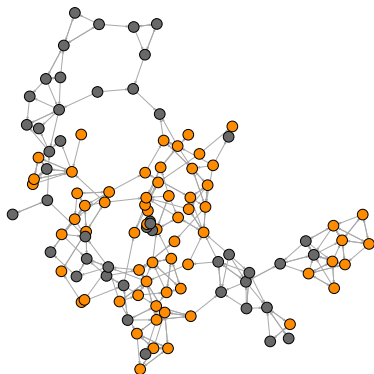
$$\mathbf{y}_l = \beta \mathbf{G} \mathbf{y}_l + \gamma \mathbf{X}_l + \eta \mathbf{G} \mathbf{X}_l + \varepsilon_l$$

- $G$  - maps friends
- $G^2$  - maps friends of friends
- $G^3$  - maps friends of friends of friends

# Challenges to measure causal peer effects

$$y_i = \beta \mathbf{G}_i + \gamma \mathbf{X}_i + \eta \mathbf{G}\mathbf{X}_i + \varepsilon_i$$

- Common shocks/environment
- Endogenous formation of peer group / friendship
- Reflection problem ([Manski, 1993](#))



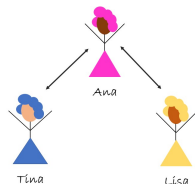
Boys (grey) and Girls (orange)



# Addressing identification challenges

$$y_i = \beta \mathbf{G}_i + \gamma \mathbf{X}_i + \eta \mathbf{G}\mathbf{X}_i + \varepsilon_i$$

- Common shocks/environment
  - Control for classroom FE
- Endogenous formation of peer group / friendship
  - Model friendship formation based on similarities in exogenous characteristics and random chances to interact (König et al., 2018) Results
- Reflection problem (Manski, 1993)
  - $\hat{\mathbf{G}}^2\mathbf{X}$ ,  $\hat{\mathbf{G}}^3\mathbf{X}$  (predicted friends of friends' characteristics) as instruments to  $\mathbf{G}\mathbf{y}$  (Bramoullé et al., 2009; De Giorgi et al., 2010)



# Peer effects on High School completion

	Dependent variable: HS completion			
	(1)	Girl (2)	Black (3)	Mother w/ less than HS (4)
Friends' HS completion	0.183*** (0.053)			
Friends' HS completion x Variable in column				
N	6075			
Mean Dep. Var.	0.637			
Instruments: $\hat{G}^2X$ , $\hat{G}^3X$				
IVs' joint significance	80.642			
Control for classroom FE	Yes			

# Peer effects on High School completion

Dependent variable: HS completion				
	(1)	Girl (2)	Black (3)	Mother w/ less than HS (4)
Friends' HS completion	0.183*** (0.053)	0.196*** (0.051)	0.162*** (0.053)	0.097 (0.063)
Friends' HS completion x Variable in column		-0.026 (0.047)	0.067** (0.033)	0.108** (0.049)
N	6075	6075	6075	6075
Mean Dep. Var.	0.637	0.637	0.637	0.637
Instruments: $\hat{G}^2X$ , $\hat{G}^3X$				
IVs' joint significance	80.642	41.187	40.690	40.703
Control for classroom FE	Yes	Yes	Yes	Yes

# Mechanisms

# Peer effects on other characteristics

	College aspiration (1)	Perceived coll. returns (2)	Fear of nerd stigma (3)	Peer pressure to work (4)	30+ min study/day (5)	Reading proficiency (6)	Math proficiency (7)
Peer effects							
N							
Mean Dep. Var.							
Instruments: $\hat{G}^2X$ , $\hat{G}^3X$							
IVs' joint significance							
Control for classroom FE							

# Peer effects on other characteristics

	College aspiration (1)	Perceived coll. returns (2)	Fear of nerd stigma (3)	Peer pressure to work (4)	30+ min study/day (5)	Reading proficiency (6)	Math proficiency (7)
Peer effects	0.178*** (0.051)	-0.046 (0.034)	0.093 (0.089)	0.214*** (0.072)	0.192** (0.076)	-0.135 (0.243)	0.731** (0.314)
N	6075	6075	6075	6075	6075	5833	5833
Mean Dep. Var.	0.684	0.612	0.256	0.298	0.396	-0.000	0.000
Instruments: $\hat{G}^2X$ , $\hat{G}^3X$							
IVs' joint significance	50.718	116.309	14.527	22.223	17.964	2.435	1.673
Control for classroom FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

# Peers' effects on HS completion – additional controls

	Dependent variable: HS completion								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Friends' HS completion	0.183*** (0.053)								
Control for perceived coll. returns									
Control for fear of nerdy stigma									
Control for peer pressure to work									
Control for 30+ min study/day									
Control for performance in 9th grade									
Control for Coll. Aspirations									
N	6075								
Mean Dep. Var.	0.637								
Instruments: $\hat{G}^2X$ , $\hat{G}^3X$									
IVs' joint significance	39.954								
Control for classroom FE	Yes								

# Peers' effects on HS completion – additional controls

	Dependent variable: HS completion						(7)	(8)	(9)
	(1)	(2)	(3)	(4)	(5)	(6)			
Friends' HS completion	0.183*** (0.053)	0.168*** (0.059)	0.179*** (0.050)	0.192*** (0.049)	0.154*** (0.054)	0.165*** (0.048)			
Control for perceived coll. returns		✓							
Control for fear of nerdy stigma			✓						
Control for peer pressure to work				✓					
Control for 30+ min study/day					✓				
Control for performance in 9th grade						✓			
Control for Coll. Aspirations									
N	6075	6075	6075	6075	6075	5833			
Mean Dep. Var.	0.637	0.637	0.637	0.637	0.637	0.650			
Instruments: $\hat{G}^2X$ , $\hat{G}^3X$									
IVs' joint significance	39.954	22.895	35.496	38.822	31.528	37.860			
Control for classroom FE	Yes	Yes	Yes	Yes	Yes	Yes			



# Peers' effects on HS completion – additional controls

	Dependent variable: HS completion								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Friends' HS completion	0.183*** (0.053)	0.168*** (0.059)	0.179*** (0.050)	0.192*** (0.049)	0.154*** (0.054)	0.165*** (0.048)	0.063 (0.064)		
Control for perceived coll. returns		✓							
Control for fear of nerdy stigma			✓						
Control for peer pressure to work				✓					
Control for 30+ min study/day					✓				
Control for performance in 9th grade						✓			
Control for Coll. Aspirations							✓		
N	6075	6075	6075	6075	6075	5833	6075		
Mean Dep. Var.	0.637	0.637	0.637	0.637	0.637	0.650	0.637		
Instruments: $\hat{G}^2X$ , $\hat{G}^3X$									
IVs' joint significance	39.954	22.895	35.496	38.822	31.528	37.860	22.031		
Control for classroom FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes		

# Peers' effects on HS conclusion – additional controls

	Dependent variable: HS completion								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Friends' HS completion	0.183*** (0.053)	0.168*** (0.059)	0.179*** (0.050)	0.192*** (0.049)	0.154*** (0.054)	0.165*** (0.048)	0.063 (0.064)	0.129** (0.060)	0.044 (0.069)
Control for perceived coll. returns		✓						✓	✓
Control for fear of nerdy stigma			✓					✓	✓
Control for peer pressure to work				✓				✓	✓
Control for 30+ min study/day					✓			✓	✓
Control for performance in 9th grade						✓		✓	✓
Control for Coll. Aspirations							✓		✓
N	6075	6075	6075	6075	6075	5833	6075	5833	5833
Mean Dep. Var.	0.637	0.637	0.637	0.637	0.637	0.650	0.637	0.650	0.650
Instruments: $\hat{G}^2X$ , $\hat{G}^3X$									
IVs' joint significance	39.954	22.895	35.496	38.822	31.528	37.860	22.031	15.218	10.849
Control for classroom FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

# Friends' aspiration and HS completion

# Friends' aspirations and HS completion

	Dependent variable: HS completion			
	(1)	Girl (2)	Black (3)	Mother w/ less than SS (4)
Friends' college aspiration	0.174***			
	(0.049)			
Friends' college aspiration x Var. in column				
N	6075			
Mean Dep. Var.	0.637			
R2	0.083			
Instruments: $\hat{G}^2X$ , $\hat{G}^3X$				
IVs' joint significance	50.718			
Control for school FE	Yes			
Control for classroom FE	Yes			

Note: \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.001$

# Friends' aspirations and HS completion

	Dependent variable: HS completion			
	(1)	Girl (2)	Black (3)	Mother w/ less than SS (4)
Friends' college aspiration	0.174*** (0.049)	0.179*** (0.048)	0.158*** (0.049)	0.096 (0.059)
Friends' college aspiration x Var. in column		-0.056 (0.044)	0.065** (0.030)	0.100** (0.046)
N	6075	6075	6075	6075
Mean Dep. Var.	0.637	0.637	0.637	0.637
R2	0.083	0.085	0.084	0.083
Instruments: $\hat{G}^2X$ , $\hat{G}^3X$				
IVs' joint significance	50.718	29.367	28.683	28.545
Control for school FE	Yes	Yes	Yes	Yes
Control for classroom FE	Yes	Yes	Yes	Yes

Note: \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.001$

# Conclusion

# Conclusions & Policy Implications

- Theoretical literature on the importance of aspirations and on how aspirations are socially determined ([Appadurai, 2004](#); [Ray, 2006](#); [Genicot and Ray, 2017](#); [Dalton et al., 2016](#)).
- In this work, I empirically show that students aspirations spread through their network and serve as a mechanism for peers' impact on students' future human capital accumulation.
- Several educational interventions increase students' aspirations ([Carlana et al., 2018](#); [Ross, 2017](#); [Chiapa et al., 2012](#))
  - This work shows that such an effect spills over to other students and concretely impacts their future outcomes.

# Thank you

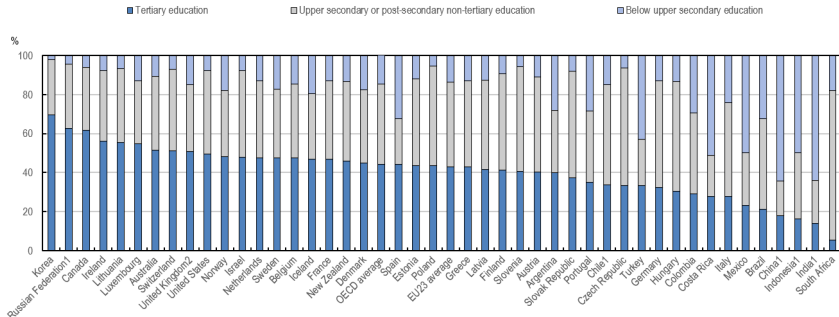
Comments are welcome at [jessica.gagemiranda@unimib.it](mailto:jessica.gagemiranda@unimib.it)



# Appendix

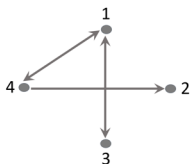
# Educational attainment of 25-34 year-olds (2018)

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Source: OECD. (2019)

	All		HS completion=1		HS completion=0	
	Mean	Std. Error	Mean	Std. Error	Mean	Std. Error
<b>Own characteristics</b>						
HS completion	0.64	0.48	1.00	0.00	0.00	0.00
College aspiration	0.68	0.46	0.75	0.43	0.57	0.50
Girl	0.49	0.50	0.56	0.50	0.38	0.49
White	0.33	0.47	0.35	0.48	0.30	0.46
Mother education: more than HS	0.24	0.43	0.28	0.45	0.17	0.38
Father education: more than HS	0.22	0.41	0.25	0.43	0.17	0.38
Father works	0.73	0.44	0.76	0.43	0.69	0.46
Reading proficiency (2009)	-0.00	1.00	0.18	1.02	-0.32	0.88
Math proficiency (2009)	-0.00	1.00	0.15	1.02	-0.26	0.90
Named friends	2.02	1.41	2.21	1.37	1.69	1.40
<b>Friends' characteristics</b>						
HS completion	0.55	0.42	0.63	0.40	0.42	0.42
College aspiration	0.59	0.42	0.65	0.40	0.48	0.43
Girl	0.43	0.45	0.48	0.45	0.33	0.43
White	0.27	0.34	0.30	0.34	0.22	0.32
Mother education: more than HS	0.21	0.30	0.22	0.30	0.18	0.30
Father education: more than HS	0.19	0.29	0.21	0.30	0.15	0.28
Father works	0.59	0.41	0.63	0.39	0.53	0.43
Math proficiency (2009)	0.08	0.66	0.12	0.67	0.00	0.64
Reading proficiency (2009)	0.10	0.67	0.16	0.67	-0.01	0.64
Named friends	1.93	1.35	2.10	1.29	1.63	1.38
Observations	6075		3871		2204	



$$G = \begin{pmatrix} 0 & 0 & 1 & 1 \\ 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{pmatrix}$$

$$G^2 = \begin{pmatrix} 2 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 1 \\ 0 & 0 & 1 & 1 \end{pmatrix}$$

## Adjacency Matrix

- $G$  - friends
- $G^2$  - friends of friends
- $G^3$  - friends of friends of friends

$$\mathbf{y}_i = \beta \mathbf{G} \mathbf{y}_i + \gamma \mathbf{X}_i + \eta \mathbf{G} \mathbf{X}_i + \varepsilon_i$$

- Friendship connection  $D_{ij}$  between two agents  $i$  and  $j$ , depends on the distance between these two agents regarding several exogenous agent-level attributes  $Z_i = \{z_{1i}, \dots, z_{Ki}\}$ .
- $W_{ij} = \sum_{k=1}^K (\mathbf{1}(z_{ki} = z_{kj}))$  - closeness index between  $i$  and  $j$

$$D_{ij} = \mathbf{1}(W'_{ij}\varphi + \theta_i + \theta_j + U_{ij} \geq 0)$$

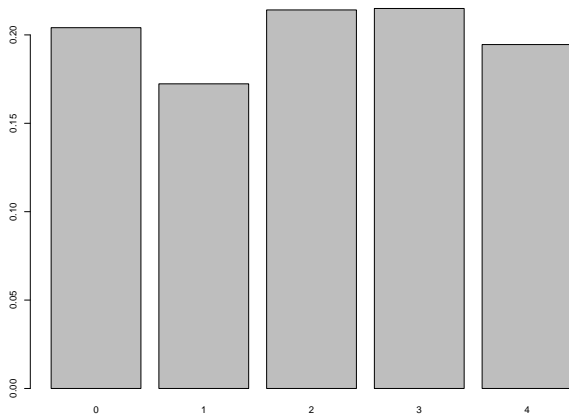
- Assume that  $U_{ij}$  is a standard logistic random variable (i.i.d. across dyads).
- Possible to model the likelihood of observing network  $\mathbf{D} = \mathbf{d}$  using a conditional logistic regression function :

$$Pr(D_{ij=d} | \mathbf{Z}, \theta_i, \mathbf{X}_j) = \frac{\exp(W'_{ij}\varphi + \theta_i + \mathbf{X}_j\phi)}{1 + \exp(W'_{ij}\varphi + \theta_i + \mathbf{X}_j\phi)}$$

# Students' allocation into classrooms in 6th grade

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	(1)	(2)
Dependent variable: same classroom in 6th grade		
$\mathbf{1[x_i = x_j]}$		
First-name initial	0.881*** (0.264)	0.803*** (0.259)
Gender	0.156 (0.189)	0.165 (0.184)
Race	-0.192 (0.159)	-0.045 (0.126)
Father finished HS	0.176 (0.258)	0.281 (0.232)
Father has college degree	-0.043 (0.587)	0.630 (0.498)
Mother finished HS	0.076 (0.297)	-0.059 (0.264)
Mother has college degree	-0.623 (0.517)	-0.594 (0.429)
N	640,826	640,826
Control for school FE	No	Yes



Note: proportion of isolated students at the same order of the one in Add-Health data (Niño et al., 2016)

- Conditional logistic regression function – dependent variable: binary variable equal 1 if  $i$  sends a friendship tie to  $j$

	Raw	OR
<b><math>1[x_i = x_j]</math></b>		
Gender	1.493*** (0.049)	4.452*** (0.219)
Race-white	0.132*** (0.024)	1.141*** (0.027)
Race-black	0.158*** (0.045)	1.171*** (0.053)
First-name initial	0.360*** (0.051)	1.433*** (0.073)
<b><math>x_j</math> characteristics</b>		
Girl	0.164*** (0.035)	1.179*** (0.041)
Race-White	0.057** (0.024)	1.059** (0.025)
Race-Black	0.100** (0.041)	1.105** (0.045)
N (potential links)	524,724	524,724



	(1)	(2)	(3)	(4)
	Dependent Variable: HS completion			
Friends' aspirationsHS conclusion	0.123** (0.062)	0.142** (0.058)	0.147** (0.058)	0.147*** (0.055)
Instrument	$\hat{G}^2 X$	$\hat{G}^2 X$	$\hat{G}'^2 X$	$\hat{G}''^2 X$
N	4893	6075	6075	6075
IVs' joint significance	70.279	81.573	80.732	82.385
Maximum out-degree $\leq 3$	Yes	No	No	No
Control for homophily	No	Yes	No	No

## Peer effects on SES

	(1)	(2)	(3)	(4)
	Mother education: more than HS	Father education: more than HS	Own house	HS conclusion
Peer Effects	-0.109 (0.111)	-0.004 (0.120)	0.018 (0.069)	0.126** (0.059)
Model	$\hat{G}^2 X$	$\hat{G}^2 X$	$\hat{G}^2 X$	$\hat{G}^2 X$
N	6075	6075	6075	6075
R2	0.012	0.010	0.003	0.075
IVs' joint significance	16.652	15.293	31.304	53.195

# Comparing OLS, 2SLS, and 3SLS Back

	(1)	(2)	(3)	(4)
Dependent variable: HS completion				
Friends' HS completion	0.117*** (0.023)	0.289*** (0.079)	0.141*** (0.053)	0.126** (0.057)
Model	OLS	IV : $\hat{G}^2 X$	IV: $\hat{G}^2 X$	IV: $\hat{G}^2 X$
N	6075	6075	6075	6075
Mean Dep. Var.	0.637	0.637	0.637	0.637
R2	0.207	0.068	0.081	0.071
IVs' joint significance		36.693	46.967	47.975
Control for school FE	Yes	Yes	Yes	Yes
Control for classroom FE	No	No	No	Yes

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