Peer Effects, Parental Migration and Children's Human Capital: A Spatial Equilibrium Analysis in China

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Overview

1. Introduction

Introduction: Motivation

- Parents care about children's education and peer group
- International and domestic migration increase drastically
  Local parents worry about migrants' negative peer effects
- China sets a good stage for the study of this issue

Introduction: Motivation

- Massive migration in China
  Under developed cities $\rightarrow$ Developed cities
- Hukou system
  Public school enrollment restriction on migrant children
- Left-behind children problem
  Parents migrate and leave children behind
- Relaxing the restriction?
  Local parents' concerns $\rightarrow$ Can migrant children harm local children?

Introduction: Main Research Question

Main Research Questions:

- 1. What are the peer effects of migrant and left-behind children?
- 2. What is the human capital consequence due to the segregation in the education system?

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Strategy

- Use a unique classroom random assignment in almost all Chinese middle schools to identify the peer effects of migrant and left-behind children
- Construct a spatial equilibrium model
  - Chinese Economy with rural-urban migration
  - Chinese Hukou system and rural-urban housing price
  - Chinese housing policy in recent years

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  - Choices: Parents migration + children education
  - School type (Public) + peer effect $\rightarrow$ human capital
  - Enrollment policy relaxation analysis

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Introduction: Preview of the Main Results

Peer effects:

- Negative peer effects from migrant and left-behind students
- Left-behinds (more negative) > Migrant
- But fade away across time

By relaxing the enrollment restriction:

- Migration of parents and students ↑
- National average human capital ↑ (0.015 s.d.)
- Children from low skill families in small cities benefit most

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Literature Review: Peer Effects

- Methodology (External validity vs. Internal validity)
  - Randomized Controlled Trial
    Duflo, Dupas, and Kremer (2011); Whitmore (2005); Graham (2008)
  - Variation across cohorts or classes in the same school
    Hoxby (2000); Ammermueller and Pischke (2009)

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- Migration and peer effects
  - International immigration
    Card (2013); Cascio and Lewis (2012); Jensen and Rasmussen (2011); Tonello (2016); Geay, McNally, and Telhaj (2013)
  - Domestic
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3. Background

Background

- Public school dominates
- Hukou: national-wide household registration system
- Registration place: where you are originally from
- Migrants: Limited access to public resources
- Hukou system and education segregation Enrollment Probability
  Children without local Hukou may not be permitted to get into public schools

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Background

Children of migrant workers

- Stay in hometown: Left-behind children
  Public school, but no parents
- Migrate with parents: Migrant children
  Sometimes no access to public schools
  → Go to private migrant schools (low quality)

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4. Empirical Strategy

Empirical Strategy: A Quasi-Experiment

For student i from class j in school s

- Traditional linear-in-mean peer effect regression

$$y_{ijs} = \varphi_0 + \theta_1 Propmig_{-ijs} + \theta_2 Propleft_{-ijs} + \varphi X_{ijs} + \mu_s + \epsilon_{ijs} \quad (1)$$

  y_{ijs}: test score;
  $Propmig_{-ijs}/Propleft_{-ijs}$: proportions of migrant/left-behind classmates;
  X_{ijs} is a set of controls;
  μ_s is the school fixed effect.

- Usually θ_1 and θ_2 are not identified due to the selection
  Students with advantaged family backgrounds sort into "good" classes with fewer migrant/left-behind students.

Empirical Strategy: A Quasi-Experiment

- According to the Compulsory Education Law of the PRC, in elementary and junior schools, assignment of students into classes based on ability or family background is prohibited. (Most schools use randomization)
- For these schools, the proportions will be random after controlling for school-grade FE

Data and Summary Statistics

- China Education Panel Survey (CEPS)
- Panel with two waves, 2013 and 2014
  In 2013: Grade 7 (Class of 2016)
  In 2014: Grade 8 (Class of 2016)
- Nationally representative
- Students, schools, teachers and parents information
- Random: Random assign new students + No reassignment in the second year
- Keep only school-grade with random assignment of students (70%) Comparison
- After data cleaning, I have 11,519 observations. (student-wave)

Data and Summary Statistics

- 21.6% are migrant students; 15.6% are left-behind students.
- Dependent variable: the score of a standardized cognitive test
  Implemented by the survey. The s.d. is 0.886; the mean is 0.156
- Definition of migrant student
  Student with a Hukou registration in another county
- Definition of left-behind student
  Student with either father or mother not living with them (excluding parents' divorce or death) More Summary Statistics

Balance Check

Table: Balance Check

	Proportion of Migrants		Proportion of Left-behinds	
	Without School FE	With School FE	Without School FE	With School FE
Age	-0.0147	0.00142	0.0520***	0.00278
Sex	0.0128**	0.00187	0.00874	0.000298
Board at School	-0.0574	-0.0109	0.126***	0.00106
Hukou Type (=1 if rural)	-0.0288*	-0.000781	0.0851***	0.00630
Only Child in Family	-0.00381	0.00185	0.121***	0.00456
Father Education Years	0.00263	-0.000551	-0.0149***	-0.00105
Mother Education Years	0.00300	-0.000307	-0.0162***	-0.000861
Whether Parents Have Conflicts	0.00336	-0.000383	0.0261**	-0.000126

5. Main Results of Peer Effects

Main Results of Peer Effects

Table: Peer Effects of Migrant Children and Left-behind Children on Standard Cognitive Scores

Dependent Variable: Student's Test Score	(1)	(2)	(3)
Proportion of Migrant Peers	-0.605*	-0.567*	-0.545*
	(0.319)	(0.297)	(0.286)
Proportion of Left-Behind Peers	-1.198**	-1.124**	-1.061**
	(0.514)	(0.448)	(0.432)
School FE	YES	YES	YES
Year Dummy	YES	YES	YES
Personal Controls	NO	YES	YES
Household Controls	NO	NO	YES
Observations	11,519	11,519	11,519
R-squared	0.292	0.310	0.314

Main Results of Peer Effects: Duration

Table: Peer Effects of Migrant Children and Left-behind Children by Duration

Dependent Variable: Student's Test Score	(1) First Year	(2) Second Year	(3) Second - First
Proportion of Migrant Peers	-0.976**	-0.026	0.950***
	(0.371)	(0.328)	(0.327)
Proportion of Left-Behind Peers	-2.062**	-1.050***	1.012**
	(0.792)	(0.311)	(0.467)
School-Grade FE	YES	YES	YES
Personal Controls	YES	YES	YES
Household Controls	YES	YES	YES
Observations	4,072	4,072	4,072
R-squared	0.359	0.335	

Main Results of Peer Effects

- First year: Both migrant and left-behind students have negative peer effects
- Second year:
  Negative effects from migrants are totally erased;
  Negative effects from left-behinds are halved (but still exist).
- Negative peer effects: Left-behinds > Migrant

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Main Results of Mechanism Analysis

- Why left-behind still negative?
  Absence of parents causes some long-lasting damage and leads to more misbehavior and negative spillover ▸ Misbehavior
- Why migrant reduces to zero?
  Better integration of migrants to the class eliminate negative spillovers ▸ Class environment
- Is family background a channel for the negative spillover?
  It is. But only explain small part of it. ▸ Family background

Robustness Check

- External validity of the estimation ▸ External Validity
- Other measures of students' performances ▸ Other Performance Measures
- Only consider rural migrant and rural left-behind students in the definition ▸ Rural Mig/LB
- Only on ordinary locals students (Recommended by Angrist (2014)) ▸ Local Students
- Only on students in public schools ▸ Public Schools
- Redefine left-behind children as children with both parents absent ▸ Redefine Left-behind Children
- Keep Hukou status constant across years ▸ Constant proportions
- Classes without dropouts ▸ No dropouts
- Parents' investment as compensation ▸ Parents' investment

6. Model

Model: Motivation

- Main Question:
  Relaxing the enrollment restriction?
- Human capital ↑? ↓? (Unclear)
  - Increase human capital?
  - Workers may not fully exit as soon as they retire, remain in

Model: Motivation

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  - Increase human capital?
    Increase Price of Non-migrants ⇒ Non-migrants ↑
    Increase Price of Migrants ⇒ Migrants ↑ ⇒ Spillover ↑
  - Decrease human capital?
    Former staying families may migrate with their children ⇒ spillover ↑

Model: Motivation

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Model: Basic Settings

- A static spatial equilibrium model
  - Rosen (1979), Roback (1982), Moretti (2011), Diamond (2016), Tarquinio and Kuminoff (2019)
- Two sectors
  - Farmers (Rural) and Non-farmers (Urban)
- Firms in a competitive market
  - Firms are free to choose their production locations
- Workers with two endowments
  - Time (Leisure and Commuting)
  - Land (Housing and Food)
- Workers make two decisions
  - Workers choose where to live and how much to commute

Model: Basic Settings

- A static spatial equilibrium model
  - Ahlfeldt et al. (2015) and Eaton and Kortum (2002)
- Two sectors
  - Workers (labor supply) and firms (labor demand)
- Firms in a competitive market
  - Endowed with a CES production function with high/low skill labors as inputs.
- Workers with two endowments
  - hukou/home city i, skill s (high/low)
  - each worker has a child
- Workers make two decisions
  - where to work j, whether to take children with him/her

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  - Workers (labor supply) and firms (labor demand)
- Firms in a competitive market
  - Endowed with a CES production function with high/low skill labors as inputs.
- Workers with two endowments
  - hukou/home city i, skill s (high/low)
  - each worker has a child
- Workers make two decisions
  - where to work j, whether to take children with him/her

Model: Basic Settings

- A static spatial equilibrium model
  - Ahlfeldt et al. (2015) and Eaton and Kortum (2002)
- Two sectors
  - Workers (labor supply) and firms (labor demand)
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Model: Basic Settings

- Workers value wages and children's human capital
  - Utility function is Cobb-Douglas
  - Consumption, Peer effects and Child human capital
  - Utility function is time separable
  - Utility shock with Gumbel distribution
- Consider two peer effects
  Proportion of migrant/left-behind children
  (Check other nonlinear settings, robust)
- Peer effects parameters are derived from the regression part
- Other parameters are estimated within the model
- Big cities: Top 5% Cities in terms of migrant students

Model: Basic Settings

- Workers value wages and children's human capital
  - Human capital is determined by:
    School type, Peer effects and Left-behind cost
  - Different cities have different:
    Public school enrollment rates p, Peer compositions
- Consider two peer effects
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Model: Workers' Labor Supply

Utility of worker o with Hukou/home city i and skill s, to work in city j:

$$U_{ijo} = \frac{z_{ijo}}{\tau_{ij}^{s}} w_{ij}^{s} (k_{ij}^{s})^{\beta} \tag{2}$$

$$F(z_{ijo}) = e^{-z_{ijo}^{-\epsilon}} \tag{3}$$

w: Wage, k: Children's human capital

τ: Migration cost, β: Weights on children's human capital

z: Unobserved taste heterogeneity across cities

Model: Workers' Labor Supply

$$U_{ijo} = \frac{z_{ijo}}{\tau_{ij}^{s}} w_{ij}^{s} (k_{ij}^{s})^{\beta}$$

- If $i = j$, workers stay at home for work, $\tau_{ij}^{s} = 1$
- If $i \neq j$, workers migrate out for work, $\tau_{ij}^{s} = \bar{\tau}_{i}^{s} \bar{d}_{ij}$
  $\bar{\tau}_{i}^{s}$: skill-home city fixed cost; $\bar{d}_{ij}$: the home-destination specific cost.
- z: Fréchet distribution, ϵ: dispersion (Gravity Equation)

Model: Children's Human Capital k_{ij}^s

- Deterministic value of each choice (child migration) + unobserved shocks
  Peer effect, school type, left-behind cost
- Timeline: Worker's migration decision ⇒ Shock on children human capital revealed ⇒ Children's migration decision ⇒ Take lottery of public/private schools
- Four types of students
  - Stayer/left-behind students
  - Migrant students (Public school)
  - Migrant students (Private school)
  - Migrant students (Public/Private school)
- Probability to be enrolled in public schools for migrant students: p_j^s
  p=1 for Stayer/left-behind students
- Private and Public schools are different:
  Qualities and peer compositions

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Model: Children's Human Capital k_{ij}^{s}

$$
\begin{aligned}
k_{ijo}^{*s} =& \zeta_0 + \mathbf{\Theta}[Peer_{i,Pub_o} \cdot lb_o + Peer_{j,Pub_o} \cdot (1 - lb_o)] + \phi^s Pub_o + \nu^s lb_o + \\
& \chi^s (1 - lb_o)\mathbf{1}(Province_i \neq Province_j) + \eta^s (1 - lb_o) dist_{ij} + \\
& \kappa_{r_i}^s lb_o + \kappa_{r_j}^s (1 - lb_o) + \zeta_1 \mathbf{1}(s = h) + \zeta_2 \mathbf{1}(i) + e_o
\end{aligned}
$$

- $Peer_{i,pub}$: peer composition in public school in city i
- ϕ^s: public school premium
- ν^s: Left-behind cost
- $\kappa_{r_i}^s$: region fixed effect
- e_o: T1EV Mean zero shock

Model: Children's Human Capital k_{ij}^{s} for Stayers

If $i = j$:

$$k_{ijo}^{*s} = \zeta_0 + \mathbf{\Theta}[\boxed{Peer_{i,Pub_o}} \cdot lb_o + Peer_{j,Pub_o} \cdot (1 - lb_o)] + \boxed{\phi^s} Pub_o + \nu^s lb_o +$$
$$\chi^s \mathbf{1}(Province_i \neq Province_j)(1 - lb_o) + \eta^s dist_{ij}(1 - lb_o) +$$
$$\boxed{\kappa_{r_i}^s} lb_o + \kappa_{r_j}^s (1 - lb_o) + \boxed{\zeta_1 \mathbf{1}(s = h)} + \boxed{\zeta_2 \mathbf{1}(i)} + \boxed{e_o}$$

- $Peer_{i,pub}$: peer composition in public school in city i
- ϕ^s: public school premium
- ν^s: Left-behind cost
- $\kappa_{r_i}^s$: region fixed effect
- e_o: T1EV Mean zero shock

Model: Children's Human Capital k_{ij}^{s} for Left-behind Children

If $i \neq j$, children are left behind:

$$k_{ijo}^{*s} = \zeta_0 + \mathbf{\Theta}[\boxed{Peer_{i,Pub_o}} \cdot lb_o + Peer_{j,Pub_o} \cdot (1 - lb_o)] + \boxed{\phi^s} Pub_o + \boxed{\nu^s lb_o} + \chi^s \mathbf{1}(Province_i \neq Province_j)(1 - lb_o) + \eta^s dist_{ij}(1 - lb_o) + \boxed{\kappa_{r_i}^s} lb_o + \kappa_{r_j}^s (1 - lb_o) + \boxed{\zeta_1 \mathbf{1}(s = h)} + \boxed{\zeta_2 \mathbf{1}(i)} + \boxed{e_o}$$

- $Peer_{i,pub}$: peer composition in public school in city i
- ϕ^s: public school premium
- ν^s: Left-behind cost
- $\kappa_{r_j}^s$: region fixed effect
- e_o: T1EV Mean zero shock

Model: Children's Human Capital k^s_{ij} for Migrant Children in Public

If $i \neq j$, children migrate with parents, then with probability p^s_j enrolling in Public:

$$k^{*s}_{ijo} = \zeta_0 + \mathbf{\Theta}[Peer_{i,Pub_o} \cdot lb_o + Peer_{j,Pub_o} \cdot (1 - lb_o)] + \phi^s Pub_o + \nu^s lb_o +$$
$$\chi^s \mathbf{1}(Province_i \neq Province_j)(1 - lb_o) + \eta^s dist_{ij}(1 - lb_o) +$$
$$\kappa^s_{r_i} lb_o + \kappa^s_{r_j}(1 - lb_o) + \zeta_1 \mathbf{1}(s = h) + \zeta_2 \mathbf{1}(i) + e_o$$

- $Peer_{j,pub}$: peer composition in public school in city j
- ϕ^s: public school premium
- ν^s: Left-behind cost
- $\kappa^s_{r_j}$: region fixed effect
- e_o: T1EV Mean zero shock

Model: Children's Human Capital k_{ij}^{s} for Migrant Children in Private

If $i \neq j$, children migrate with parents, then with probability $1 - p_j^s$ enrolling in Private:

$$
\begin{aligned}
k_{ijo}^{*s} = & \zeta_0 + \mathbf{\Theta}[Peer_{i,Pub_o} \cdot lb_o + Peer_{j,Pub_o} \cdot (1 - lb_o)] + \phi^s Pub_o + \nu^s lb_o + \\
& \chi^s \mathbf{1}(Province_i \neq Province_j)(1 - lb_o) + \eta^s dist_{ij}(1 - lb_o) + \\
& \kappa_{r_i}^s lb_o + \kappa_{r_j}^s (1 - lb_o) + \zeta_1 \mathbf{1}(s = h) + \zeta_2 \mathbf{1}(i) + e_o
\end{aligned}
$$

- $Peer_{j,pub}$: peer composition in private school in city j
- ϕ^s: public school premium
- ν^s: Left-behind cost
- $\kappa_{r_j}^s$: region fixed effect
- e_o: T1EV Mean zero shock

Model: Other Parts

- Closed-form children's migration probability and choice value ▸ Children migration
- Closed-form workers' commuting probability ▸ Gravity equation
- Competitive firms ▸ Labor demand
- Spatial Equilibrium ▸ Equilibrium definition

Model: Data

- Main: Population Census 2010
  City-skill level migration flows, household and children migration choices
- City Statistical Yearbooks, Mini Census 2005
  City-skill level average wages in 2010
- Public school enrollment probability: China Migrants Dynamic Survey (CMDS)
  Average enrollment probability: 75% for low skill; 77% for high skill (Province level)

Model: Estimation

- Step 1: Estimating Peer Effects using the Quasi-experiment
  Peer composition is endogenous $\Rightarrow$ Use estimates from the random experiment.
- Step 2: Estimating Parameters in Children's Human Capital
  Basic idea: MLE for a Logit model

$$Prob(mig) = \frac{exp(V^s(Mig))}{exp(V^s(Mig)) + exp(V^s(Left))}$$

Variations used: Migrant workers' different choices of whether to take their children to migrate or leave them behind.

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Model: Estimation

- Step 3: Estimating Parameters in the Utility Function
  Basic idea: Poisson regression of the Gravity Equation
  Variations used: Workers migration choices
- Step 4: Labor elasticity of substitution σ is calibrated to 1.4 (Katz and Murphy, 1992). Also try 0.9, 3, 10, no change.

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Model: Estimation Results

Table: Estimation of the Parameters in Children's Human Capital Equation

	Parameter	Estimate	Elasticity
Public School Premium	ϕ^h	-0.0936 (0.325)	0.34
	ϕ^l	0.805*** (0.284)	
Left-behind Cost	ν^h	-0.800*** (0.0817)	19.3
	ν^l	-0.0248 (0.0495)	

Model: Estimation Results

Table: Estimation of Gravity Equation

Variables	PPML
Wage (w_j^s)	1.429***
	(0.207)
Human Capital (k_{ij}^s)	2.539***
	(0.847)
Original-Destination City Fixed Effects	YES
Original City-Skill Fixed Effects	YES

Notes: Standard errors are calculated in a bootstrap procedure.

$$\epsilon = 1.43, \quad \beta = 2.54 \div 1.43 = 1.78$$

- Low-skill Chinese parents are willing to pay about $\frac{3}{4}$ of the annual wages to enroll their children in public schools. This translates to about 9,500 RMB or about 1,356 US dollars in 2010.

Model fit

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7. Counterfactual

Counterfactual I: Increasing Migrant Students Seats

- Government promises the seats for migrant students in public schools increases by a certain amount
- From 0% (baseline) to total removal

Counterfactual I: Increasing Migrant Students Seats

Table: Counterfactual Changes: Increasing Seats for Migrant Students

Variables	Changes	
	50% Seat Increase	Total Removal
Total Migrants	7.2%	19.0%
Net Migrant from Small to Big	5.5%	18.1%
Total High-skill Migrants	7.1%	12.8%
Total Low-skill Migrants	7.2%	19.4%
Total Migrant Students	17.5%	47.5%
Total Students in Public in Big	9.5%	34.4%
Total Students in Public in Small	-0.25%	-1.1%
Ratio of Left-behind Students/Migrant	-13.2%	-29.1%

Counterfactual I: Increasing Migrant Students Seats

Table: Changes of Human Capital: Increasing Seats for Migrant Students

Variables	Changes (Test Score s.d.)	
	50% Seat Increase	Total Removal
Average HC	0.0040	0.015
Average HC of High-skill from Big	-0.040	-0.11
Average HC of Low-skill from Big	-0.028	-0.073
Average HC of High-skill from Small	-0.0095	-0.024
Average HC of Low-skill from Small	0.0097	0.031

Notes: Average HC stands for Human Capital.

Back-of-envelope calculation: 0.004 (0.015) s.d. $\uparrow \Rightarrow$ 32 (120) RMB $\uparrow$ annual incomes

Counterfactual I: Increasing Migrant Students Seats

Table: Changes of Wages: Increasing Seats for Migrant Students

Variables	Changes	
	50% Seat Increase	Total Removal
Mean Wages of High-skill from Big	1.1%	4.3%
Mean Wages of Low-skill from Big	-0.74%	-2.3%
Mean Wages of High-skill from Small	0.72%	1.2%
Mean Wages of Low-skill from Small	0.79%	2.5%

Counterfactual I: Increasing Migrant Students Seats

When we relax the enrollment restriction for migrant students:

- Gain in average human capital:
  0.004 s.d. when 50% increase, 0.015 s.d. when totally removed
  Low-skill families from small cities benefit
- Large inflow of migration of workers and students to big cities
  Big cities need to expand public school seats by 9.5% when 50% increase; 34.4% when totally removed

Counterfactual II: Reduced Peer Effects

- In the main setting, I use the peer effects in the pooled regression
  Samples from both the first and the second year
- Peer effects are smaller in the second year
  Zero for migrant students
- What is the gain if we can reduce the peer effects to the level of the second year?

Counterfactual II: Reduced Peer Effects

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Counterfactual II: Reduced Peer Effects

Table: Changes of Human Capital: Reduced Peer Effects

Variables	Changes (Test Score s.d.)
Average HC	0.048
Average HC of High-skill from Big Cities	0.14
Average HC of Low-skill from Big Cities	0.12
Average HC of High-skill from Small Cities	0.050
Average HC of Low-skill from Small Cities	0.040

Notes: Average HC stands for Human Capital.

Very important if gov can help to smooth the transition period of migrant and left-behind students!

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Counterfactual III: Allocation with Higher HC, Big or Small?

- Assume that the resources of the central government are limited
- Where should we put a fixed increase of the seats to achieve higher human capital? Big or small cities?
- Allocate all resources to either big or small cities
- Number of new seats increases from 1000 (0.29 million) to 15,000 (4.29 million)

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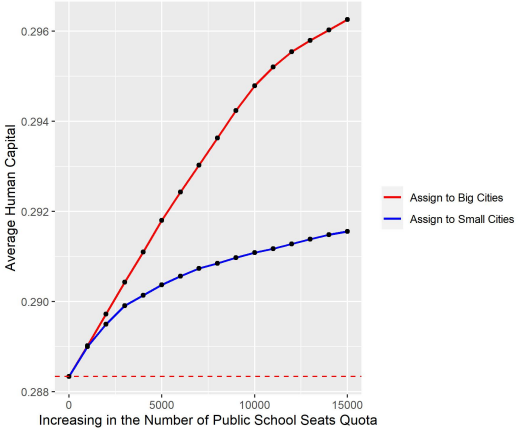

Figure: Human Capital Changes for Seats Increasing in Only Big/Small Cities

Counterfactual III: Allocation with Higher HC, Big or Small?

- For small increases: No difference
- For big increases: More efficient to put new seats in big cities

▸ Case 2: Interior solution

Channel Analysis

- Relative importance of the direct/indirect channel
- Direct: Increase public school enrollment vs. Indirect: Reduce negative spillover
- Set the peer effects of migrant and left-behind students at zero
  $\Rightarrow$ Mute the indirect channel
- Consider this in a PE model
  - Parents move $\times$; Children of migrant parents move $\surd$
  - Avoid negative effect channel by new parental migration

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Channel Analysis

- Relative importance of the direct/indirect channel
- Direct: Increase public school enrollment vs. Indirect: Reduce negative spillover
- Set the peer effects of migrant and left-behind students at zero
  $\Rightarrow$ Mute the indirect channel
- Consider this in a PE model
  - Parents move $\times$; Children of migrant parents move $\surd$
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  - Parents move $\times$; Children of migrant parents move $\surd$
  - Avoid negative effect channel by new parental migration

Channel Analysis

Table: Channel Analysis

Variables	Human Capital Changes (Test Score s.d.)	
	50% Seat Increase	Total Removal
Average HC (Original)	0.014	0.030
Average HC (Indirect channel muted)	0.0098	0.021

Notes: HC stands for Human Capital.

Channel Analysis

- Both channels are important
- Direct channel explains 70% of the policy effect; Indirect channel explains 30% of the policy effect.

Conclusion

- I identify peer effects of migrant and left-behind students
- Both have negative spillovers which decay over time. Left-behind students have larger spillovers
- I construct a spatial equilibrium model with migration and education choices
- If the enrollment restriction for migrant students is relaxed, the national average human capital can increase. Migration also increases. Low-skill families from small cities benefit the most.
- The burden of governments in big cities is not small.

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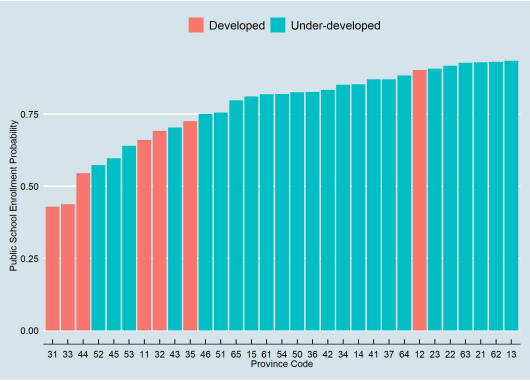
- The burden of governments in big cities is not small.

Appendix: Enrollment Probability of Migrant Students to Public Schools

Figure: Public School Enrollment Probability of Migrant Students by Provinces in 2010



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Appendix: Summary Statistics for Remaining and Dropped Observations

Table: Summary Statistics of Schools with/without Random Assignment

Variable	With Random	Without Random	Differences
Urban School	0.632	0.615	0.0169
	(0.484)	(0.490)	(0.0718)
Public School	0.929	0.938	-0.00943
	(0.258)	(0.242)	(0.0374)
School Ranking	3.819	3.969	-0.149
	(0.825)	(0.0.925)	(0.127)
Proportion of Migrant Students	0.219	0.179	0.0405
	(0.218)	(0.190)	(0.0310)
Proportion of Left-behind Students	0.190	0.143	0.0467**
	(0.167)	(0.120)	(0.0229)

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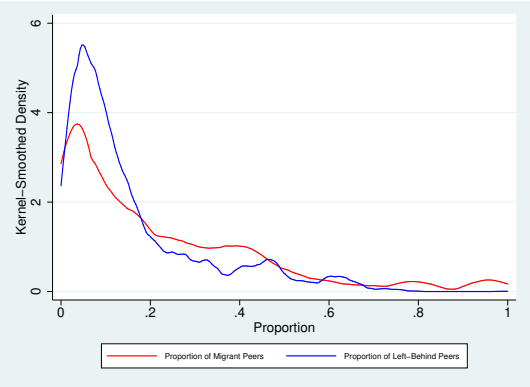
Appendix: More Summary Statistics

Table: More Summary Statistics

Variable	Migrant	Left-Behind	Local
Student Gender(=1 if boy)	0.524	0.552	0.499
	(0.500)	(0.497)	(0.500)
Student Age	12.985	12.985	12.934
	(0.864)	(0.939)	(0.829)
Student Hukou Type(=1 if rural)	0.606	0.620	0.397
	(0.489)	(0.486)	(0.489)
Father Education Years	10.290	9.586	11.156
	(3.104)	(2.909)	(3.383)
Mother Education Years	9.477	8.562	10.616
	(3.343)	(3.704)	(3.659)
Socioeconomic Condition	2.891	2.700	2.878
	(0.542)	(0.666)	(0.583)
Standardized Test Scores	0.129	-0.0770	0.240
	(0.864)	(0.891)	(0.870)

Appendix: More Summary Statistics

Figure: Distributions of Proportions of Migrant/Left-Behind Peers



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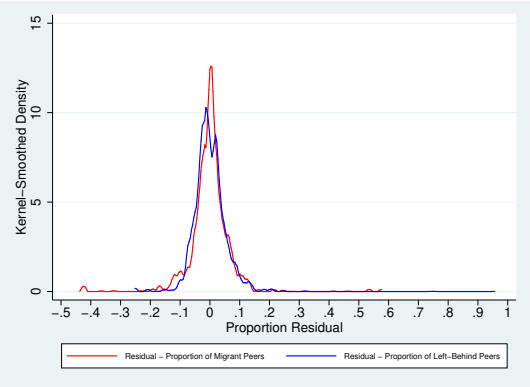
Appendix: More Summary Statistics

Figure: Distributions of Residulized Proportions of Migrant/Left-Behind Peers



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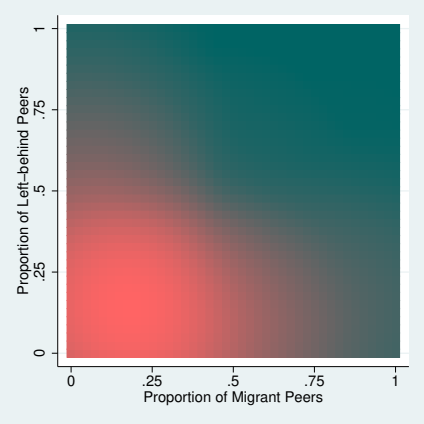
Appendix: More Summary Statistics

Figure: Joint Distribution of Proportions of Migrant/Left-Behind Peers



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Mechanism: Family Background

Table: Peer Effects Netting Out Average Family Background

	(1)	(2)	(3)	(4)	(5)
Proportion of Migrant Peers	-0.545*	-0.571**	-0.296	-0.351	-0.344
	(0.286)	(0.282)	(0.293)	(0.267)	(0.273)
Proportion of Left-behind Peers	-1.061**	-0.812*	-0.701**	-0.732**	-0.606*
	(0.432)	(0.447)	(0.321)	(0.336)	(0.354)
Average Socioeconomic Condition of Classmates		0.511*			0.257
		(0.290)			(0.306)
Average Father Education of Classmates			0.142***		0.0763
			(0.0404)		(0.0671)
Average Mother Education of Classmates				0.127***	0.0521
				(0.0325)	(0.0548)
School FE	YES	YES	YES	YES	YES
Year Dummy	YES	YES	YES	YES	YES
Personal Controls	YES	YES	YES	YES	YES
Household Controls	YES	YES	YES	YES	YES
Observations	11,519	11,519	11,519	11,519	11,519
R-squared	0.314	0.319	0.322	0.321	0.324

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Mechanism: Misbehavior

Table: Students' Misbehaviors and the Peer Effects: Second Year

	Often Fight	Often Cheat	Often Smoke	Often Gaming	Average Index	FPC
Proportion of Migrant Peers	-0.0899	0.269***	0.0424	0.124***	0.0614*	0.620
	(0.0996)	(0.0530)	(0.0356)	(0.0435)	(0.0364)	(0.445)
Proportion of Left-Behind Peers	0.227***	0.182***	0.0126	0.135**	0.0918**	0.869
	(0.0469)	(0.0599)	(0.0519)	(0.0607)	(0.0424)	(0.587)
Whether Is a Migrant	0.00537	-0.00661	0.0135	0.0408***	0.00864	0.118
	(0.0181)	(0.0196)	(0.0120)	(0.0147)	(0.00888)	(0.119)
Whether Is a Left-Behind	0.0420*	0.0197	0.0214**	0.0151	0.0156*	0.170
	(0.0211)	(0.0271)	(0.00932)	(0.0158)	(0.00836)	(0.102)
School FE	YES	YES	YES	YES	YES	YES
Personal Controls	YES	YES	YES	YES	YES	YES
Household Controls	YES	YES	YES	YES	YES	YES
Observations	4,088	4,088	4,088	4,088	4,088	4,088
R-squared	0.060	0.082	0.042	0.074	0.085	0.076

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Mechanism: Misbehavior - Parents' Relation

Table: Relation With Parents: First Year

	On Exam	On School Performance	On Internet	Relation with Mother	Relation with Father	Average Index	FPC
Whether Is a Migrant	0.0290	0.00102	0.0370	0.0231	-0.00485	0.0132	0.0716
	(0.0399)	(0.0378)	(0.0344)	(0.0307)	(0.0438)	(0.0283)	(0.143)
Whether Is a Left-Behind	-0.113***	-0.0692**	-0.0394	-0.0527***	-0.0672**	-0.0654***	-0.330***
	(0.0308)	(0.0310)	(0.0291)	(0.0195)	(0.0277)	(0.0129)	(0.0688)
School FE	YES	YES	YES	YES	YES	YES	YES
Year Dummy	YES	YES	YES	YES	YES	YES	YES
Personal Controls	YES	YES	YES	YES	YES	YES	YES
Household Controls	YES	YES	YES	YES	YES	YES	YES
Observations	3,944	3,944	3,944	3,944	3,944	3,944	3,944
R-squared	0.059	0.050	0.061	0.088	0.083	0.099	0.092

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Mechanism: Misbehavior - Parents' Relation

Table: Relation With Parents: Second Year

	On Exam	On School Performance	On Internet	Relation with Mother	Relation with Father	Average Index	FPC
Whether Is a Migrant	-0.00575	-0.0871***	0.0116	-0.0228	-0.0245	-0.0129	-0.0532
	(0.0299)	(0.0291)	(0.0346)	(0.0286)	(0.0304)	(0.0191)	(0.0985)
Whether Is a Left-Behind	-0.0239	-0.0448**	-0.0297	-0.0770***	-0.119***	-0.0506***	-0.211**
	(0.0413)	(0.0207)	(0.0337)	(0.0271)	(0.0301)	(0.0170)	(0.0896)
School FE	YES	YES	YES	YES	YES	YES	YES
Year Dummy	YES	YES	YES	YES	YES	YES	YES
Personal Controls	YES	YES	YES	YES	YES	YES	YES
Household Controls	YES	YES	YES	YES	YES	YES	YES
Observations	3,944	3,944	3,944	3,944	3,944	3,944	3,944
R-squared	0.080	0.071	0.062	0.079	0.079	0.108	0.099

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Mechanism: Misbehavior

Table: Adding Students' Misbehaviors in the Main Regression: Second Year

	(1)	(2)	(3)
Proportion of Migrant Peers	-0.0193	0.201	0.160
	(0.322)	(0.253)	(0.259)
Proportion of Left-Behind Peers	-1.057***	-0.514**	-0.583**
	(0.319)	(0.234)	(0.247)
Average of Classmates Misbehavior Average Index		-3.822**	
		(1.652)	
Average of Classmates Misbehavior FPC Index			-0.291**
			(0.141)
School FE	YES	YES	YES
Personal Controls	YES	YES	YES
Household Controls	YES	YES	YES
Observations	4,088	4,088	4,088
R-squared	0.334	0.346	0.346

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Mechanism: Classroom Environment

Table: Peer Effects on Class Environment: First Year

	Friendly-2013	Learning-2013	Average Index-2013	FPC-2013
Proportion of Migrant Peers	-0.197**	-0.271*	-0.234**	-0.914**
	(0.0886)	(0.137)	(0.106)	(0.412)
Proportion of Left-Behind Peers	-0.392***	-0.743***	-0.568***	-2.194***
	(0.106)	(0.237)	(0.155)	(0.594)
School FE	YES	YES	YES	YES
Personal Controls	YES	YES	YES	YES
Household Controls	YES	YES	YES	YES
Observations	4,005	4,005	4,005	4,005
R-squared	0.048	0.125	0.109	0.106

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Mechanism: Classroom Environment

Table: Peer Effects on Class Environment: Second Year

	Friendly-2014	Learning-2014	Average Index-2014	FPC-2014
Proportion of Migrant Peers	-0.000667	-0.324	-0.162	-0.586
	(0.0436)	(0.205)	(0.113)	(0.421)
Proportion of Left-Behind Peers	-0.429***	-0.509***	-0.469***	-1.881***
	(0.0830)	(0.141)	(0.105)	(0.411)
School FE	YES	YES	YES	YES
Personal Controls	YES	YES	YES	YES
Household Controls	YES	YES	YES	YES
Observations	4,005	4,005	4,005	4,005
R-squared	0.075	0.112	0.114	0.111

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Mechanism: Classroom Environment

Table: Adding Class Environment in the Main Regression: First Year

	(1)	(2)	(3)	(4)
Proportion of Migrant Peers	-0.999**	-0.578*	-0.567*	-0.663**
	(0.383)	(0.296)	(0.296)	(0.266)
Proportion of Left-Behind Peers	-2.157***	-1.104	-1.088	-0.885
	(0.808)	(0.784)	(0.782)	(0.603)
Average of Environment Average Index		1.589***		
		(0.468)		
Average of Environment FPC Index			0.417***	
			(0.120)	
Average Classmates' Relation				2.655***
				(0.733)
Average Learning Environment				-0.134
				(0.347)
School FE	YES	YES	YES	YES
Personal Controls	YES	YES	YES	YES
Household Controls	YES	YES	YES	YES
Observations	4,005	4,005	4,005	4,005
R-squared	0.358	0.366	0.366	0.370

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Mechanism: Classroom Environment

Table: Adding Class Environment in the Main Regression: Second Year

	(1)	(2)	(3)	(4)
Proportion of Migrant Peers	-0.0283	0.263	0.235	0.312
	(0.328)	(0.277)	(0.271)	(0.279)
Proportion of Left-Behind Peers	-1.012***	-0.0779	-0.0537	-0.0402
	(0.335)	(0.228)	(0.234)	(0.281)
Average of Environment Average Index		1.911***		
		(0.435)		
Average of Environment FPC Index			0.483***	
			(0.111)	
Average Classmates' Relation				0.785
				(0.674)
Average Learning Environment				1.265***
				(0.401)
School FE	YES	YES	YES	YES
Personal Controls	YES	YES	YES	YES
Household Controls	YES	YES	YES	YES
Observations	4,005	4,005	4,005	4,005
R-squared	0.330	0.362	0.362	0.363

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Mechanism: Classroom Environment

Table: Long-term Migrant Students' Peer Effect

	(1)	(2)
Proportion of Migrant Peers	-1.058*	0.106
	(0.551)	(0.325)
Proportion of Left-Behind Peers	-1.242	-0.928**
	(0.841)	(0.425)
Proportion of Migrant Peers (more than five years)	0.958	-0.393
	(0.663)	(0.519)
School FE	YES	YES
Personal Controls	YES	YES
Household Controls	YES	YES
Observations	4,072	4,072
R-squared	0.319	0.337

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Appendix: External Validity Concerns

Table: Peer Effects Netting Out Average Previous Test Scores: Second Year

	(1)	(2)
Proportion of Migrant Peers	0.294	0.854
	(0.744)	(0.573)
Proportion of Left-Behind Peers	-0.946*	-0.669*
	(0.530)	(0.350)
Average Score of Migrant Peers in 2013		0.156
		(0.101)
Average Score of Left-behind Peers in 2013		0.385*
		(0.228)
School-Grade FE	YES	YES
Personal Controls	YES	YES
Household Controls	YES	YES
Observations	3,654	3,654
R-squared	0.356	0.383

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Appendix: Model with Peer Effects of High-skill Children

Additionally consider proportion of high-skill peers.

Table: Peer Effects of Migrant, Left-Behind and High-skill Family Children

	(1)
Proportion of Migrant Peers	-0.349
	(0.273)
Proportion of Left-Behind Peers	-0.824**
	(0.341)
Proportion of Peers from High-skill Families	0.938***
	(0.298)
School FE	YES
Year Dummy	YES
Personal Controls	YES
Household Controls	YES
Observations	11,519
R-squared	0.319

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Appendix: Model with Peer Effects of High-skill Children

Table: Changes of Human Capital: Increasing Seats for Migrant Students

Variables	Human Capital Changes (Test Score s.d.)	
	50% Seat Increase	Total Removal
Average HC	0.008	0.028
Average HC of High-skill Families from Big Cities	-0.046	-0.16
Average HC of Low-skill Families from Big Cities	-0.030	-0.095
Average HC of High-skill Families from Small Cities	-0.004	-0.017
Average HC of Low-skill Families from Small Cities	0.015	0.049

Notes: Average HC stands for Human Capital.

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Appendix: Other Measures of Students' Performances

Table: Robustness: Using School-Level Performance Measurement

	Chinese		Math		English	
	(1) First Year	(2) Second Year	(3) First Year	(4) Second Year	(5) First Year	(6) Second Year
Proportion of Migrant Peers	-12.26**	-2.914	-5.352	-1.106	-6.577	-4.789
	(4.992)	(2.785)	(5.600)	(5.836)	(4.777)	(3.828)
Proportion of Left-Behind Peers	-24.48**	-8.003***	-33.45***	-12.26**	-29.52***	-13.69***
	(9.550)	(2.991)	(11.67)	(5.834)	(10.17)	(3.829)
School FE	YES	YES	YES	YES	YES	YES
Personal Controls	YES	YES	YES	YES	YES	YES
Household Controls	YES	YES	YES	YES	YES	YES
Observations	4,072	4,072	4,072	4,072	4,072	4,072
R-squared	0.145	0.132	0.072	0.071	0.158	0.140

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Appendix: Only Consider Rural Migrants and Left-Behind

Table: Robustness: Consider Rural Migrants and Rural Left-Behind

	(1) Both Years	(2) First Year	(3) Second Year
Proportion of Rural Migrant Peers	-0.305	-1.123***	0.379
	(0.375)	(0.374)	(0.517)
Proportion of Rural Left-Behind Peers	-1.226***	-1.757***	-1.084***
	(0.358)	(0.632)	(0.304)
School FE	YES	YES	YES
Year Dummy	YES	YES	YES
Personal Controls	YES	YES	YES
Household Controls	YES	YES	YES
Observations	8,144	4,072	4,072
R-squared	0.336	0.358	0.334

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Appendix: Only on Ordinary Locals

Table: Robustness: Only on Ordinary Locals

	(1) Both Years	(2) First Year	(3) Second Year
Proportion of Migrant Peers	-0.586	-1.179	-0.456
	(0.764)	(1.082)	(0.832)
Proportion of Left-Behind Peers	-1.308***	-2.098**	-1.006***
	(0.410)	(1.009)	(0.251)
School FE	YES	YES	YES
Year Dummy	YES	NO	NO
Personal Controls	YES	YES	YES
Household Controls	NO	YES	YES
Observations	4,968	2,484	2,484
R-squared	0.339	0.353	0.346

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Appendix: Only on Public Schools

Table: Robustness: Only on Public Schools

	(1) Both Years	(2) First Year	(3) Second Year
Proportion of Migrant Peers	-0.120	-1.209	0.351
	(0.591)	(0.766)	(0.734)
Proportion of Left-Behind Peers	-1.231***	-2.053**	-1.117***
	(0.420)	(0.847)	(0.290)
School FE	YES	YES	YES
Year Dummy	YES	NO	NO
Personal Controls	YES	YES	YES
Household Controls	NO	YES	YES
Observations	7,500	3,750	3,750
R-squared	0.337	0.353	0.340

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Appendix: Left-Behind Children with Both Parents Absent

Table: Robustness: Left-Behind Children with Both Parents Absent

	(1) Both Years	(2) First Year	(3) Second Year
Proportion of Migrant Peers	-0.212	-0.531**	0.0397
	(0.235)	(0.217)	(0.327)
Proportion of Left-Behind Peers	-1.460***	-2.237***	-1.058***
	(0.447)	(0.631)	(0.373)
School FE	YES	YES	YES
Year Dummy	YES	NO	NO
Personal Controls	YES	YES	YES
Household Controls	YES	YES	YES
Observations	8,144	4,072	4,072
R-squared	0.336	0.359	0.332

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Appendix: Fixing Hukou Status for All Students

Table: Robustness: Fixing Hukou Status for All Students

	(1) Both Years	(2) First Year	(3) Second Year
Proportion of Migrant Peers	-0.360*	-0.976**	-0.0579
	(0.209)	(0.371)	(0.193)
Proportion of Left-Behind Peers	-1.243***	-2.062**	-1.050***
	(0.381)	(0.792)	(0.296)
School FE	YES	YES	YES
Year Dummy	YES	NO	NO
Personal Controls	YES	YES	YES
Household Controls	NO	YES	YES
Observations	8,144	4,072	4,072
R-squared	0.338	0.359	0.334

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Appendix: No Dropouts

Table: Classes Without Dropouts

	(1) First Year	(2) Second Year	(3) Second Year
Proportion of Migrant Peers	-0.828**	-0.443	-0.0604
	(0.335)	(0.316)	(0.231)
Proportion of Left-Behind Peers	-2.309	-1.545*	-0.967*
	(1.413)	(0.782)	(0.504)
Test Score in 2013			0.432***
			(0.0320)
School-Grade FE	YES	YES	YES
Personal Controls	YES	YES	YES
Household Controls	YES	YES	YES
Observations	3,488	3,488	3,488
R-squared	0.272	0.281	0.438

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Appendix: Parents' Investment

Table: Robustness: Parents' Investment

Dependent Variable	Time Spend on Children		Education Expenditure	
	(1) First Years	(2) Second Year	(3) First Year	(4) Second Year
Proportion of Migrant Peers	-1.060	-3.720	-670.7	212.6
	(0.911)	(3.463)	(489.4)	(442.3)
Proportion of Left-Behind Peers	0.802	4.712***	-520.1	-247.9
	(1.895)	(0.705)	(991.9)	(314.4)
School FE	YES	YES	YES	YES
Personal Controls	YES	YES	YES	YES
Household Controls	YES	YES	YES	YES
Observations	3,358	3,358	3,358	3,358
R-squared	0.073	0.067	0.198	0.254

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Model: Children's Human Capital k_{ij}^{s}

- When $i = j$:

$$k_{ij}^{*s} = E[k_{ijo}^{*s}]$$

- When $i \neq j$:

$$V_{ij}^{s}(Migchi) = p_j^s v_{ij}^s(migchi_{pub}) + (1 - p_j^s) v_{ij}^s(migchi_{pri})$$
$$k_{ij}^{*s} = E[max\{V_{ij}^{s}(Migchi) + e_{oj}, V_{ij}^{s}(Left) + e_{oi}\}]$$

Model: Children's Human Capital k_{ij}^{s}

By assuming T1EV, we have

- The probability of taking children with parents:

$$Prob(mig) = \frac{exp(V^s(Migchi))}{exp(V^s(Mig)) + exp(V^s(Left))}$$

- The value of the option when $i \neq j$:

$$E[max\{V^s(Mig) + e_{oj}, V^s(Left) + e_{oi}\}] = ln[exp(V^s(Mig)) + exp(V^s(Left))]$$

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Model: Commuting Probability

For workers **endowed with skill** s **and hometown** i, I can write the proportion of them working in city j as follows:

$$\pi_{ij}^{s} = \frac{\Phi_{ij}^{s}}{\Phi_{i}^{s}} = \frac{(w_j^s(k_{ij}^{s'})^{\beta})^{\epsilon}(\tau_{ij}^{s})^{-\epsilon}}{\sum_r (w_r^s(k_{ir}^{s'})^{\beta})^{\epsilon}(\tau_{ir}^{s})^{-\epsilon}}$$

This is a standard Gravity Equation. Back

Model: Labor Demand

Competitive market. Each city has a CES production function with two inputs: high skill labor and low skill labor

$$\max_{L_j^l, L_j^h} \quad y_j - w_j^h L_j^h - w_j^l L_j^l$$

$$y_j = [(A_j^h L_j^h)^{\frac{\sigma-1}{\sigma}} + (A_j^l L_j^l)^{\frac{\sigma-1}{\sigma}}]^{\frac{\sigma}{\sigma-1}}$$

- A_j^h, A_j^l: high/low skill labor augmenting productivity
- L_j^h, L_j^l: high/low skill labor demand
- σ: elasticity of substitution

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Model: Spatial Equilibrium

Definition

Given the parameter vector $\mathbf{\Gamma} = \{\beta, \epsilon, \Theta, \phi, \nu, \kappa, \chi, \eta, \sigma\}$ *and the city characteristics vector* $\mathbf{\Omega} = \{\mathbf{\Xi}, \mathbf{p}, \mathbf{A}, \tau\}$*, the spatial equilibrium is achieved by the endogenous variable vector* $\mathbf{\Delta} = \{\mathbf{w}, \mathbf{L}, \mathbf{Peer}\}$ *with the following conditions to be satisfied:*
(1) Firms solve their profit maximization problems; (Firm maximization)
(2) Workers choose locations and whether to take their children to migrate with the highest utility; (Worker maximization)
(3) Labor supply equals labor demand in each city for both skill levels; (Labor market clearing)
(4) Workers can perfectly expect the peer composition in each city. (Perfect foresight)

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Model: Fit

Table: Model Fit

Variables	Model	Data	Difference
Total Migrants	73419	73716	-0.40%
Net Migrant Inflow from Small to Big	39978	40215	-0.59%
Total High-skill Migrants	4719	4744	-0.54%
Total Low-skill Migrants	68701	68972	-0.39%
Total Migrant Students	24604	24866	-1.1%
Total Migrant Students to Big	12279	11787	4.2%
Total Migrant Students to Small	12325	13079	-5.8%
Total Left-behind Students	48816	48850	-0.070%
Total Students in Public in Big	33434	32958	1.4%
Total Students in Public in Small	305567	305947	-0.12%
Mean Wages of High-skill from Big	54657	54825	-0.31%
Mean Wages of High-skill from Small	31438	31544	-0.33%
Mean Wages of Low-skill from Big	20925	20960	-0.17%
Mean Wages of Low-skill from Small	13836	13871	-0.25%

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Counterfactual III: Allocation with Higher HC, Big or Small?

- Case 2: Given 20,000/15,000/10,000 new seats. Allocate some resources to big cities, some resources to small cities
- To achieve the highest human capital

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Counterfactual III: Allocation with Higher HC, Big or Small?

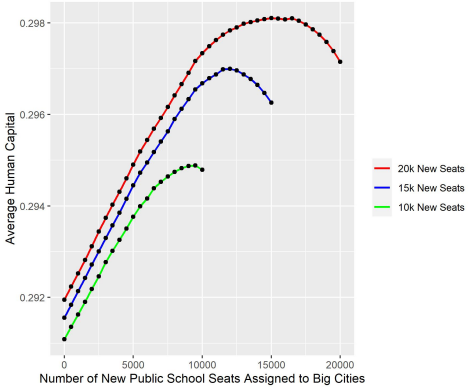

Figure: Human Capital Changes for Different Seats Allocations

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