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

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Overview

1 Introduction
2 Literature Review
3 Background
4 Empirical Strategy
5 Main Results of Peer Effects
6 Model
7 Counterfactual
8 Conclusion
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 → 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 → Can migrant children harm local children?
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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- 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:
  - Choices: Parents migration + children education
  - School type (Public) + peer effect → 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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- Methodology (External validity vs. Internal validity)
  - Randomized Controlled Trial
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  - Variation across cohorts or classes in the same school
    Hoxby (2000); Ammermueller and Pischke (2009)

A clean and representative identification of peer effects

- Migration and peer effects
  - International immigration
    Card (2013); Cascio and Lewis (2012); Jensen and Rasmussen (2011); Tonello (2016); Geay, McNally, and Telhaj (2013)
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One of the first papers about peer effects from domestic migrant students
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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
  - Children without local Hukou may not be permitted to get into public schools
Public school dominates

Hukou: national-wide household registration system

Registration place: where you are originally from

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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

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

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

- Usually $\theta_1$ and $\theta_2$ 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%)
- 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)
### Table: Balance Check

<table>
<thead>
<tr>
<th></th>
<th>Proportion of Migrants</th>
<th>Proportion of Left-behinds</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Without School FE</td>
<td>With School FE</td>
</tr>
<tr>
<td>Age</td>
<td>-0.0147</td>
<td>0.00142</td>
</tr>
<tr>
<td>Sex</td>
<td>0.0128**</td>
<td>0.00187</td>
</tr>
<tr>
<td>Board at School</td>
<td>-0.0574</td>
<td>-0.0109</td>
</tr>
<tr>
<td>Hukou Type (=1 if rural)</td>
<td>-0.0288*</td>
<td>-0.000781</td>
</tr>
<tr>
<td>Only Child in Family</td>
<td>-0.00381</td>
<td>0.00185</td>
</tr>
<tr>
<td>Father Education Years</td>
<td>0.00263</td>
<td>-0.000551</td>
</tr>
<tr>
<td>Mother Education Years</td>
<td>0.00300</td>
<td>-0.000307</td>
</tr>
<tr>
<td>Whether Parents Have Conflicts</td>
<td>0.00336</td>
<td>-0.000383</td>
</tr>
</tbody>
</table>
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**

<table>
<thead>
<tr>
<th>Dependent Variable: Student’s Test Score</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of Migrant Peers</td>
<td>-0.605*</td>
<td>-0.567*</td>
<td>-0.545*</td>
</tr>
<tr>
<td></td>
<td>(0.319)</td>
<td>(0.297)</td>
<td>(0.286)</td>
</tr>
<tr>
<td>Proportion of Left-Behind Peers</td>
<td>-1.198**</td>
<td>-1.124**</td>
<td>-1.061**</td>
</tr>
<tr>
<td></td>
<td>(0.514)</td>
<td>(0.448)</td>
<td>(0.432)</td>
</tr>
<tr>
<td>School FE</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Year Dummy</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Personal Controls</td>
<td>NO</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Household Controls</td>
<td>NO</td>
<td>NO</td>
<td>YES</td>
</tr>
<tr>
<td>Observations</td>
<td>11,519</td>
<td>11,519</td>
<td>11,519</td>
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<tr>
<td>R-squared</td>
<td>0.292</td>
<td>0.310</td>
<td>0.314</td>
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Main Results of Peer Effects: Duration

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

<table>
<thead>
<tr>
<th>Dependent Variable: Student’s Test Score</th>
<th>(1) First Year</th>
<th>(2) Second Year</th>
<th>(3) Second - First</th>
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<tr>
<td>Proportion of Migrant Peers</td>
<td>-0.976**</td>
<td>-0.026</td>
<td>0.950***</td>
</tr>
<tr>
<td></td>
<td>(0.371)</td>
<td>(0.328)</td>
<td>(0.327)</td>
</tr>
<tr>
<td>Proportion of Left-Behind Peers</td>
<td>-2.062**</td>
<td>-1.050***</td>
<td>1.012**</td>
</tr>
<tr>
<td></td>
<td>(0.792)</td>
<td>(0.311)</td>
<td>(0.467)</td>
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<td>YES</td>
<td>YES</td>
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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;
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- 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.

- **Why migrant reduces to zero?**
  Better integration of migrants to the class eliminate negative spillovers.

- **Is family background a channel for the negative spillover?**
  It is. But only explain small part of it.
Robustness Check

- External validity of the estimation
- Other measures of students’ performances
- Only consider rural migrant and rural left-behind students in the definition
- Only on ordinary locals students (Recommended by Angrist (2014))
- Only on students in public schools
- Redefine left-behind children as children with both parents absent
- Keep Hukou status constant across years
- Classes without dropouts
- Parents’ investment as compensation
6. Model
Main Question:
Relaxing the enrollment restriction?

Human capital ↑? ↓? (Unclear)
- Increase human capital?
- Decrease human capital?
  Former staying families may migrate with their children ⇒ spillover ↑
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Model: Basic Settings

- A static spatial equilibrium model
- 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 / skill's (high/low)
  - each worker has a child
- Workers make two decisions
  - where to work $j$, whether to take children with him/her
A static spatial equilibrium model

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- A static spatial equilibrium model
- 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
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A static spatial equilibrium model

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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
  - 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

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- Big cities: Top 5% Cities in terms of migrant students
Utility of worker $o$ with Hukou/home city $i$ and skill $s$, to work in city $j$:

$$U_{ijo} = \frac{Z_{ijo}}{\tau_{ij}} w_{ij}^s (k_{ij}^s)^\beta$$  \hspace{1cm} (2)

$$F(z_{ijo}) = e^{-z_{ijo}^\epsilon}$$  \hspace{1cm} (3)

w: Wage, k: Children’s human capital
$\tau$: Migration cost, $\beta$: 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, \( \epsilon \): 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 $\Rightarrow$ Shock on children human capital revealed $\Rightarrow$ Children’s migration decision $\Rightarrow$ Take lottery of public/private schools
- Four types of students
  - Stayers (Parents, children stay)
  - Left-behind (Parents move, children stay)
  - Migrant in public (Both move)
  - Migrant in private (Both move)
- 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
Model: Children’s Human Capital $k^s_{ij}$

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Model: Children’s Human Capital $k_{ij}^s$

$$k_{ijo}^s = \zeta_0 + \Theta[Peer_{i,Pub_o} \cdot lb_o + Peer_{j,Pub_o} \cdot (1 - lb_o)] + \phi^s Pub_o + \nu^s lb_o + \chi^s (1 - lb_o) \mathbf{1}(\text{Province}_i \neq \text{Province}_j) + \eta^s (1 - lb_o) \text{dist}_{ij} + \kappa^s_r lb_o + \kappa^s_j (1 - lb_o) + \zeta_1 \mathbf{1}(s = h) + \zeta_2 \mathbf{1}(i) + e_o$$

- $Peer_{i, pub}$: peer composition in public school in city $i$
- $\phi^s$: public school premium
- $\nu^s$: Left-behind cost
- $\kappa^s_r$: region fixed effect
- $e_o$: T1EV Mean zero shock
Model: Children’s Human Capital $k^s_{ij}$ for Stayers

If $i = j$:

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

- $Peer_{i, pub}$: peer composition in public school in city $i$
- $\phi^s$: public school premium
- $\nu^s$: Left-behind cost
- $\kappa^s_r$: 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:

$$k_{ijo}^s = \zeta_0 + \Theta [ Peer_{i, Pubo} \cdot lbo + Peer_{j, Pubo} \cdot (1 - lbo)] + \phi^s Pubo + \nu^s lbo +$$

$$\chi^s 1(Province_i \neq Province_j)(1 - lbo) + \eta^s dist_{ij} (1 - lbo) +$$

$$\kappa_{ri}^s lbo + \kappa_{rj}^s (1 - lbo) + \zeta_1^s 1(s = h) + \zeta_2^s 1(i) + e_o$$

- $Peer_{i, pub}$: peer composition in public school in city $i$
- $\phi^s$: public school premium
- $\nu^s$: Left-behind cost
- $\kappa_{ri}^s$: region fixed effect
- $e_o$: T1EV Mean zero shock
Model: Children’s Human Capital \( k_{ij}^s \) for Migrant Children in Public

If \( i \neq j \), children migrate with parents, then with probability \( p_j^s \) enrolling in Public:

\[
k_{ij}^* = \zeta_0 + \Theta[Peer_{i, Pubo} \cdot lb_o + Peer_{j, Pubo} \cdot (1 - lb_o)] + \phi^s Pubo + \nu^s lb_o +
\]

\[
\chi^s \mathbf{1}(Province_i \neq Province_j) (1 - lb_o) + \eta^s dist_{ij} (1 - lb_o) +
\]

\[
\kappa_{ri}^s lb_o + \kappa_{rj}^s (1 - lb_o) + \zeta_1 \mathbf{1}(s = h) + \zeta_2 \mathbf{1}(i) + e_o
\]

- \( Peer_{j, pub} \): peer composition in public school in city \( j \)
- \( \phi^s \): public school premium
- \( \nu^s \): Left-behind cost
- \( \kappa_{rj}^s \): region fixed effect
- \( e_o \): T1EV Mean zero shock
If $i \neq j$, children migrate with parents, then with probability $1 - p_j^s$ enrolling in Private:

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

- $Peer_{j, pub}$: peer composition in private school in city $j$
- $\phi^s$: public school premium
- $\nu^s$: Left-behind cost
- $\kappa^s_{r}$: region fixed effect
- $e_o$: T1EV Mean zero shock
Model: Other Parts

- Closed-form children’s migration probability and choice value
- Closed-form workers’ commuting probability
- Competitive firms
- Spatial Equilibrium
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 ⇒ 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.
Model: Estimation

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  Variations used: Migrant workers’ different choices of whether to take their children to migrate or leave them behind.
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 $\sigma$ is calibrated to 1.4 (Katz and Murphy, 1992). Also try 0.9, 3, 10, no change.
Model: Estimation

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

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<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>Elasticity</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\phi^h$</td>
<td>-0.0936</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.325)</td>
<td></td>
</tr>
<tr>
<td>$\phi^l$</td>
<td>0.805***</td>
<td>0.34</td>
</tr>
<tr>
<td></td>
<td>(0.284)</td>
<td></td>
</tr>
<tr>
<td>$\nu^h$</td>
<td>-0.800***</td>
<td>19.3</td>
</tr>
<tr>
<td></td>
<td>(0.0817)</td>
<td></td>
</tr>
<tr>
<td>$\nu^l$</td>
<td>-0.0248</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.0495)</td>
<td></td>
</tr>
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</table>
Model: Estimation Results

Table: Estimation of Gravity Equation

<table>
<thead>
<tr>
<th>Variables</th>
<th>PPML</th>
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<tbody>
<tr>
<td>Wage ((w_j^s))</td>
<td>1.429***</td>
</tr>
<tr>
<td></td>
<td>(0.207)</td>
</tr>
<tr>
<td>Human Capital ((k_{ij}^s))</td>
<td>2.539***</td>
</tr>
<tr>
<td></td>
<td>(0.847)</td>
</tr>
<tr>
<td>Original-Destination City</td>
<td>YES</td>
</tr>
<tr>
<td>Fixed Effects</td>
<td></td>
</tr>
<tr>
<td>Original City-Skill Fixed</td>
<td>YES</td>
</tr>
<tr>
<td>Effects</td>
<td></td>
</tr>
</tbody>
</table>

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.
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Table: Estimation of Gravity Equation

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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.
7. Counterfactual
Government promises the seats for migrant students in public schools increases by a certain amount

From 0% (baseline) to total removal
### Table: Counterfactual Changes: Increasing Seats for Migrant Students

<table>
<thead>
<tr>
<th>Variables</th>
<th>Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>50% Seat Increase</td>
</tr>
<tr>
<td>Total Migrants</td>
<td>7.2%</td>
</tr>
<tr>
<td>Net Migrant from Small to Big</td>
<td>5.5%</td>
</tr>
<tr>
<td>Total High-skill Migrants</td>
<td>7.1%</td>
</tr>
<tr>
<td>Total Low-skill Migrants</td>
<td>7.2%</td>
</tr>
<tr>
<td>Total Migrant Students</td>
<td>17.5%</td>
</tr>
<tr>
<td>Total Students in Public in Big</td>
<td>9.5%</td>
</tr>
<tr>
<td>Total Students in Public in Small</td>
<td>-0.25%</td>
</tr>
<tr>
<td>Ratio of Left-behind Students/Migrant</td>
<td>-13.2%</td>
</tr>
</tbody>
</table>
## Counterfactual I: Increasing Migrant Students Seats

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

<table>
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<tr>
<th>Variables</th>
<th>Changes (Test Score s.d.)</th>
<th>50% Seat Increase</th>
<th>Total Removal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average HC</td>
<td></td>
<td>0.0040</td>
<td>0.015</td>
</tr>
<tr>
<td>Average HC of High-skill from Big</td>
<td></td>
<td>-0.040</td>
<td>-0.11</td>
</tr>
<tr>
<td>Average HC of Low-skill from Big</td>
<td></td>
<td>-0.028</td>
<td>-0.073</td>
</tr>
<tr>
<td>Average HC of High-skill from Small</td>
<td></td>
<td>-0.0095</td>
<td>-0.024</td>
</tr>
<tr>
<td>Average HC of Low-skill from Small</td>
<td></td>
<td>0.0097</td>
<td>0.031</td>
</tr>
</tbody>
</table>

Notes: Average HC stands for Human Capital.

Back-of-envelope calculation: 0.004 (0.015) s.d. $\uparrow \Rightarrow 32 \ (120) \text{ RMB } \uparrow \text{ annual incomes}$
### Changes of Wages: Increasing Seats for Migrant Students

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<th>Changes</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>50% Seat Increase</td>
<td>Total Removal</td>
<td></td>
</tr>
<tr>
<td>Mean Wages of High-skill from Big</td>
<td>1.1%</td>
<td>4.3%</td>
<td></td>
</tr>
<tr>
<td>Mean Wages of Low-skill from Big</td>
<td>-0.74%</td>
<td>-2.3%</td>
<td></td>
</tr>
<tr>
<td>Mean Wages of High-skill from Small</td>
<td>0.72%</td>
<td>1.2%</td>
<td></td>
</tr>
<tr>
<td>Mean Wages of Low-skill from Small</td>
<td>0.79%</td>
<td>2.5%</td>
<td></td>
</tr>
</tbody>
</table>
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?
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?
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

#### Table: Changes of Human Capital: Reduced Peer Effects

<table>
<thead>
<tr>
<th>Variables</th>
<th>Changes (Test Score s.d.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average HC</td>
<td>0.048</td>
</tr>
<tr>
<td>Average HC of High-skill from Big Cities</td>
<td>0.14</td>
</tr>
<tr>
<td>Average HC of Low-skill from Big Cities</td>
<td>0.12</td>
</tr>
<tr>
<td>Average HC of High-skill from Small Cities</td>
<td>0.050</td>
</tr>
<tr>
<td>Average HC of Low-skill from Small Cities</td>
<td>0.040</td>
</tr>
</tbody>
</table>

Notes: Average HC stands for Human Capital.

Very important if gov can help to smooth the transition period of migrant and left-behind students!
**Table: Changes of Human Capital: Reduced Peer Effects**

<table>
<thead>
<tr>
<th>Variables</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Average HC</td>
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</tr>
<tr>
<td>Average HC of High-skill from Big Cities</td>
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</tr>
<tr>
<td>Average HC of High-skill from Small Cities</td>
<td>0.050</td>
</tr>
<tr>
<td>Average HC of Low-skill from Small Cities</td>
<td>0.040</td>
</tr>
</tbody>
</table>

Notes: Average HC stands for Human Capital.

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

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Number of new seats increases from 1000 (0.29 million) to 15,000 (4.29 million).
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- Assume that the resources of the central government are limited
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- 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)
Counterfactual III: Allocation with Higher HC, Big or Small?

**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
  - ⇒ Mute the indirect channel
- Consider this in a PE model
  - Parents move \( \times \); Children of migrant parents move \( \checkmark \)
  - Avoid negative effect channel by new parental migration
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
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- Direct: Increase public school enrollment vs. Indirect: Reduce negative spillover

- Set the peer effects of migrant and left-behind students at zero
  \[\Rightarrow \text{Mute the indirect channel}\]

- Consider this in a PE model
  - Parents move \(\times\); Children of migrant parents move \(\checkmark\)
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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
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Channel Analysis

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- Consider this in a PE model
  - Parents move ×; Children of migrant parents move √
  - Avoid negative effect channel by new parental migration
### Table: Channel Analysis

<table>
<thead>
<tr>
<th>Variables</th>
<th>Human Capital Changes (Test Score s.d.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>50% Seat Increase</td>
</tr>
<tr>
<td>Average HC (Original)</td>
<td>0.014</td>
</tr>
<tr>
<td>Average HC (Indirect channel muted)</td>
<td>0.0098</td>
</tr>
</tbody>
</table>

Notes: HC stands for Human Capital.
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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- 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.
Appendix: Enrollment Probability of Migrant Students to Public Schools

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

![Bar chart showing public school enrollment probability for migrant students by provinces in 2010. The chart compares developed and under-developed provinces, with a clear trend indicating higher enrollment probability in under-developed provinces.]
### Table: Summary Statistics of Schools with/without Random Assignment

<table>
<thead>
<tr>
<th>Variable</th>
<th>With Random</th>
<th>Without Random</th>
<th>Differences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban School</td>
<td>0.632</td>
<td>0.615</td>
<td>0.0169</td>
</tr>
<tr>
<td></td>
<td>(0.484)</td>
<td>(0.490)</td>
<td>(0.0718)</td>
</tr>
<tr>
<td>Public School</td>
<td>0.929</td>
<td>0.938</td>
<td>-0.00943</td>
</tr>
<tr>
<td></td>
<td>(0.258)</td>
<td>(0.242)</td>
<td>(0.0374)</td>
</tr>
<tr>
<td>School Ranking</td>
<td>3.819</td>
<td>3.969</td>
<td>-0.149</td>
</tr>
<tr>
<td></td>
<td>(0.825)</td>
<td>(0.925)</td>
<td>(0.127)</td>
</tr>
<tr>
<td>Proportion of Migrant Students</td>
<td>0.219</td>
<td>0.179</td>
<td>0.0405</td>
</tr>
<tr>
<td></td>
<td>(0.218)</td>
<td>(0.190)</td>
<td>(0.0310)</td>
</tr>
<tr>
<td>Proportion of Left-behind Students</td>
<td>0.190</td>
<td>0.143</td>
<td>0.0467**</td>
</tr>
<tr>
<td></td>
<td>(0.167)</td>
<td>(0.120)</td>
<td>(0.0229)</td>
</tr>
</tbody>
</table>
### Appendix: More Summary Statistics

#### Table: More Summary Statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Migrant</th>
<th>Left-Behind</th>
<th>Local</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student Gender (=1 if boy)</td>
<td>0.524</td>
<td>0.552</td>
<td>0.499</td>
</tr>
<tr>
<td></td>
<td>(0.500)</td>
<td>(0.497)</td>
<td>(0.500)</td>
</tr>
<tr>
<td>Student Age</td>
<td>12.985</td>
<td>12.985</td>
<td>12.934</td>
</tr>
<tr>
<td></td>
<td>(0.864)</td>
<td>(0.939)</td>
<td>(0.829)</td>
</tr>
<tr>
<td>Student Hukou Type (=1 if rural)</td>
<td>0.606</td>
<td>0.620</td>
<td>0.397</td>
</tr>
<tr>
<td></td>
<td>(0.489)</td>
<td>(0.486)</td>
<td>(0.489)</td>
</tr>
<tr>
<td>Father Education Years</td>
<td>10.290</td>
<td>9.586</td>
<td>11.156</td>
</tr>
<tr>
<td></td>
<td>(3.104)</td>
<td>(2.909)</td>
<td>(3.383)</td>
</tr>
<tr>
<td>Mother Education Years</td>
<td>9.477</td>
<td>8.562</td>
<td>10.616</td>
</tr>
<tr>
<td></td>
<td>(3.343)</td>
<td>(3.704)</td>
<td>(3.659)</td>
</tr>
<tr>
<td>Socioeconomic Condition</td>
<td>2.891</td>
<td>2.700</td>
<td>2.878</td>
</tr>
<tr>
<td></td>
<td>(0.542)</td>
<td>(0.666)</td>
<td>(0.583)</td>
</tr>
<tr>
<td>Standardized Test Scores</td>
<td>0.129</td>
<td>-0.0770</td>
<td>0.240</td>
</tr>
<tr>
<td></td>
<td>(0.864)</td>
<td>(0.891)</td>
<td>(0.870)</td>
</tr>
</tbody>
</table>
Figure: Distributions of Proportions of Migrant/Left-Behind Peers
Appendix: More Summary Statistics

Figure: Distributions of Residualized Proportions of Migrant/Left-Behind Peers
Appendix: More Summary Statistics

Figure: Joint Distribution of Proportions of Migrant/Left-Behind Peers
## Mechanism: Family Background

### Table: Peer Effects Netting Out Average Family Background

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of Migrant Peers</td>
<td>-0.545*</td>
<td>-0.571**</td>
<td>-0.296</td>
<td>-0.351</td>
<td>-0.344</td>
</tr>
<tr>
<td></td>
<td>(0.286)</td>
<td>(0.282)</td>
<td>(0.293)</td>
<td>(0.267)</td>
<td>(0.273)</td>
</tr>
<tr>
<td>Proportion of Left-behind Peers</td>
<td>-1.061**</td>
<td>-0.812*</td>
<td>-0.701**</td>
<td>-0.732**</td>
<td>-0.606*</td>
</tr>
<tr>
<td></td>
<td>(0.432)</td>
<td>(0.447)</td>
<td>(0.321)</td>
<td>(0.336)</td>
<td>(0.354)</td>
</tr>
<tr>
<td>Average Socioeconomic Condition of Classmates</td>
<td>0.511*</td>
<td>0.142***</td>
<td>0.127***</td>
<td>0.257</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.290)</td>
<td>(0.0404)</td>
<td>(0.0325)</td>
<td>(0.306)</td>
<td>(0.0671)</td>
</tr>
<tr>
<td>Average Father Education of Classmates</td>
<td>0.0763</td>
<td>0.0521</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.0671)</td>
<td>(0.0548)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Mother Education of Classmates</td>
<td>0.142***</td>
<td>0.127***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.0404)</td>
<td>(0.0325)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>School FE</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Year Dummy</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Personal Controls</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Household Controls</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Observations</td>
<td>11,519</td>
<td>11,519</td>
<td>11,519</td>
<td>11,519</td>
<td>11,519</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.314</td>
<td>0.319</td>
<td>0.322</td>
<td>0.321</td>
<td>0.324</td>
</tr>
</tbody>
</table>
# Mechanism: Misbehavior

**Table: Students’ Misbehaviors and the Peer Effects: Second Year**

<table>
<thead>
<tr>
<th></th>
<th>Often Fight</th>
<th>Often Cheat</th>
<th>Often Smoke</th>
<th>Often Gaming</th>
<th>Average Index</th>
<th>FPC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of Migrant Peers</td>
<td>-0.0899</td>
<td>0.269***</td>
<td>0.0424</td>
<td>0.124***</td>
<td>0.0614*</td>
<td>0.620</td>
</tr>
<tr>
<td></td>
<td>(0.0996)</td>
<td>(0.0530)</td>
<td>(0.0356)</td>
<td>(0.0435)</td>
<td>(0.0364)</td>
<td>(0.445)</td>
</tr>
<tr>
<td>Proportion of Left-Behind Peers</td>
<td>0.227***</td>
<td>0.182***</td>
<td>0.0126</td>
<td>0.135**</td>
<td>0.0918**</td>
<td>0.869</td>
</tr>
<tr>
<td></td>
<td>(0.0469)</td>
<td>(0.0599)</td>
<td>(0.0519)</td>
<td>(0.0607)</td>
<td>(0.0424)</td>
<td>(0.587)</td>
</tr>
<tr>
<td>Whether Is a Migrant</td>
<td>0.00537</td>
<td>-0.00661</td>
<td>0.0135</td>
<td>0.0408***</td>
<td>0.00864</td>
<td>0.118</td>
</tr>
<tr>
<td></td>
<td>(0.0181)</td>
<td>(0.0196)</td>
<td>(0.0120)</td>
<td>(0.0147)</td>
<td>(0.00888)</td>
<td>(0.119)</td>
</tr>
<tr>
<td>Whether Is a Left-Behind</td>
<td>0.0420*</td>
<td>0.0197</td>
<td>0.0214**</td>
<td>0.0151</td>
<td>0.0156*</td>
<td>0.170</td>
</tr>
<tr>
<td></td>
<td>(0.0211)</td>
<td>(0.0271)</td>
<td>(0.00932)</td>
<td>(0.0158)</td>
<td>(0.00836)</td>
<td>(0.102)</td>
</tr>
</tbody>
</table>

- **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
### Mechanism: Misbehavior - Parents’ Relation

**Table: Relation With Parents: First Year**

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

<table>
<thead>
<tr>
<th></th>
<th>On Exam</th>
<th>On School Performance</th>
<th>On Internet</th>
<th>Relation with Mother</th>
<th>Relation with Father</th>
<th>Average Index</th>
<th>FPC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Whether Is a Migrant</strong></td>
<td>-0.00575</td>
<td>-0.0871***</td>
<td>0.0116</td>
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<td></td>
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<td>(0.0291)</td>
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<td>(0.0191)</td>
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<td><strong>Whether Is a Left-Behind</strong></td>
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<td>-0.0448**</td>
<td>-0.0297</td>
<td>-0.0770***</td>
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<td>-0.0506***</td>
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<tr>
<td></td>
<td>(0.0413)</td>
<td>(0.0207)</td>
<td>(0.0337)</td>
<td>(0.0271)</td>
<td>(0.0301)</td>
<td>(0.0170)</td>
<td>(0.0896)</td>
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<td><strong>School FE</strong></td>
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<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td><strong>Year Dummy</strong></td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
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<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td><strong>Personal Controls</strong></td>
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<td>YES</td>
<td>YES</td>
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<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td><strong>Household Controls</strong></td>
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<td>YES</td>
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<td>YES</td>
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<tr>
<td><strong>Observations</strong></td>
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<td>3,944</td>
<td>3,944</td>
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<td>3,944</td>
<td>3,944</td>
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<tr>
<td><strong>R-squared</strong></td>
<td>0.080</td>
<td>0.071</td>
<td>0.062</td>
<td>0.079</td>
<td>0.079</td>
<td>0.108</td>
<td>0.099</td>
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Table: Adding Students’ Misbehaviors in the Main Regression: Second Year

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<td>0.201</td>
<td>0.160</td>
</tr>
<tr>
<td></td>
<td>(0.322)</td>
<td>(0.253)</td>
<td>(0.259)</td>
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<td>Proportion of Left-Behind Peers</td>
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<td>-0.514**</td>
<td>-0.583**</td>
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<tr>
<td></td>
<td>(0.319)</td>
<td>(0.234)</td>
<td>(0.247)</td>
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<td>Average of Classmates Misbehavior Average Index</td>
<td></td>
<td>-3.822**</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.652)</td>
<td></td>
</tr>
<tr>
<td>Average of Classmates Misbehavior FPC Index</td>
<td></td>
<td></td>
<td>-0.291**</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>(0.141)</td>
</tr>
<tr>
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<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Personal Controls</td>
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<td>YES</td>
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<tr>
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<td>YES</td>
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<tr>
<td>Observations</td>
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<td>4,088</td>
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<tr>
<td>R-squared</td>
<td>0.334</td>
<td>0.346</td>
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### Mechanism: Classroom Environment

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<th>Proportion of Migrant Peers</th>
<th>Friendly-2013</th>
<th>Learning-2013</th>
<th>Average Index-2013</th>
<th>FPC-2013</th>
</tr>
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<tr>
<td></td>
<td>-0.197**</td>
<td>-0.271*</td>
<td>-0.234**</td>
<td>-0.914**</td>
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<td>(0.137)</td>
<td>(0.106)</td>
<td>(0.412)</td>
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<td>Proportion of Left-Behind Peers</td>
<td>-0.392***</td>
<td>-0.743***</td>
<td>-0.568***</td>
<td>-2.194***</td>
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<tr>
<td></td>
<td>(0.106)</td>
<td>(0.237)</td>
<td>(0.155)</td>
<td>(0.594)</td>
</tr>
</tbody>
</table>

| 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 |
### Table: Peer Effects on Class Environment: Second Year

<table>
<thead>
<tr>
<th></th>
<th>Friendly-2014</th>
<th>Learning-2014</th>
<th>Average Index-2014</th>
<th>FPC-2014</th>
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<tr>
<td>Proportion of Migrant Peers</td>
<td>-0.000667</td>
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<td>-0.162</td>
<td>-0.586</td>
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<tr>
<td></td>
<td>(0.0436)</td>
<td>(0.205)</td>
<td>(0.113)</td>
<td>(0.421)</td>
</tr>
<tr>
<td>Proportion of Left-Behind Peers</td>
<td>-0.429***</td>
<td>-0.509***</td>
<td>-0.469***</td>
<td>-1.881***</td>
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<tr>
<td></td>
<td>(0.0830)</td>
<td>(0.141)</td>
<td>(0.105)</td>
<td>(0.411)</td>
</tr>
<tr>
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<td>YES</td>
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<tr>
<td>Personal Controls</td>
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<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Household Controls</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Observations</td>
<td>4,005</td>
<td>4,005</td>
<td>4,005</td>
<td>4,005</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.075</td>
<td>0.112</td>
<td>0.114</td>
<td>0.111</td>
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## Mechanism: Classroom Environment

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

<table>
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<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of Migrant Peers</td>
<td>-0.999**</td>
<td>-0.578*</td>
<td>-0.567*</td>
<td>-0.663**</td>
</tr>
<tr>
<td></td>
<td>(0.383)</td>
<td>(0.296)</td>
<td>(0.296)</td>
<td>(0.266)</td>
</tr>
<tr>
<td>Proportion of Left-Behind Peers</td>
<td>-2.157***</td>
<td>-1.104</td>
<td>-1.088</td>
<td>-0.885</td>
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<tr>
<td></td>
<td>(0.808)</td>
<td>(0.784)</td>
<td>(0.782)</td>
<td>(0.603)</td>
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<tr>
<td>Average of Environment Average Index</td>
<td>1.589***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.468)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average of Environment FPC Index</td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.120)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Classmates’ Relation</td>
<td></td>
<td></td>
<td></td>
<td>2.655***</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.733)</td>
</tr>
<tr>
<td>Average Learning Environment</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.347)</td>
</tr>
<tr>
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<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Personal Controls</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
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<tr>
<td>Household Controls</td>
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<td>YES</td>
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<tr>
<td>Observations</td>
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<td>4,005</td>
<td>4,005</td>
<td>4,005</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.358</td>
<td>0.366</td>
<td>0.366</td>
<td>0.370</td>
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</table>
**Mechanism: Classroom Environment**

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

<table>
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<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
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</thead>
<tbody>
<tr>
<td>Proportion of Migrant Peers</td>
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<td>0.235</td>
<td>0.312</td>
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<td></td>
<td>(0.328)</td>
<td>(0.277)</td>
<td>(0.271)</td>
<td>(0.279)</td>
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<tr>
<td>Proportion of Left-Behind Peers</td>
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<td>-0.0402</td>
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<td>(0.335)</td>
<td>(0.228)</td>
<td>(0.234)</td>
<td>(0.281)</td>
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<td>1.911***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
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<td>(0.111)</td>
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<td>Average Classmates’ Relation</td>
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<td></td>
<td>(0.674)</td>
</tr>
<tr>
<td>Average Learning Environment</td>
<td></td>
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<td></td>
<td>1.265***</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.401)</td>
</tr>
<tr>
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<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Personal Controls</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
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<tr>
<td>Household Controls</td>
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<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Observations</td>
<td>4,005</td>
<td>4,005</td>
<td>4,005</td>
<td>4,005</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.330</td>
<td>0.362</td>
<td>0.362</td>
<td>0.363</td>
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</table>
### Table: Long-term Migrant Students’ Peer Effect

<table>
<thead>
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</thead>
<tbody>
<tr>
<td>Proportion of Migrant Peers</td>
<td>-1.058*</td>
<td>0.106</td>
</tr>
<tr>
<td></td>
<td>(0.551)</td>
<td>(0.325)</td>
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<tr>
<td>Proportion of Left-Behind Peers</td>
<td>-1.242</td>
<td>-0.928**</td>
</tr>
<tr>
<td></td>
<td>(0.841)</td>
<td>(0.425)</td>
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<tr>
<td>Proportion of Migrant Peers (more than five years)</td>
<td>0.958</td>
<td>-0.393</td>
</tr>
<tr>
<td></td>
<td>(0.663)</td>
<td>(0.519)</td>
</tr>
<tr>
<td>School FE</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Personal Controls</td>
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<td>YES</td>
</tr>
<tr>
<td>Household Controls</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Observations</td>
<td>4,072</td>
<td>4,072</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.319</td>
<td>0.337</td>
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</table>
## Appendix: External Validity Concerns

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

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<td>Proportion of Migrant Peers</td>
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<td>0.854</td>
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<tr>
<td></td>
<td>(0.744)</td>
<td>(0.573)</td>
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<td>Proportion of Left-Behind Peers</td>
<td>-0.946*</td>
<td>-0.669*</td>
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<tr>
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<td>(0.530)</td>
<td>(0.350)</td>
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<tr>
<td>Average Score of Migrant Peers in 2013</td>
<td>0.156</td>
<td>0.385*</td>
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<tr>
<td></td>
<td>(0.101)</td>
<td>(0.228)</td>
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<td>Average Score of Left-behind Peers in 2013</td>
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<td></td>
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<td>3,654</td>
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<tr>
<td>R-squared</td>
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<td>0.383</td>
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</table>
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

<table>
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<tr>
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</tr>
<tr>
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<td>(0.273)</td>
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<td>Proportion of Left-Behind Peers</td>
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<tr>
<td></td>
<td>(0.341)</td>
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<td>Proportion of Peers from High-skill Families</td>
<td>0.938***</td>
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<tr>
<td>Year Dummy</td>
<td>YES</td>
</tr>
<tr>
<td>Personal Controls</td>
<td>YES</td>
</tr>
<tr>
<td>Household Controls</td>
<td>YES</td>
</tr>
<tr>
<td>Observations</td>
<td>11,519</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.319</td>
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</table>
### Table: Changes of Human Capital: Increasing Seats for Migrant Students

<table>
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<tr>
<th>Variables</th>
<th>Human Capital Changes (Test Score s.d.)</th>
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<tr>
<td></td>
<td>50% Seat Increase</td>
</tr>
<tr>
<td>Average HC</td>
<td>0.008</td>
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<tr>
<td>Average HC of High-skill Families from Big Cities</td>
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<tr>
<td>Average HC of Low-skill Families from Big Cities</td>
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<tr>
<td>Average HC of High-skill Families from Small Cities</td>
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</tr>
<tr>
<td>Average HC of Low-skill Families from Small Cities</td>
<td>0.015</td>
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</table>

Notes: Average HC stands for Human Capital.
Appendix: Other Measures of Students’ Performances

**Table:** Robustness: Using School-Level Performance Measurement

<table>
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<th>Math</th>
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<tr>
<td></td>
<td>(1) First Year (2) Second Year</td>
<td>(3) First Year (4) Second Year</td>
<td>(5) First Year (6) Second Year</td>
</tr>
<tr>
<td>Proportion of Migrant Peers</td>
<td>-12.26** (4.992)</td>
<td>-2.914 (2.785)</td>
<td>-5.352 (5.600)</td>
</tr>
<tr>
<td>Proportion of Left-Behind Peers</td>
<td>-24.48** (9.550)</td>
<td>-8.003*** (2.991)</td>
<td>-33.45*** (11.67)</td>
</tr>
<tr>
<td>School FE</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Personal Controls</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Household Controls</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Observations</td>
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<td>4,072</td>
<td>4,072</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.145</td>
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<td>0.072</td>
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<tr>
<td>R-squared</td>
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</tr>
</tbody>
</table>
### Table: Robustness: Consider Rural Migrants and Rural Left-Behind

<table>
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<th>(1) Both Years</th>
<th>(2) First Year</th>
<th>(3) Second Year</th>
</tr>
</thead>
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<tr>
<td>Proportion of Rural Migrant Peers</td>
<td>-0.305 (0.375)</td>
<td>-1.123*** (0.374)</td>
<td>0.379 (0.517)</td>
</tr>
<tr>
<td>Proportion of Rural Left-Behind Peers</td>
<td>-1.226*** (0.358)</td>
<td>-1.757*** (0.632)</td>
<td>-1.084*** (0.304)</td>
</tr>
<tr>
<td>School FE</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Year Dummy</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Personal Controls</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Household Controls</td>
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<td>YES</td>
<td>YES</td>
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<tr>
<td>Observations</td>
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<td>4,072</td>
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<tr>
<td>R-squared</td>
<td>0.336</td>
<td>0.358</td>
<td>0.334</td>
</tr>
</tbody>
</table>
**Table: Robustness: Only on Ordinary Locals**

<table>
<thead>
<tr>
<th></th>
<th>(1) Both Years</th>
<th>(2) First Year</th>
<th>(3) Second Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of Migrant Peers</td>
<td>-0.586</td>
<td>-1.179</td>
<td>-0.456</td>
</tr>
<tr>
<td></td>
<td>(0.764)</td>
<td>(1.082)</td>
<td>(0.832)</td>
</tr>
<tr>
<td>Proportion of Left-Behind Peers</td>
<td>-1.308***</td>
<td>-2.098**</td>
<td>-1.006***</td>
</tr>
<tr>
<td></td>
<td>(0.410)</td>
<td>(1.009)</td>
<td>(0.251)</td>
</tr>
<tr>
<td>School FE</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Year Dummy</td>
<td>YES</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>Personal Controls</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Household Controls</td>
<td>NO</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Observations</td>
<td>4,968</td>
<td>2,484</td>
<td>2,484</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.339</td>
<td>0.353</td>
<td>0.346</td>
</tr>
</tbody>
</table>
## Table: Robustness: Only on Public Schools

<table>
<thead>
<tr>
<th></th>
<th>(1) Both Years</th>
<th>(2) First Year</th>
<th>(3) Second Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of Migrant Peers</td>
<td>-0.120 (0.591)</td>
<td>-1.209 (0.766)</td>
<td>0.351 (0.734)</td>
</tr>
<tr>
<td>Proportion of Left-Behind Peers</td>
<td>-1.231*** (0.420)</td>
<td>-2.053** (0.847)</td>
<td>-1.117*** (0.290)</td>
</tr>
<tr>
<td>School FE</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Year Dummy</td>
<td>YES</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>Personal Controls</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Household Controls</td>
<td>NO</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Observations</td>
<td>7,500</td>
<td>3,750</td>
<td>3,750</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.337</td>
<td>0.353</td>
<td>0.340</td>
</tr>
</tbody>
</table>
### Table: Robustness: Left-Behind Children with Both Parents Absent

<table>
<thead>
<tr>
<th></th>
<th>(1) Both Years</th>
<th>(2) First Year</th>
<th>(3) Second Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of Migrant Peers</td>
<td>-0.212</td>
<td>-0.531**</td>
<td>0.0397</td>
</tr>
<tr>
<td></td>
<td>(0.235)</td>
<td>(0.217)</td>
<td>(0.327)</td>
</tr>
<tr>
<td>Proportion of Left-Behind Peers</td>
<td>-1.460***</td>
<td>-2.237***</td>
<td>-1.058***</td>
</tr>
<tr>
<td></td>
<td>(0.447)</td>
<td>(0.631)</td>
<td>(0.373)</td>
</tr>
<tr>
<td>School FE</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Year Dummy</td>
<td>YES</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>Personal Controls</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Household Controls</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Observations</td>
<td>8,144</td>
<td>4,072</td>
<td>4,072</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.336</td>
<td>0.359</td>
<td>0.332</td>
</tr>
</tbody>
</table>
## Appendix: Fixing Hukou Status for All Students

### Table: Robustness: Fixing Hukou Status for All Students

<table>
<thead>
<tr>
<th></th>
<th>(1) Both Years</th>
<th>(2) First Year</th>
<th>(3) Second Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of Migrant Peers</td>
<td>-0.360*</td>
<td>-0.976**</td>
<td>-0.0579</td>
</tr>
<tr>
<td></td>
<td>(0.209)</td>
<td>(0.371)</td>
<td>(0.193)</td>
</tr>
<tr>
<td>Proportion of Left-Behind Peers</td>
<td>-1.243***</td>
<td>-2.062**</td>
<td>-1.050***</td>
</tr>
<tr>
<td></td>
<td>(0.381)</td>
<td>(0.792)</td>
<td>(0.296)</td>
</tr>
<tr>
<td>School FE</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Year Dummy</td>
<td>YES</td>
<td>NO</td>
<td>YES</td>
</tr>
<tr>
<td>Personal Controls</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Household Controls</td>
<td>NO</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Observations</td>
<td>8,144</td>
<td>4,072</td>
<td>4,072</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.338</td>
<td>0.359</td>
<td>0.334</td>
</tr>
</tbody>
</table>
## Table: Classes Without Dropouts

<table>
<thead>
<tr>
<th></th>
<th>(1) First Year</th>
<th>(2) Second Year</th>
<th>(3) Second Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of Migrant Peers</td>
<td>-0.828**</td>
<td>-0.443</td>
<td>-0.0604</td>
</tr>
<tr>
<td></td>
<td>(0.335)</td>
<td>(0.316)</td>
<td>(0.231)</td>
</tr>
<tr>
<td>Proportion of Left-Behind Peers</td>
<td>-2.309</td>
<td>-1.545*</td>
<td>-0.967*</td>
</tr>
<tr>
<td></td>
<td>(1.413)</td>
<td>(0.782)</td>
<td>(0.504)</td>
</tr>
<tr>
<td>Test Score in 2013</td>
<td></td>
<td></td>
<td>0.432***</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.0320)</td>
</tr>
<tr>
<td>School-Grade FE</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Personal Controls</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Household Controls</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Observations</td>
<td>3,488</td>
<td>3,488</td>
<td>3,488</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.272</td>
<td>0.281</td>
<td>0.438</td>
</tr>
</tbody>
</table>
Appendix: Parents’ Investment

Table: Robustness: Parents’ Investment

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Time Spend on Children</th>
<th>Education Expenditure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1) First Years</td>
<td>(2) Second Year</td>
</tr>
<tr>
<td>Proportion of Migrant Peers</td>
<td>-1.060</td>
<td>-3.720</td>
</tr>
<tr>
<td></td>
<td>(0.911)</td>
<td>(3.463)</td>
</tr>
<tr>
<td>Proportion of Left-Behind Peers</td>
<td>0.802</td>
<td>4.712***</td>
</tr>
<tr>
<td></td>
<td>(1.895)</td>
<td>(0.705)</td>
</tr>
<tr>
<td>School FE</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Personal Controls</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Household Controls</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Observations</td>
<td>3,358</td>
<td>3,358</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.073</td>
<td>0.067</td>
</tr>
</tbody>
</table>
Model: Children’s Human Capital $k_{ij}^s$

- When $i = j$:

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

- When $i \neq j$:

$$V_{ij}^s(Migchi) = p_j^s v_{ij}^s(migchi_{pub}) + (1 - p_j^s) v_{ij}^s(migchi_{pri})$$

$$k_{ij}^* = E[\max\{V_{ij}^s(Migchi) + e_{oj}, V_{ij}^s(Left) + e_{oi}\}]$$
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 $i \neq j$:

$$E[max\{V^s(Mig) + e_{oj}, V^s(Left) + e_{oi}\}] = \ln[\exp(V^s(Mig)) + \exp(V^s(Left))]$$
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.
Competitive market. Each city has a CES production function with two inputs: high skill labor and low skill labor

\[
\max_{L_j^h, L_j^l} y_j - w_j^h L_j^h - w_j^l L_j^l
\]

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

- \( A_j^h, A_j^l \): high/low skill labor augmenting productivity
- \( L_j^h, L_j^l \): high/low skill labor demand
- \( \sigma \): elasticity of substitution
Definition

Given the parameter vector \( \Gamma = \{ \beta, \epsilon, \Theta, \phi, \nu, \kappa, \chi, \eta, \sigma \} \) and the city characteristics vector \( \Omega = \{ \Xi, p, A, \tau \} \), the spatial equilibrium is achieved by the endogenous variable vector \( \Delta = \{ w, L, \text{Peer} \} \) 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)
## Model: Fit

### Table: Model Fit

<table>
<thead>
<tr>
<th>Variables</th>
<th>Model</th>
<th>Data</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Migrants</td>
<td>73419</td>
<td>73716</td>
<td>-0.40%</td>
</tr>
<tr>
<td>Net Migrant Inflow from Small to Big</td>
<td>39978</td>
<td>40215</td>
<td>-0.59%</td>
</tr>
<tr>
<td>Total High-skill Migrants</td>
<td>4719</td>
<td>4744</td>
<td>-0.54%</td>
</tr>
<tr>
<td>Total Low-skill Migrants</td>
<td>68701</td>
<td>68972</td>
<td>-0.39%</td>
</tr>
<tr>
<td>Total Migrant Students</td>
<td>24604</td>
<td>24866</td>
<td>-1.1%</td>
</tr>
<tr>
<td>Total Migrant Students to Big</td>
<td>12279</td>
<td>11787</td>
<td>4.2%</td>
</tr>
<tr>
<td>Total Migrant Students to Small</td>
<td>12325</td>
<td>13079</td>
<td>-5.8%</td>
</tr>
<tr>
<td>Total Left-behind Students</td>
<td>48816</td>
<td>48850</td>
<td>-0.070%</td>
</tr>
<tr>
<td>Total Students in Public in Big</td>
<td>33434</td>
<td>32958</td>
<td>1.4%</td>
</tr>
<tr>
<td>Total Students in Public in Small</td>
<td>305567</td>
<td>305947</td>
<td>-0.12%</td>
</tr>
<tr>
<td>Mean Wages of High-skill from Big</td>
<td>54657</td>
<td>54825</td>
<td>-0.31%</td>
</tr>
<tr>
<td>Mean Wages of High-skill from Small</td>
<td>31438</td>
<td>31544</td>
<td>-0.33%</td>
</tr>
<tr>
<td>Mean Wages of Low-skill from Big</td>
<td>20925</td>
<td>20960</td>
<td>-0.17%</td>
</tr>
<tr>
<td>Mean Wages of Low-skill from Small</td>
<td>13836</td>
<td>13871</td>
<td>-0.25%</td>
</tr>
</tbody>
</table>
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
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
Counterfactual III: Allocation with Higher HC, Big or Small?

Figure: Human Capital Changes for Different Seats Allocations