



ARTICLE



<https://doi.org/10.1057/s41599-024-03199-8>

OPEN

Are migrants a threat? Migrant children and human capital investments among local households in urban China

Xiaodong Zheng^{1,2,3} & Yanran Zhou^{1,2}✉

The educational spillovers of migrant children in receiving areas have drawn widespread attention in countries undergoing massive internal migration. Yet few studies have explored how migrant students affect the decision-making process of native households. This study examines the effects and underlying mechanisms of internal migrant children on human capital investments among local households in urban China. Leveraging the random student-classroom assignment within middle schools, we find that migrant peer composition has a significant positive impact on local households' spending on their children's education, especially out-of-school education expenditure. These positive effects are more pronounced among local students who are male, in the ninth grade, and come from high socioeconomic status families. The results of our mechanism analysis suggest that the presence of migrant children leads local parents to overestimate their children's academic performance and raises concerns about potential adverse effects on their children's educational outcomes. However, we have not found compelling evidence indicating that migrant classmates significantly affect local students' learning environment, emotional well-being, and actual academic achievements. Our study contributes to the ongoing debate on the educational inclusion of internal migrant children in China and similar contexts, highlighting the importance of addressing the biased beliefs of local households over migrants.

¹KRI-Modern Business Research Center of Zhejiang Gongshang University, Hangzhou, China. ²School of Economics, Zhejiang Gongshang University, Hangzhou, China. ³School of Economics, Fudan University, Shanghai, China. ✉email: zhouyanran@zjgsu.edu.cn

Introduction

With the continuous global expansion of international and internal migration over the past decades, there has been a substantial focus on the effects of migration on the developmental prospects of both migrants and the native population (Card, 2009; Edo, 2019; Hendriks, 2015). In particular, extensive research has examined the association between the presence of migrant peers and the academic achievements of native children (Brunello and Rocco, 2013; Geay et al., 2013; Hunt, 2017; Hu, 2018; Ohinata and van Ours, 2013). However, there is a scarcity of studies investigating the social spillovers of migrant children on the decision-making process of human capital investments among native families. The significance of this research gap lies in the potential presence of social externalities associated with migrant children influencing local household behaviors. This suggests that prior research on the impact of migration in receiving areas may have been considerably underestimated. Furthermore, exploring the behavioral responses of native families to the presence of migrant children, along with the underlying mechanisms, can provide valuable insights into how these reactions emerge and whether they are warranted. This, in turn, contributes to the development of optimization measures for policies related to population migration and the education market.

To fill this literature gap, our study aims to examine the impacts and potential pathways through which internal migrant children affect human capital investments among local households in urban China, which complements the full picture of the behavioral consequences of migration in receiving areas. As the largest developing country in the world, China presents an interesting case for exploring this issue. First, China has the world's largest scale of internal migration, resulting in a significant number of migrant children.¹ Similar to concerns in Western countries about high migrant populations in schools, many urban Chinese parents are concerned that the presence of migrant students could adversely affect their children's academic performance (Card, 2013; Wang et al., 2018). Second, as a unique feature of China's administrative structure, the household registration (*hukou*) system often determines access to local public resources and services (e.g., child education). This system has become an institutional barrier affecting the educational outcomes of migrant children compared to their local counterparts. Third, Chinese parents prioritize child education and invest heavily in private tutoring to boost student learning and achievement (Zhang, 2013; Zheng et al., 2020).² Due to parents' aspirations for their children to excel and access top schools leading to better job prospects, a competitive dynamic exists among families in investing in private tutoring, even though it doesn't significantly enhance student skills (Guo and Qu, 2022).

Our research primarily addresses two questions: First, do migrant children have spillover effects on human capital investments in local urban households? Second, if the answer to the first question is "yes", how these reactions are generated? Given the causal focus of this study, we apply controls for within-school variations and concentrate on schools employing a random student-classroom assignment. Using data from a nationally representative survey of urban middle school students, our study shows that the presence of migrant children in a class has significant positive effects on household financial investments in the human capital of native students. More specifically, a one-percentage-point increase in the proportion of migrant students in a class results in a 2.3% increase in total education expenditure for their local classmates and a 4.8% increase in out-of-school education expenditure. These positive effects are more pronounced among native students who are boys, in grade nine, and come from families with high socioeconomic status (SES).

We have explored the potential mechanisms and find that the human capital investments of native parents in response to the presence of migrant students appear to stem largely from unfounded concerns regarding the potential adverse effects on their children's academic achievements. Specifically, our findings suggest that as the proportion of migrant students rises in a class, native parents tend to overestimate their children's academic performance and believe that migrant students negatively impact their children's educational outcomes. This perception drives them to invest more in children's private tutoring. From the perspective of local students and teachers, we find that migrant students generally do not have significant effects on the classroom learning environment, quality of school life, emotional well-being, or actual academic test scores of native students. We have additionally explored an alternative hypothesis that migrant students might intensify competition for education investment but find no supporting evidence.

This study contributes to the literature in the following three aspects. First, previous relevant studies primarily concentrate on the impacts of migrant children on the academic achievements of local children, without examining the effects on human capital investments among native families. To the best of our knowledge, this study is the first to investigate the consequences of migrants in receiving areas by focusing on the causal effects of migrant children on the behavioral responses of local households in urban China, highlighting the shadow education investments for their children. Second, we add to the growing body of research on external determinants of household human capital investments by examining the effects of children's migrant peers and delving into the underlying mechanisms driving these behavioral responses. Third, our study also broadly contributes to the ongoing debate on whether native parents' concerns about the negative impacts of migrant children on local children's learning environment and academic performance are valid or unfounded. This carries important implications for policies regarding migration and the local education market, especially considering the widespread phenomenon of internal migrant children in China and similar contexts.

Related literature and background

Educational spillovers of migrant children on native students.

A growing body of literature has investigated the educational consequences of migrant children on native students. Most of the related evidence originates from developed countries, where these studies, with mixed findings, have investigated whether the influx of migrants has a crowding-out effect on the educational outcomes of the natives. Prior research suggests that migrants in the United States are negatively associated with native students' schooling years, especially among native minorities (Betts and Lofstrom, 2000; Borjas, 2004). Using data from the Program for International Student Assessment (PISA) across 27 European countries, Brunello and Rocco (2013) find slight reductions in cognitive skills among native students due to migrant children, with consistent findings in Israel and Denmark (Gould et al., 2009; Jensen and Rasmussen, 2011). However, recent studies from the Netherlands, the UK, and Austria indicate that migrant children have no significant impact on native students' academic performance (Geay et al., 2013; Ohinata and van Ours, 2013; Schneeweis, 2015). Hermansen and Birkelund (2015) even find that Norwegian students with more migrant peers are slightly more likely to complete upper-secondary education.

Comparatively, there are relatively few studies regarding the educational impacts of internal migrant children in developing countries, despite the much larger scale of internal migration

compared to international migration flows (Hu, 2018). Within this limited evidence, the educational spillovers of migrant children on native students also remain ambiguous. Berker (2009) demonstrates that rising internal migrant inflows across Turkish provinces decrease completion rates for middle school and high school among native students, particularly those from low SES households. Nyika and Shepherd (2023) suggest that internal migrants create competition in the local job market, leading to increased enrollment and completion rates for non-migrants in South Africa.

In the context of China, three studies have exploited the random class assignment within middle schools to investigate the impact of internal migrant peers on the academic achievements of local students. Among these, Hu (2018) shows that the rise in the proportion of migrant children in a class has significant adverse effects on the academic performance of local students, largely due to worsened classroom environments and adjustments in teachers' pedagogical practices. Nevertheless, Wang et al. (2018), in their analysis focusing on urban areas, demonstrate that the migrant composition in the classroom does not have a significant impact on the math and English test scores of local ninth graders. Conversely, it has a slight positive effect on the Chinese test scores of local students, which could be attributed to positive peer effects on students' learning attitudes. Huang and Zhang (2023) indicate that the initial presence of internal migrant children has a small negative impact on the cognitive skills of their local peers, but this negative effect vanishes within one year.

The ambiguous effects of migration on natives' educational outcomes may stem from the fact that migrant inflow can alter both the marginal costs and benefits of education. The costs introduced to the local education market by migration include school resource constraints and negative peer effects. An increase in the number of migrant students can strain the efficient utilization of fixed-level school resources, potentially affecting their educational outcomes (Gould et al., 2009). Meanwhile, as migrant children often come from less-resourced educational backgrounds, teachers may adjust their expectations and teaching approaches to cater to those requiring additional support, which can negatively influence the learning experiences of native students (Ohinata and van Ours, 2013).

The migration-induced benefits for local education primarily revolve around the skill premium and potential positive peer effects. On the one hand, when migrants possess skills that are relatively inferior to those of natives, it can lead to an increase in the skill premium for natives and subsequently improve the educational outcomes for local students (Nyika and Shepherd, 2023). On the other hand, new migrants often have a positive view of education and a drive for upward mobility. This could lead migrant children to have high educational aspirations influenced by parental expectations, thereby generating a constructive peer influence that benefits native students (Fekjær and Birkelund, 2007).

Migrant children and human capital investments among local households. Currently, there is scarce research directly investigating the impact of migrant children on human capital investments among local households. However, the existing relevant literature can be leveraged to explore the underlying mechanisms through which such social spillovers may occur. First, if migrant children have impacts on the academic achievements of native students, local households may adopt corresponding human capital investment strategies in response to the peer effects generated by migrant students on their children. Previous studies indicate two primary parental investment strategies related to

child abilities. According to a classic model of intrahousehold resource allocation, parents often reinforce the human capital of their more advantaged children (Becker and Tomes, 1976). Conversely, when prioritizing equity over efficiency, parents tend to adopt a compensatory approach by investing more in the human capital of children with lower abilities (Behrman et al., 1982). Empirically, past research has demonstrated that families with lower SES are more likely to employ a reinforcement strategy, whereas families with higher SES tend to favor a compensatory strategy (Hsin, 2012; Restrepo, 2016). In this scenario, if migrant children negatively affect the skill development of local children, parents in affluent urban areas may adopt a compensatory approach, boosting investments in their children's human capital.

Second, local parents may have the fear or prejudice that migrant children adversely influence their children's learning environment and educational outcomes, even though this is not warranted by the actual situation. Consequently, they increase household investments in their children's education, especially private tutoring, to mitigate potential negative educational effects. A related branch of literature investigates the influence of migrant composition on local families' school choices. These studies reveal a phenomenon of "native flight," wherein the presence of migrant children in public schools can compel native students to switch to private institutions. This shift is driven by local households' concerns regarding the potential adverse effects of migrant children on school resources and teaching methods (Betts and Fairlie, 2003; Rangvid, 2010; Tumen, 2019). Furthermore, recent studies suggest that the local environment, as measured by the average academic achievement of students in the same school, can distort parental beliefs about their child's cognitive skills relative to children of the same age (Kinsler and Pavan, 2021). In this case, given the lower quality of prior education or limited educational background of migrant children, local parents may overestimate their own children's cognitive abilities, thereby intensifying concerns and prejudices regarding the negative educational spillover effects brought about by migrant children.

Third, another possible channel that underlies the spillovers of migrant children on human capital investments among local households is the "competition effect," which motivates native students to pursue higher educational levels to gain an advantage in labor market competition (Hunt, 2017). Parents in Asian countries prioritize child education due to the high returns and competitive school admission systems shaped by socioeconomic inequality (Chung and Lee, 2017; Chen et al., 2021). In China, the belief that "he who excels in study can follow an official career" motivates parents to have high educational expectations of their children and actively participate in the competition for human capital investments to attain upward mobility (Doepke et al., 2019). A recent study has shown a significant "competition effect" among Chinese parents regarding household investments in their children's human capital, particularly in the context of shadow education (Guo and Qu, 2022). They argue that such a "competition" stems from parents' high educational expectations and the greater returns on education due to social inequality, even though it doesn't have a significant impact on children's skills.

Therefore, the presence of migrant children could reshape the wage structure of local labor markets, causing concerns among native families about their children's future job prospects and economic status. Consequently, local households may boost investments in their children's education to improve their competitive edge and potential returns in the future job market. However, the validity of this explanation depends on the extent to which migrant children influence peer pressure and education investment preferences among local households (Zheng and Zhou, 2024).

The *hukou* system and internal migrant children in China. The *hukou* system is a unique and fundamental institution in China that has classified individuals as permanent residents of specific areas since the 1950s. Different from population registration systems in other countries that primarily serve statistical or record-keeping purposes, China's *hukou* system initially operated more like an internal passport system to control population movement and maintain social order (Hu, 2018). Over the past four decades, the *hukou* system has undergone several reforms with migration restrictions gradually being relaxed, which leads to a notable increase in internal migrants and migrant children. As of 2020, it was estimated that China had a total of 71.09 million internal migrant children whose current residence differed from their *hukou* location, with 51.55 million (72.5%) being of school age (NBSC, UNICEF China, UNFPA China, 2023).

Nevertheless, migrants without local *hukou* still face limitations in accessing economic opportunities, social welfare benefits, and public services in local areas. One important constraint is the restricted accessibility to public schools. Although all Chinese school-age children are entitled to a free and compulsory 9-year education as per law, local governments have limited incentives and financial capacity to address the needs of migrant children. This is because elementary education funding is allocated based on the number of children with *hukou* and is not easily portable across different administrative units (Chen and Feng, 2013).

Consequently, many migrant children have to attend informal or poorly-resourced migrant schools. In 2015, around 77% of Chinese internal migrant students attended public schools. In the Pearl River Delta cities, only 46% of migrant children were enrolled in public schools (Yang, 2016). Migrant parents seeking to enroll their children in public schools often face extra costs like "temporary student fees," and "school selection fees." They may also have to submit additional documents, such as proof of local housing ownership, formal employment, and social insurance registration, which many temporary migrants are unable to provide (Hu, 2018). Given the profound long-term impact of child education on a nation's human capital accumulation, economic growth, and societal development, the education issue of migrant children in China has garnered widespread attention from the government, academic community, and the public.

Migrant children and native urban children in China often exhibit differences in family SES, academic performance, and health outcomes. Migrant children typically come from low-SES families characterized by limited parental education, unstable employment, and inadequate housing, which restricts their access to quality educational resources (Chen and Feng, 2013). As a result, migrant children, especially those attending migrant schools with low quality, often lag behind their urban counterparts in academic outcomes and cognitive development (Huang and Zhang, 2023). Additionally, migrant children are more likely to develop mental health problems (e.g., loneliness) since they are often ostracised about their disadvantaged family background and dialect (Hou et al., 2011). Given that migrant children often face socioeconomic and academic challenges, the influx of migrant students in local public schools has raised fears among native households about potential adverse impacts on the learning and behavior of their children (Wang et al., 2018).

However, many previous studies have indicated that there are generally no significant differences in academic achievements between migrant and local students within the same public schools (Lu and Zhou, 2013; Xu and Xie, 2015). Using self-collected panel data in Shanghai, Chen and Feng (2017, 2019) demonstrate that migrant students in public schools perform significantly better than those attending migrant schools. They also show that the lower test scores of migrant students compared to local students are primarily attributed to between-school test

score disparities rather than within-school differences, suggesting the importance of access to high-quality public schools for migrant children's academic success.

Data and variables

Data. The data used in this study are drawn from the China Education Panel Survey (CEPS), a nationally representative longitudinal survey focusing on middle school students since 2014. The CEPS has been conducted by the National Survey Research Center (NSRC) at the Renmin University of China, aiming to explore the links between family, school, and broader societal structures and their impacts on children's developmental outcomes. The survey employed a stratified and multistage sampling design with probability proportional to size (PPS).³ In 2014, a total of 19,487 seventh and ninth students in 438 classes across 112 middle schools in 28 counties participated in the survey. Additionally, the survey included interviews with students' parents, teachers, and school principals.

According to the objective of this study, we initially restrict our sample to the students in public middle schools located in urban areas, highlighting the social spillovers of migrant children on urban households' human capital investments. Given that the primary concern of our study is the potential selection bias issue, we align with previous research and focus on schools that employ random student assignment to classes (Gong et al., 2018; Huang and Zhu, 2020). With the presence of randomization, we can identify the causal effects of migrant children on household human capital investments in local students. Specifically, based on the school principal's report on class assignments, we limit our sample to meet the following two criteria: (i) students are assigned to classrooms randomly at the start of seventh grade, and (ii) schools maintain the same class configurations throughout the eighth and ninth grades. In our sample, 77.7% of urban public middle schools employ a random classroom assignment and do not rearrange classes in grades eight and nine. This aligns with the recommendation by the Ministry of Education of China, which advocates for random classroom assignments to ensure equal and fair opportunities for students during the compulsory education stage.

Additionally, considering the possibility of principals' misreport, we further retain the schools where all head teachers in the same grade confirm that students are not assigned based on test scores. Based on head teachers' reports, we exclude 4.6% of the schools in which teachers report that student assignments are executed according to their test scores. Finally, the sample used for empirical analysis consists of 4312 students (including 797 migrant children and 3515 local children) across 152 classes and 41 schools, with 2328 seventh graders distributed among 80 classes and 1984 ninth graders from 72 classes.

Variables and summary statistics. We measure household human capital investments using four key indicators from parents' reported questions: total education expenditure, in-school education expenditure, out-of-school education expenditure, and parental time investment. These indicators capture both financial outlays and time devoted to students' education (Wang et al., 2022). The overall financial investment is gauged by the total household expenditure spending on their children's education during the surveyed semester. We further categorize household education expenses into two types: in-school expenditure (covering tuition, textbooks, teaching aids, school uniforms, accommodation, and insurance premiums) and out-of-school expenditure (including extracurricular classes, private tutoring, and hobby training). Parental time investment is quantified by the

average daily hours parents dedicate to assisting their children with homework.

In accordance with previous studies (Chen and Feng, 2013; Hu, 2018), we define a migrant student as one whose residence is located outside their home county, where their *hukou* is registered. Subsequently, we calculate the proportion of migrant students in the classroom as the class-level migrant peer composition. In the empirical analysis, we incorporate a range of control variables into our regressions, including student characteristics (gender, age, only-child status, ethnic background, academic record rank in grade six), family characteristics (father's schooling years, mother's schooling years, family economic status), and class attributes (class size, head teacher's gender, age, working experience, and education level).

Table S1 presents the summary statistics for the primary variables used in this study, along with group comparisons based on migrant status using two-sample *t*-tests. In our sample, 23.7% of students are classified as migrant children who left their place of *hukou*. In terms of the disparities in education investments between migrant children and local children, it is intriguing to observe that, without considering other factors, migrant families allocate significantly higher total education expenditure compared to local households. When examining different categories of education spending, migrant children receive significantly greater in-school expenditure than their local peers, while local children's out-of-school expenditure is slightly higher. One important reason could be that the *hukou* system imposes additional costs on migrant students attending urban public schools, as local budgets rely on *hukou* registrations and lack transferability across regions (Hu, 2018). Regarding time investment, local families allocate significantly more time to their children's education than migrant families. The between-group comparisons also demonstrate significant differences in characteristics at the student, family, and class levels between migrant and local students. Therefore, our empirical analyses should account for these factors and include grade-by-school fixed effects to identify the causal impacts.

Empirical methods

Balance tests for the random student-classroom assignment.

Consistent with prior literature regarding classroom peer effects (e.g., Hoxby, 2000; Lavy and Schlosser, 2011; Gong et al., 2018), we adopt students' classmates as the primary peer group in our analysis. A major challenge for our study to identify the causal effects lies in addressing potential selection biases arising from self-selection issues or confounding heterogeneity. Specifically, the composition of migrant peers in classrooms may be influenced by school sorting and the "native flight" phenomenon (Betts and Fairlie, 2003; Card, 2013). Moreover, the presence of migrant children might spuriously correlate with local households' investments in their children's human capital due to other unobserved factors.

To address these concerns, this study focuses on students from middle schools who are randomly assigned to classes based on the reports of school principals and head teachers. We argue that the causal effects would be compelling if the randomness of classroom assignment is confirmed within our sample, as the class-level migrant peer composition is unrelated to potential confounding factors in this context. To ascertain the causal nature of our empirical results, it is crucial to verify the randomness of classroom assignments. As such, we undertake several randomization checks for our sample.

First, we perform a balance test on the characteristics of students in different classes within the same grade of each school. Given that the CEPS includes two classrooms in the same grade

Table 1 Pearson's χ^2 tests for the class assignment, *p*-values.

	Grade 7	Grade 9
Panel A: Student characteristics		
Migrant status	0.249	0.261
Gender	0.903	0.278
Age	0.810	0.756
Only child	0.961	0.349
Ethnic minority	0.754	0.397
Academic record rank in grade 6	0.377	0.834
Panel B: Family characteristics		
Father's education	0.191	0.128
Mother's education	0.131	0.142
Family economic status	0.380	0.194
Panel C: Class characteristics		
Class size	0.706	0.340
Gender of head teacher	0.237	0.808
Age of head teacher	0.664	0.578
Working experience of head teacher	0.275	0.881
Education level of head teacher	0.824	0.820

for each school, we adopt the approach of Ammermueller and Pischke (2009) by conducting Pearson's χ^2 tests to compare a rich set of baseline variables in the survey between these paired classes. Table 1 presents the *p*-values of Pearson's χ^2 tests for the class assignment of grades seven and nine, respectively. The results indicate that students' migrant status and other characteristics related to students, families, and classes show no significant association with their assigned classes. This suggests a well-balanced distribution of attributes between classrooms, providing no significant evidence to reject the null hypothesis of random classroom assignment.

Second, following Ohinata and van Ours (2013), we simulate the process of random student-classroom assignment to test whether there is endogenous sorting of migrant students across classes within a school. Using simulations under random assignment, we compare predicted and actual migrant peer distributions in a class and differences in migrant student numbers between two classes in the same school. If migrant students are truly randomly assigned to classes, we should observe the similarity between the two distributions. Figures S1 and S2 illustrate the kernel density of simulated and actual distributions. It is evident that the classroom migrant student compositions in Fig. S1 are generally identical, with both a two-sample *t*-test (*p*-value = 0.432) and an Epps-Singleton test (*p*-value = 0.564) showing no significant differences in means or distributions, respectively. Likewise, in Fig. S2, the two distributions of between-class differences in the number of migrant children also show no significant distinctions (two-sample *t*-test *p*-value = 0.243; Epps-Singleton test *p*-value = 0.931). These results once again affirm that the schools we focus on randomly assign students to classrooms.

Third, despite the random formation of classes, the non-random assignment of educational resources, such as head teacher capability, could also introduce bias into our estimation results. Therefore, we conduct another balance test to examine the correlations between the proportion of migrant students in a class and the student, parent, and class characteristics (Gong et al., 2018; Zheng and Zhou, 2024). We first separately regress each baseline variable on the class-level proportion of migrant students. In Table 2, column 1 shows that several variables (e.g., academic record rank in grade 6) significantly correlate with the class-level proportion of migrant students, possibly due to grade and school variations. However, after adjusting for grade-by-school fixed effects in column 2, these correlations become

insignificant. Further, we also perform a multiple regression and conduct an *F*-test to assess the joint significance of the associations between the predetermined characteristics and the proportion of migrant children in a class. Table S2 shows an *F*-statistic of 1.36, suggesting no joint significance of student, family, and school characteristics on the share of migrant students. This suggests a balanced distribution of these characteristics across classes with different proportions of migrant children.

In summary, the results of the above three balance tests consistently suggest the random student-classroom assignment, and we cannot reject the hypothesis of idiosyncratic variations in the proportion of migrant children across classes within grades and schools.

Regression model. The objective of this study is to investigate the causal impacts of the migrant peer composition on household human capital investments in local students. If students are assigned to classrooms randomly, unbiased estimates can be obtained using a reduced-form linear regression model through the ordinary least squares (OLS) approach as follows:

$$HI_{ics} = \alpha + propMC_{cs}\beta + X'_{ics}\lambda + D_{gs} + \varepsilon_{ics}$$

(1)

Table 2 Balancing test: migrant children proportion and characteristics of student, family, and class.		
Dependent variable	OLS	Grade-by-school fixed effects
Panel A: Student characteristics		
Gender	0.016 (0.053)	0.152 (0.146)
Age	−0.595 (0.563)	0.237 (0.160)
Only child	−0.041 (0.135)	−0.019 (0.113)
Ethnic minority	−0.208** (0.091)	−0.041 (0.066)
Academic record rank in grade 6	−6.159*** (2.154)	1.841 (3.541)
Panel B: Family characteristics		
Father's education	−0.305 (0.531)	−0.589 (0.786)
Mother's education	−0.300 (0.576)	0.726 (0.696)
Family economic status	0.103 (0.106)	0.107 (0.155)
Panel C: Class characteristics		
Class size	−0.989*** (0.151)	−0.117 (0.132)
Gender of head teacher	−0.276 (0.264)	0.436 (0.428)
Age of head teacher	0.287 (0.432)	1.220 (1.084)
Working experience of head teacher	0.009 (0.398)	0.542 (0.766)
Education level of head teacher	−0.832*** (0.280)	−0.096 (0.557)
Notes: Standard errors in parentheses are clustered at the class level. * <i>p</i> < 0.1, ** <i>p</i> < 0.05, *** <i>p</i> < 0.01.		

where HI_{ics} represents the human capital investment outcomes, including financial and time investments in education, for a local student i in class c of school s . $propMC_{cs}$ denotes is the key independent variable, measuring the proportion of migrant children in the class c of school s . X_{ics} represents a vector of control variables, including predetermined characteristics of students, families, and classes. Considering that the randomization of student-classroom assignment depends on variations in grades and schools, grade-by-school fixed effects (D_{gs}) have been incorporated into the regression model to control for grade-by-school level confounders. ε_{ics} is the unobserved error term. In our regression analysis, standard errors are clustered at the class level to address heteroskedasticity and correlations among students within the same classroom.

Similar to prior studies on classroom peer effects (e.g., Bietenbeck, 2020; Wang et al., 2018), we focus on human capital investments among urban households and use a sample of local students from urban schools in our regression analysis. Given our concentration on middle schools that randomly assign students to classrooms, the migrant peer composition ($propMC_{cs}$) in our restricted sample should be orthogonal to the error term (ε_{ics}) after conditioning on grade-by-school fixed effects (D_{gs}). The vector of control variables (X_{ics}) is expected to have a limited impact on the estimated coefficients but helps to enhance estimation precision. Under the assumption of random student-classroom assignment, our identification strategy involves comparing the household human capital investments in local students from two classes within the same grade of the same school who share similar characteristics, except that one class has a relatively higher share of migrant children due to random factors.⁴ Given that our balance tests in the section “Balance tests for the random student-classroom assignment” show no evidence against the null hypothesis of random student-classroom assignment, the estimated regression results are unlikely affected by school or class selections and other unobserved factors. As such, by using the restricted sample and conditioning on grade-by-school fixed effects, the coefficient of interest, β can be interpreted as a causal effect.

Results

Migrant children and local households’ human capital investments. We first examine the impacts of migrant children on human capital investments among local households in urban areas. Panel A of Table 3 presents the estimates using students from urban schools that randomly assign students to classrooms. The results demonstrate that the presence of migrant peers in the classroom has significant positive impacts on household financial investments in local students’ education. Specifically, in columns (1) and (3), a one-percentage-point rise in the proportion of migrant children in a class increases local students’ total

Table 3 Effects of migrant children on local household human capital investments.				
	Total education expenditure	In-school expenditure	Out-of-school expenditure	Parental time investment
Panel A: students from urban schools that adopt random assignment				
Proportion of migrant children	2.312* (1.196)	0.810 (1.381)	4.766*** (1.075)	−0.193 (0.152)
Observations	3515	3515	3515	3515
R ²	0.073	0.040	0.232	0.032
Panel B: students from urban schools that do not adopt random assignment				
Proportion of migrant children	8.399*** (2.694)	6.209** (3.068)	11.596*** (2.968)	0.206 (0.275)
Observations	1091	1091	1091	1091
R ²	0.179	0.168	0.213	0.038
Notes: Standard errors in parentheses are clustered at the class level. Each regression includes all control variables and controls for grade-by-school fixed effects. * <i>p</i> < 0.1, ** <i>p</i> < 0.05, *** <i>p</i> < 0.01.				

Table 4 Robustness checks: alternative measures of out-of-school educational investment.

	Time on tutoring courses (weekdays)	Time on tutoring courses (weekends)	Number of tutoring subjects	Private tutoring on vacations
Proportion of migrant children	0.303*** (0.070)	0.494*** (0.105)	0.928*** (0.164)	0.280*** (0.071)
Control variables	Yes	Yes	Yes	Yes
Grade-by-school fixed effects	Yes	Yes	Yes	Yes
Observations	3483	3484	3500	3491
R ²	0.050	0.161	0.142	0.138

Notes: Standard errors in parentheses are clustered at the class level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

education expenditure and out-of-school education expenditure by 2.3% and 4.8%, respectively. For a class of 50 students in urban China, having one more migrant classmate (i.e., a 2% increase in the share of migrant children) can result in a 4.6% and 9.8% increase in total education expenditure and extracurricular education expenditure, respectively. However, as seen in columns (2) and (4), class-level migrant peer composition has no significant effects on in-school education expenditure and parental time investment. This suggests that the impacts of migrant children on local household human capital investments are primarily evident in out-of-school education expenses, such as private tutoring and training courses.

In panel B, we perform similar estimations using non-randomized assignment schools, which provide insights into potential estimation biases that may arise when not accounting for the selection problem associated with the migrant peer composition in a class. Panel B reveals a more pronounced positive impact of class-level migrant children on financial education investments compared to Panel A, implying that pooled estimates may overestimate the influence of migrant children on local households' human capital investments. Henceforth, in the subsequent empirical analysis, we exclusively utilize the sample from urban schools that meet the random classroom assignment criteria of this study.

Robustness checks. To validate our main findings, we have performed a battery of robustness checks. First, given our baseline findings highlight migrant children's impact on out-of-school education spending, we test the sensitivity of our results to alternative measures focusing on private tutoring. These measures include students' time (log hours) spent on tutoring courses during weekdays and weekends, the number of tutored subjects, and tutoring attendance during summer or winter vacations. The results in Table 4 consistently indicate that the presence of migrant peers has significant and positive effects on the engagement of local students in private tutoring, as evidenced by both the duration and quantity of tutoring sessions attended. This aligns with our baseline regression results.

Second, we use alternative definitions of migrant children to test the robustness of our main results, including categorizing them as rural or urban based on *hukou* type, and further distinguishing them by living arrangements with parents. Panel A of Table 5 demonstrates that regardless of the alternative measure of migrant children used, the composition of migrant peers has significant positive effects on household financial education investment in local students. Furthermore, among these alternative measures of migrant children, rural migrant children have the most pronounced impact on local households' education expenditures, suggesting that parents of local urban children respond more strongly to rural migrant students.

Third, considering the variations in school quality and community environment across different regions of the city, we further refine our sample by restricting it to schools located at the center of the city based on principals' responses. The estimates in Panel B of Table 5 closely align with our baseline regression results. This suggests that, after controlling for grade-by-school fixed effects, the influence of school and region-related factors on our estimation results is limited.

Fourth, following Eisenberg et al. (2014), we include controls for average attributes of both migrant and local students to account for contextual factors, including the proportion of boys, average paternal and maternal schooling years, and average family economic status. Panel C of Table 5 demonstrates that, even with slightly diminishing effect sizes, the findings persistently affirm the significant positive impact of migrant peers on households' financial human capital investments in local students.

Fifth, considering that local parents' awareness of their children's peers may influence their behavioral responses to migrant children, we address this "observability" issue by narrowing our sample to local students whose parents know some or all of their children's friends. The results in Panel D of Table 5 consistently uphold the notion that the presence of migrant children positively influences local household investments in child education, with slightly larger effect sizes compared to the baseline results.

Sixth, despite the distinct separation of the initiators and recipients of spillover effects in our context, we further include migrant children in our sample to test the robustness of our results. As illustrated in Panel E of Table 5, the estimates reaffirm the positive spillover effects of migrant children on household out-of-school education expenditure, suggesting that our main findings are robust.

Seventh, we implement Oster's (2019) sensitivity analysis for omitted variable bias within the framework of linear regression. As shown in Panel F of Table 5, the values of the proportional degree of selection on unobservables to selection on observables (δ) are 4.3 and 2.1, respectively, when the observed effects are eliminated. This suggests at least a partial causal impact of migrant children on local households' educational spending, especially in shadow education.

Finally, we conduct an additional sensitivity test, as proposed by Gong et al. (2018), to further validate the randomization design. Specifically, we randomly exclude about 10% of schools to create a reduced sample and derive regression estimates, repeating this process 1,000 times to generate coefficient distributions for each human capital investment outcome. As depicted in Fig. S4, the distribution of coefficients obtained from reduced samples consistently centers around our baseline estimates, suggesting that potential bias arising from the inclusion of schools that non-randomly assigned students to classrooms is unlikely to be a significant driver of our results.

Table 5 Additional robustness checks.

	Total education expenditure	In-school expenditure	Out-of-school expenditure	Parental time investment
Panel A: Alternative measures of migrant children				
Proportion of rural migrant children	4.895** (2.098)	2.616 (2.536)	10.469*** (1.877)	−0.172 (0.216)
Proportion of urban migrant children	1.885** (0.899)	0.231 (1.977)	3.512** (1.473)	−0.276 (0.230)
Proportion of migrant children (living with at least one parent)	2.482** (1.225)	0.900 (1.445)	4.952*** (1.108)	−0.212 (0.159)
Proportion of migrant children (living with both parents)	3.483** (1.474)	1.759 (1.709)	5.818*** (1.256)	−0.188 (0.172)
Panel B: Schools located at center of the city				
Proportion of migrant children	2.628** (1.213)	1.258 (1.406)	4.818*** (1.109)	−0.224 (0.157)
Panel C: Additional controls (contextual characteristics)				
Proportion of migrant children	2.044* (1.165)	0.544 (1.343)	4.607*** (1.052)	−0.213 (0.154)
Panel D: Parents know some or all of their child's friends				
Proportion of migrant children	2.395* (1.255)	0.891 (1.452)	4.830*** (1.089)	−0.208 (0.147)
Panel E: Including migrant children				
Proportion of migrant children	1.207 (1.267)	0.366 (1.362)	2.636** (1.017)	−0.136 (0.163)
Panel F: Oster (2019)'s sensitivity test on unobservables				
Proportion of migrant children	2.312* (1.196)	0.810 (1.381)	4.766*** (1.075)	−0.193 (0.152)
Bounds: [β_1 , β_0]	[2.135, 2.312]	[0.810, 1.300]	[3.180, 4.766]	[−0.242, −0.193]
δ required for $\beta = 0$	4.302	−2.308	2.100	−8.971
R^2	0.073	0.040	0.232	0.032
R_{\max}	0.095	0.052	0.302	0.042

Notes: Standard errors in parentheses are clustered at the class level. Each regression has controlled for all controls and grade-by-school fixed effects. The coefficients and corresponding standard errors in each cell come from one regression. Additional controls in Panel B include the proportion of boys, average paternal schooling years, average maternal schooling years, and average family economic status among migrant children, and proportion of boys, average paternal schooling years, average maternal schooling years, and average family economic status among non-migrant children. Oster's test assumes $R_{\max} = 1.3(R^2)$, where R^2 is from the OLS regressions with all controls. The lower bound β_1 is estimated on the basis that the proportional amount of selection on unobservables to selection on observables is 0 (i.e., $\delta = 0$). The upper bound β_0 is calculated when $\delta = 1$, that is, the proportional degree of selection on unobservables is equal to selection on observables ($\delta = 1$). The estimated δ required for $\beta = 0$ indicates that relative to selection on observables, there should be δ times the amount of selection on unobservables for the estimated relationship between the proportion of migrant children and local urban households' human capital investment indicators to become insignificant. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Heterogeneous effects. Table 6 reports the results of the heterogeneity analysis by local students' gender, grade, parental education, and family economic status. Panel A shows that, compared to their female counterparts, the proportion of migrant children in the class has a relatively larger positive impact on educational expenditures in local boys. An important potential reason is the prevailing son preference in Chinese households and the elevated expectations for male education (Jiang et al., 2016). This results in families frequently allocating more resources to boys' education than to girls' when making decisions about human capital investments.

In Panel B, heterogeneous effects by students' grades demonstrate that ninth graders are more significantly influenced by migrant peer composition on both in-school and out-of-school education expenditures compared to seventh graders. A plausible explanation is that ninth graders often experience greater academic pressures due to the competitive nature of high school enrollment exams (Zheng and Zhou, 2024). This heightened pressure makes local households more sensitive to investments in their children's education in the presence of migrant students.

Concerning heterogeneity by household SES, we initially divide the sample into two subgroups by parental education, using a threshold indicating whether at least one parent has obtained a high school degree. In Panel C, the spillover effects of migrant children on financial education investments are significantly larger for local households with higher-educated parents compared to those with lower educational levels. Additionally, we differentiate between high ("somewhat rich" or "very rich") and low economic status families based on parent-reported questions about household financial condition. The estimates in Panel D reveal that the positive effects of migrant peer composition on financial education investments are more pronounced among local households with higher economic status

than those with lower financial conditions. Taken together, local households with a higher SES significantly increase education investment for their children due to the presence of migrant children.

Mechanism analysis. In this section, we explore the underlying mechanisms by which migrant children influence human capital investments among local households, including parental beliefs and teachers' perspectives on students' learning environments and academic achievements, as well as students' perceived well-being and actual performance (see variable definitions for mechanism analysis in Table S3).

Table 7 presents the results of the impacts of class-level migrant peer composition on local parents' beliefs about their children's academic achievements and learning environment. Columns (1) and (2) of Panel A show that the share of migrant children in a class has no significant impact on local parents' educational expectations or confidence in their children's future. However, columns (3) to (5) in Panel A demonstrate that migrant students lead local parents to overestimate their children's academic achievement, perceiving migrant students' performance as generally lagging behind their children's achievement. In Panel B, columns (1) and (2) indicate that a larger share of migrant children heightens local parents' emphasis on friends and private tutoring for their children's academic performance. Columns (3) to (5) suggest that with a rising number of migrant students, native parents increasingly feel that their children dislike peers and view migrant students as detrimental to educational quality and school atmosphere. Concerning parental beliefs about school teachers in Panel C, columns (1) and (2) suggest that migrant children lead local parents to believe that their children are less fond of school teachers. Additionally, in columns (3) to (5), an

Table 6 Heterogeneous effects of migrant children on local household human capital investments.

	Total education expenditure	In-school expenditure	Out-of-school expenditure	Parental time investment
<i>Panel A: Gender</i>				
Male	2.608*** (0.926)	2.163** (1.025)	5.395*** (0.762)	−0.082 (0.141)
Female	2.037 (1.289)	−0.503 (1.030)	4.032*** (0.800)	−0.252 (0.222)
Group differences	0.270	0.030	0.150	0.470
(p-value)				
<i>Panel B: Grade</i>				
Grade 7	2.362** (0.987)	−0.600 (1.094)	3.852*** (0.797)	−0.150 (0.159)
Grade 9	3.036*** (0.909)	2.657** (1.065)	5.755*** (0.795)	−0.104 (0.144)
Group differences	0.190	0.010	0.030	0.420
(p-value)				
<i>Panel C: Parental education</i>				
High school degree or above	3.871*** (1.002)	2.626** (1.030)	5.262*** (0.765)	−0.111 (0.180)
Below high school degree	0.713 (1.232)	−0.822 (1.058)	3.786*** (0.826)	−0.307 (0.231)
Group differences	0.000	0.020	0.090	0.120
(p-value)				
<i>Panel D: Family economic status</i>				
High family economic status	3.445** (1.391)	3.731** (1.824)	4.730*** (1.509)	−0.126 (0.251)
Low family economic status	2.115*** (0.695)	0.356 (0.789)	3.498*** (0.596)	−0.191 (0.128)
Group differences	0.160	0.060	0.140	0.360
(p-value)				

Notes: Standard errors in parentheses are clustered at the class level. Each regression includes all control variables and controls for grade-by-school fixed effects. The coefficients and corresponding standard errors in each cell come from one regression. In Panel D, if the answers to the parent-reported question “how is the financial condition of your family at present” are “somewhat rich” or “very rich”, we then treat the households as high-economic status families. Otherwise, they are regarded as low economic status families. Group differences (p-value) are from between-group tests of difference in coefficients after seemingly unrelated estimations (SUEST). * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 7 Mechanism analysis: parental beliefs.

Panel A: Parental beliefs about their children					
	Education expectation	Confidence about the child's future	Biased belief about the child's academic achievement	Underestimate the child's academic achievement	Overestimate the child's academic achievement
Proportion of migrant children	−0.053 (0.295)	−0.030 (0.289)	1.259*** (0.271)	−0.478*** (0.128)	0.547*** (0.132)
Observations	3507	3504	3443	3443	3443
R ²	0.178	0.102	0.132	0.112	0.106
Panel B: Parental beliefs about students' peers and private tutoring					
	Friends are important for students' grade	Private tutoring is important for students' grade	This child likes his/her schoolmates	Migrant children are harmful to educational quality	Migrant children are harmful to school atmosphere
Proportion of migrant children	0.233*** (0.076)	0.069* (0.037)	−0.290* (0.149)	0.129*** (0.044)	0.073* (0.041)
Observations	3515	3515	3515	3320	3317
R ²	0.023	0.018	0.038	0.022	0.020
Panel C: Parental beliefs about school teachers					
	This child likes homeroom teacher	This child likes other teachers at school	Students with academic records above average benefit most from the teachers	School teachers are responsible for this child	School teachers are patient with this child
Proportion of migrant children	−0.580*** (0.157)	−0.385** (0.160)	−0.080* (0.045)	−0.323** (0.142)	−0.441*** (0.143)
Observations	3482	3466	3468	3503	3495
R ²	0.063	0.070	0.020	0.070	0.087

Notes: The dependent variable in each regression is standardized to zero mean and unit variance. Standard errors in parentheses are clustered at the class level. Each regression includes all control variables and controls for grade-by-school fixed effects. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

	Total education expenditure	In-school expenditure	Out-of-school expenditure	Parental time investment
Panel A: Ranking distance within 5				
Proportion of migrant children	1.040** (0.462)	−0.007 (0.532)	2.563*** (0.411)	−0.129 (0.081)
Observations	3464	3464	3464	3464
R ²	0.077	0.050	0.220	0.030
Panel B: Ranking distance within 10				
Proportion of migrant children	1.370** (0.554)	0.265 (0.627)	3.327*** (0.477)	−0.119 (0.087)
Observations	3497	3497	3497	3497
R ²	0.077	0.050	0.222	0.030
Panel C: Ranking distance within 20				
Proportion of migrant children	1.765*** (0.601)	0.346 (0.689)	4.292*** (0.516)	−0.149 (0.095)
Observations	3509	3509	3509	3509
R ²	0.078	0.050	0.228	0.031
Panel D: Students ranked lower than the child as peers				
Proportion of migrant children	0.990** (0.478)	−0.242 (0.548)	2.522*** (0.431)	−0.072 (0.074)
Observations	3504	3504	3504	3504
R ²	0.077	0.050	0.219	0.030
Panel E: Students ranked higher than the child as peers				
Proportion of migrant children	0.579 (0.467)	−0.046 (0.526)	1.882*** (0.429)	−0.128 (0.083)
Observations	3309	3309	3309	3309
R ²	0.074	0.050	0.219	0.033

Notes: Standard errors in parentheses are clustered at the class level. Each regression includes all control variables and controls for grade-by-school fixed effects. *p < 0.1, **p < 0.05, ***p < 0.01.

increase in local children’s migrant peers also leads local parents to think that academically strong students face more challenges with teacher instruction and see teachers as less dedicated and patient with their children.

In Table 8, we examine the “competition effect” hypothesis regarding local households’ behavioral responses to migrant students. If this hypothesis holds true, the impact of migrant children on local households’ education investment is expected to be more pronounced among peers with similar academic performance. With this in mind, we redefine the peer group for each student based on classmates whose academic ranking is within 5 places from them in grade six, then calculate the percentage of migrant children within this revised peer group and rerun the baseline regressions.

Panel A of Table 8 shows the positive impacts of migrant peers on local students’ human capital investments, but the effect sizes are smaller in the new peer group compared to baseline regressions. When extending the ranking distance to 10 and 20 in Panels B and C, the effect sizes of migrant children increase. This suggests the “competition effect” is not the main driver of local households’ investment responses. In Panels D and E, we differentiate peers based on academic rankings relative to the focal student. The results reveal a stronger impact on local households’ education expenditures when considering migrant peers with lower academic achievement. This once again underscores that local parents’ concerns are primarily driven by potential negative spillovers from migrant children with poor academic performance, rather than increased educational competition.

Table 9 examines the impact of migrant children on teachers’ reported pedagogical practices and classroom learning environment. Panel A shows that the presence of migrant children does not significantly affect the pedagogical practices of Chinese and English teachers, while math teachers less frequently use group discussions, teacher-student interaction, multi-media projectors, and internet-based tools in classrooms with a higher proportion of migrant students. This may stem from migrant students’ lower prior education levels or potential discrimination by some local teachers (Zheng et al., 2023). In Panel B, we find no significant impact of migrant children on the classroom learning

environment reported by teachers across various subjects, including class discipline, student relationships, and teaching effectiveness.

Table 10 reports the estimation results for students’ quality of school life, emotional well-being, and actual academic test scores. Panel A indicates no significant association between the proportion of migrant children and class climate or student relationships. Similarly, Panel B shows no significant rise in emotional problems among local students due to migrant peers. Moreover, Panel C reveals no significant impact of having migrant classmates on the academic test scores of local students. One concern about the results’ validity is that household human capital investments might mediate the relationship between migrant peers and local students’ academic performance. To address this concern, we further control for total education expenditure and parental time investment to isolate the direct impact of migrant children on local students’ academic outcomes.

In Panel A of Table S4, the presence of migrant children remains insignificantly associated with local students’ academic performance and cognitive skills after accounting for household human capital investments. This suggests that increased household investments may not be effective in improving student test scores in response to migrant peers. Given that peer effects on students’ academic performance may need time to become apparent, in Panel B, we substitute the dependent variable with the academic indicators of 8th-grade students from the follow-up survey conducted one year later. The results suggest that even after considering baseline household human capital investments, the presence of migrant peers still does not significantly affect the academic performance of local students.

Discussion

Exploiting the random assignment of students to classrooms in middle schools, this study sheds light on the social spillovers of internal migrant children on human capital investments among local households in urban China. The results show that the share of migrant children in a class has a significant positive effect on local households’ educational expenditures, especially out-of-school education spending. These positive educational spillover

Table 9 Teachers' view: teachers' pedagogical practices and students' learning environment.

	Panel A: Teachers' pedagogical practices				
	Lecturing	Group discussion	Interaction with students	Multi-media projectors	Internet
<i>Chinese teachers' view</i>					
Proportion of migrant children	0.551 (1.028)	−0.624 (1.029)	−1.694 (1.272)	0.785 (0.706)	0.954 (0.791)
Observations	2627	2683	2672	2683	2484
R ²	0.375	0.558	0.444	0.726	0.710
<i>Math teachers' view</i>					
Proportion of migrant children	−0.115 (1.022)	−1.965** (0.969)	−2.005* (1.034)	−1.833* (1.091)	−3.199** (1.607)
Observations	2406	2415	2425	2425	2359
R ²	0.605	0.621	0.548	0.573	0.450
<i>English teachers' view</i>					
Proportion of migrant children	−0.314 (1.153)	1.984 (1.260)	0.677 (1.024)	−1.142 (0.877)	−1.482 (1.156)
Observations	2870	2870	2870	2842	2641
R ²	0.471	0.534	0.516	0.728	0.531
	Panel B: Students' learning environment				
	Class discipline	Class management	Student relationship	Student academic ability	Teaching effectiveness
<i>Chinese teachers' view</i>					
Proportion of migrant children	1.550 (1.131)	1.133 (1.314)	1.140 (0.775)	0.184 (1.131)	0.813 (1.278)
Observations	2530	2712	2558	2666	2530
R ²	0.417	0.354	0.140	0.526	0.393
<i>Math teachers' view</i>					
Proportion of migrant children	0.694 (1.295)	−1.112 (0.955)	1.849 (1.220)	−0.581 (1.308)	1.245 (1.319)
Observations	2109	2398	2109	2398	2109
R ²	0.669	0.587	0.631	0.402	0.678
<i>English teachers' view</i>					
Proportion of migrant children	0.344 (1.088)	0.606 (0.750)	0.520 (1.048)	−0.541 (1.240)	0.932 (1.116)
Observations	2576	2743	2576	2741	2576
R ²	0.619	0.132	0.588	0.558	0.567

Notes: The dependent variable in each regression is standardized to zero mean and unit variance. Standard errors in parentheses are clustered at the class level. Each regression includes all control variables and controls for grade-by-school fixed effects. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 10 Students' quality of school life, emotional well-being, and academic achievement.

	Panel A: Quality of school life				
	Classmates are nice	Often take part in class activities	Class in a good atmosphere	Feel close to people at school	Feel bored at school
Proportion of migrant children	0.058 (0.256)	−0.071 (0.281)	−0.295 (0.311)	−0.152 (0.326)	−0.352 (0.279)
Observations	3485	3491	3489	3462	3483
R ²	0.090	0.159	0.149	0.124	0.088
	Panel B: Emotional well-being				
	Feeling blue	Feeling depressed	Feeling unhappy	Feeling not enjoying life	Feeling sad
Proportion of migrant children	−0.093 (0.152)	−0.059 (0.141)	−0.002 (0.146)	0.031 (0.147)	−0.177 (0.148)
Observations	3434	3429	3428	3426	3430
R ²	0.028	0.028	0.032	0.020	0.027
	Panel C: Academic achievement				
	Chinese test score	Math test score	English test score	Average academic score	Cognitive test score
Proportion of migrant children	−0.005 (0.625)	−0.434 (0.566)	−0.500 (0.610)	−0.308 (0.569)	−0.384 (0.289)
Observations	3461	3461	3463	3464	3515
R ²	0.519	0.405	0.469	0.500	0.315

Notes: The dependent variable in each regression is standardized to zero mean and unit variance. Standard errors in parentheses are clustered at the class level. Each regression includes all control variables and controls for grade-by-school fixed effects. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

effects are more prominent among local students who are boys, in grade nine, and come from families with high parental education and economic status. Furthermore, compared to urban migrant children, the presence of rural migrant children leads to a more significant increase in educational spending by local urban families.

We have explored possible mechanisms and find that the presence of migrant children leads local parents to overestimate their children's academic performance and harbor concerns about potential adverse "threats" on their children's learning environment and educational quality. Nevertheless, we have not found strong evidence that migrant children significantly affect the classroom's learning environment, teaching effectiveness, or local students' emotional well-being and academic achievements. Additionally, we consider the notion that the presence of migrant children might create "competition effects" on local household investments in education but find no evidence to support this hypothesis.

Our findings are consistent with previous studies suggesting that the presence of internal migrant children in the same class has little influence on local students' educational outcomes (e.g., Wang et al., 2018; Huang and Zhang, 2023). As highlighted by Cheng and Feng (2019), the academic performance gap between migrant children and native children is mainly attributed to differences between schools rather than within-school variations. This suggests that the root cause of the lower academic performance often observed in migrant children is their lack of accessibility to local public schools offering high-quality education. Consequently, the behavioral responses of local households towards their children's educational expenditures appear to be driven by unwarranted overconcern. This behavioral reaction largely stems from biases and prejudice against migrants held by local families, posing a challenge to the social integration of migrants in the local community.

Furthermore, our research findings indicate that regardless of whether compensatory investments by local households are considered, there is no significant improvement in the academic performance of urban students due to increased education expenditure in response to migrant children, at least in the short term. This suggests that the compensatory strategies adopted by local parents to enhance their children's human capital yield limited results. One potential explanation is that engaging in high-intensity private tutoring can negatively impact children's emotional well-being and hinder their academic improvement. The high academic burden of students has already prompted regulatory measures by the Chinese government to reduce academic stress and control the excessive growth of the tutoring industry (Guo and Qu, 2022; Zheng et al., 2020).

Our findings carry significant policy implications for the educational inclusion of migrant children in China. First, local governments should reduce institutional barriers for migrant students, especially those from lower socioeconomic backgrounds, ensuring equal access to high-quality education in local public schools. Second, policymakers should also implement measures to reduce incentives for excessive extracurricular spending by increasing public education funding and promoting social equality. Third, fostering effective communication between local schools and parents can also help mitigate biased perceptions and subsequent irrational behaviors of local households arising from information friction.

This study has several limitations due to data constraints. First, despite employing various definitions of migrant children and obtaining consistent results, we are unable to explore heterogeneous effects based on the duration of their local residence. Second, due to the lack of information, we are also

constrained from investigating other forms of household time investments in child education, including the time contributed by additional caregivers (e.g., grandparents). Third, given that our sample consists exclusively of middle school students rather than encompassing children of all age groups, caution is warranted when generalizing the findings of our study. Additionally, given our focus on internal migrant children within China's context, it is also important to exercise caution when applying our findings to other contexts with different migration types (e.g., international migration) and varying levels of educational market competitiveness. Thus, we encourage future studies in diverse contexts to deepen our understanding of local households' decision-making processes in response to the presence of migrants.

Conclusion

This study examines the effects of migrant children on local households' human capital investments in urban China. The results reveal that having migrant classmates significantly increases education expenditures for local students, particularly among males, ninth graders, and those from high SES families. We further find that the increase in local households' human capital investments is not due to the negative impacts of migrant peers on the learning environment, educational quality, or academic outcomes of native students. Instead, the presence of migrant children leads local parents to overestimate their own children's academic performance and harbor unfounded concerns about the potential negative educational effects of migrant students on their children. Our study provides new insights into the social exclusion of migrant children in receiving areas, underscoring the importance of addressing local households' biased beliefs towards migrants.

Data availability

The data that support the findings of this study have been enclosed as supplementary files. Further inquiries can be directed to the corresponding author upon reasonable request.

Received: 22 December 2023; Accepted: 14 May 2024;

Published online: 25 May 2024

Notes

- 1 In 2020, 249 million individuals (66.2%) migrated from rural to urban areas, whereas 127 million (33.8%) moved between urban areas. Meanwhile, there were 71.09 million internal migrant children in China, comprising 23.9% of the total child population (NBSC, UNICEF China, UNFPA China, 2023).
- 2 According to a report by the research and consulting firm Frost & Sullivan, shadow education was accessed by 33.9% (57.3 million) of primary and middle school students in China in 2017, with a penetration rate of 62.9% in top-tier cities and 25.3% in other cities.
- 3 See supplementary material S1 for more details about the sampling design of the CEPS.
- 4 Fig. S3 illustrates the kernel distribution of the class-level proportion of migrant children, suggesting a large variation in class-level migrant peer composition.

References

- Ammermueller A, Pischke J (2009) Peer effects in European primary schools: evidence from the progress in international reading literacy study. *J Labor Econ* 27:315–348. <https://doi.org/10.1086/603650>
- Becker GS, Tomes N (1976) Child endowments and the quantity and quality of children. *J Polit Econ* 84:S143–S162. <https://doi.org/10.1086/260536>
- Behrman JR, Pollak RA, Taubman P (1982) Parental preferences and provision for progeny. *J Polit Econ* 90:52–73. <https://doi.org/10.1086/261039>

- Berker A (2009) The impact of internal migration on educational outcomes: evidence from Turkey. *Econ Educ Rev* 28:739–749. <https://doi.org/10.1016/j.econedurev.2009.03.003>
- Betts JR, Fairlie RW (2003) Does immigration induce 'native flight' from public schools into private schools? *J Public Econ* 87:987–1012. [https://doi.org/10.1016/S0047-2727\(01\)00164-5](https://doi.org/10.1016/S0047-2727(01)00164-5)
- Betts JR, Lofstrom M (2000) The Educational Attainment of Immigrants: Trends and Implications. In: Issues in the economics of immigration. University of Chicago Press, pp. 51–116
- Bietenbeck J (2020) The long-term impacts of low-achieving childhood peers: evidence from project STAR. *J Eur Econ Assoc* 18:392–426. <https://doi.org/10.1093/jea/jvy049>
- Borjas GJ (2004) Do foreign students crowd out native students from graduate programs? National Bureau of Economic Research Working Paper Series
- Brunello G, Rocco L (2013) The effect of immigration on the school performance of natives: cross country evidence using PISA test scores. *Econ Educ Rev* 32:234–246. <https://doi.org/10.1016/j.econedurev.2012.10.006>
- Card D (2009) Immigration and inequality. *Am Econ Rev* 99:1–21. <https://doi.org/10.1257/aer.99.2.1>
- Card D (2013) Peer effects of immigrant children on academic performance of native speakers: introduction. *Econ J* 123:F279–F280. <https://doi.org/10.1111/ecoj.12053>
- Chen Y, Feng S (2013) Access to public schools and the education of migrant children in China. *China Econ Rev* 26:75–88. <https://doi.org/10.1016/j.chieco.2013.04.007>
- Chen Y, Feng S (2017) Quality of migrant schools in China: evidence from a longitudinal study in Shanghai. *J Popul Econ* 30:1007–1034. <https://doi.org/10.1007/s00148-016-0629-5>
- Chen Y, Feng S (2019) The education of migrant children in China's urban public elementary schools: evidence from Shanghai. *China Econ Rev* 54:390–402. <https://doi.org/10.1016/j.chieco.2019.02.002>
- Chen Y, Dong C, Zhu B (2021) Peer effects between migrant and local children: who dominates? *China Econ Quart* 21(2):511–532. (in Chinese)
- Chung K, Lee D (2017) Inefficient competition in shadow-education investment. *J Econ Behav Organ* 139:152–165. <https://doi.org/10.1016/j.jebo.2017.05.007>
- Doepke M, Sorrenti G, Zilibotti F (2019) The economics of parenting. *Annu Rev Econ* 11:55–84. <https://doi.org/10.1146/annurev-economics-080218-030156>
- Edo A (2019) The impact of immigration on the labor market. *J Econ Surv* 33:922–948. <https://doi.org/10.1111/joes.12300>
- Eisenberg D, Golberstein E, Whitlock JL (2014) Peer effects on risky behaviors: new evidence from college roommate assignments. *J Health Econ* 33:126–138. <https://doi.org/10.1016/j.jhealeco.2013.11.006>
- Fekjær SN, Birkelund GE (2007) Does the ethnic composition of upper secondary schools influence educational achievement and attainment? A multilevel analysis of the Norwegian case. *Eur Socio Rev* 23:309–323. <https://doi.org/10.1093/esr/jcm003>
- Geay C, McNally S, Telhaj S (2013) Non-native speakers of English in the classroom: what are the effects on pupil performance? *Econ J* 123:F281–F307. <https://doi.org/10.1111/ecoj.12054>
- Gong J, Lu Y, Song H (2018) The effect of teacher gender on students' academic and noncognitive outcomes. *J Labor Econ* 36:743–778. <https://doi.org/10.1086/696203>
- Gould ED, Lavy V, Daniele Paserman M (2009) Does immigration affect the long-term educational outcomes of natives? Quasi-experimental evidence. *Econ J* 119:1243–1269. <https://doi.org/10.1111/j.1468-0297.2009.02271.x>
- Guo J, Qu X (2022) Competition in household human capital investments: Strength, motivations and consequences. *J Dev Econ* 158:102937. <https://doi.org/10.1016/j.jdeveco.2022.102937>
- Hendriks M (2015) The happiness of international migrants: a review of research findings. *Migr Stud* 3:343–369. <https://doi.org/10.1093/migration/mnu053>
- Hermansen AS, Birkelund GE (2015) The impact of immigrant classmates on educational outcomes. *Soc Forces* 94:615–646. <https://doi.org/10.1093/sf/sov073>
- Hoxby C (2000) Peer effects in the classroom: learning from gender and race variation. National Bureau of Economic Research Working Paper Series
- Hou S, Yuan X, Liu Y, Lin X, Fang X (2011) The effect of social support and perceived discrimination on loneliness among migrant children: a longitudinal study. *Psychol Dev Educ* 27(4):401–411
- Hsin A (2012) Is biology destiny? Birth weight and differential parental treatment. *Demography* 49:1385–1405. <https://doi.org/10.1007/s13524-012-0123-y>
- Hu F (2018) Migrant peers in the classroom: is the academic performance of local students negatively affected? *J Comp Econ* 46(2):582–597. <https://doi.org/10.1016/j.jce.2017.11.001>
- Huang B, Zhu R (2020) Peer effects of low-ability students in the classroom: evidence from China's middle schools. *J Popul Econ* 33:1343–1380. <https://doi.org/10.1007/s00148-020-00780-8>
- Huang Z, Zhang J (2023) School restrictions, migration, and peer effects: a spatial equilibrium analysis of children's human capital in China. Available at <https://doi.org/10.2139/ssrn.3678300>. Accessed on 10 December 2023
- Hunt J (2017) The impact of immigration on the educational attainment of natives. *J Hum Resour* 52:1060–1118. <https://doi.org/10.3368/jhr.52.4.0115-6913R1>
- Jensen P, Rasmussen AW (2011) The effect of immigrant concentration in schools on native and immigrant children's reading and math skills. *Econ Educ Rev* 30(6):1503–1515. <https://doi.org/10.1016/j.econedurev.2011.08.002>
- Jiang Q, Li Y, Sánchez-Barricarte JJ (2016) Fertility intention, son preference, and second childbirth: survey findings from Shaanxi Province of China. *Soc Indic Res* 125:935–953. <https://doi.org/10.1007/s12005-015-0875-z>
- Kinsler J, Pavan R (2021) Local distortions in parental beliefs over child skill. *J Polit Econ* 129:81–100. <https://doi.org/10.1086/711347>
- Lavy V, Schlosser A (2011) Mechanisms and impacts of gender peer effects at school. *Am Econ J Appl Econ* 3:1–33. <https://doi.org/10.1257/app.3.2.1>
- Lu Y, Zhou H (2013) Academic achievement and loneliness of migrant children in China: school segregation and segmented assimilation. *Comp Educ Rev* 57:85–116. <https://doi.org/10.1086/667790>
- NBSC, UNICEF China, UNFPA China (2023) What the 2020 census can tell us about children in China: facts and figures. Available at <https://www.unicef.cn/en/reports/population-status-children-china-2020-census>. Accessed on 3 April 2024
- Nyika F, Shepherd D (2023) Impact of migration on non-migrant school completion rates and enrolment in South Africa. *Afr Hum Mobil Rev* 9(1):10–32. <https://doi.org/10.14426/ahmr.v9i1.1158>
- Ohinata A, van Ours JC (2013) How immigrant children affect the academic achievement of native Dutch children. *Econ J* 123:F308–F331. <https://doi.org/10.1111/ecoj.12052>
- Oster E (2019) Unobservable selection and coefficient stability: theory and evidence. *J Bus Econ Stat* 37:187–204. <https://doi.org/10.1080/07350015.2016.1227711>
- Rangvid BS (2010) School choice, universal vouchers and native flight from local schools. *Eur Socio Rev* 26:319–335. <https://doi.org/10.1093/esr/jcp024>
- Restrepo BJ (2016) Parental investment responses to a low birth weight outcome: who compensates and who reinforces? *J Popul Econ* 29:969–989. <https://doi.org/10.1007/s00148-016-0590-3>
- Schneeweis N (2015) Immigrant concentration in schools: Consequences for native and migrant students. *Labour Econ* 35:63–76. <https://doi.org/10.1016/j.labeco.2015.03.004>
- Tumen S (2019) Refugees and 'native flight' from public to private schools. *Econ Lett* 181:154–159. <https://doi.org/10.1016/j.econlet.2019.05.030>
- Wang H, Cheng Z, Smyth R (2018) Do migrant students affect local students' academic achievements in urban China? *Econ Educ Rev* 63:64–77. <https://doi.org/10.1016/j.econedurev.2018.01.007>
- Wang H, Cheng Z, Smyth R (2022) Parental misbeliefs and household investment in children's education. *Econ Educ Rev* 89:102284. <https://doi.org/10.1016/j.econedurev.2022.102284>
- Xu H, Xie Y (2015) The causal effects of rural-to-urban migration on children's well-being in China. *Eur Socio Rev* 31:502–519. <https://doi.org/10.1093/esr/jcv009>
- Yang D (2016) The development and policy evolution of China's education of migrant children. In D Yang, H Qin, & J Wei (Eds.). Report on the development of education of migrant children in China (in Chinese). China: Social Sciences Academic Press
- Zhang Y (2013) Does private tutoring improve students' National College Entrance Exam performance?—a case study from Jinan, China. *Econ Educ Rev* 32:1–28. <https://doi.org/10.1016/j.econedurev.2012.09.008>
- Zheng X, Wang C, Shen Z, Fang X (2020) Associations of private tutoring with Chinese students' academic achievement, emotional well-being, and parent-child relationship. *Child Youth Serv Rev* 112:104934. <https://doi.org/10.1016/j.childyouth.2020.104934>
- Zheng X, Zhang Y, Jiang W (2023) Migrating with parents or left-behind: associations of internal migration with cognitive and noncognitive outcomes among Chinese children. *Curr Psychol* 42:19208–19229. <https://doi.org/10.1007/s12144-022-03095-x>
- Zheng X, Zhou Y (2024) Social spillovers of parental absence: the classroom peer effects of 'left-behind' children on household human capital investments in rural China. *J Dev Stud* 60:288–308. <https://doi.org/10.1080/00220388.2023.2255719>

Acknowledgements

This work was supported by the National Natural Science Foundation of China [72003173, 72103182]; Humanities and Social Science Fund of the Ministry of Education of China [21YJC790171]; Natural Science Foundation of Zhejiang Province, China [LY21G030008]; project funded by China Postdoctoral Science Foundation [2023M730715]; and Zhejiang Provincial Philosophy and Social Sciences Planning Project [24NDJC138YB, 24ZJQN033Y]. The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Author contributions

XZ: conceptualization, writing—original draft, writing—review & editing, project administration, funding acquisition, and supervision; YZ: conceptualization, writing—review & editing, project administration.

Competing interests

The authors declare no competing interests.

Ethical approval

This study exclusively involved secondary analysis of de-identified data, with no human beings or animals participating in the research process. This study was performed based on publicly accessible data from the China Education Panel Survey (CEPS), conducted by the National Survey Research Center (NSRC) at Renmin University of China. The CEPS dataset has been thoroughly anonymized, ensuring that any association with the original subjects from whom the data was collected is impossible.

Informed consent

Written informed consent has been obtained from all CEPS respondents by the National Survey Research Center (NSRC) at the Renmin University of China. The empirical analysis in this study relied on publicly available CEPS data, which contains no private information and is not individually identifiable. Therefore, informed consent was not required as our data analysis did not involve any human subjects.

Additional information

Supplementary information The online version contains supplementary material available at <https://doi.org/10.1057/s41599-024-03199-8>.

Correspondence and requests for materials should be addressed to Yanran Zhou.

Reprints and permission information is available at <http://www.nature.com/reprints>

Publisher's note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.

© The Author(s) 2024