

DISCUSSION PAPER SERIES

IZA DP No. 17531

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The Positive Peer Effects of Kindergarten  
on Learning and Mental Health**

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## ABSTRACT

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# The Company You Keep: The Positive Peer Effects of Kindergarten on Learning and Mental Health\*

Attending kindergarten (KG) has been shown to have persistent benefits, but the peer effects of KG remain largely unexplored. We fill this gap in the literature by using nationally representative panel data on a cohort of middle-school students (grade 7) in China. We demonstrate that when peers have had limited time to interact with one another (three to six months), there are no discernable effects of peer KG status. However, in the medium-term (14+ months), having a peer group with KG experience improves academic (math, English, and Chinese exam scores) and non-cognitive outcomes including mental health and social adjustment. These impacts are more pronounced among children from underprivileged families, and are explained by reallocation of student time and effort, a better classroom environment, improved friends' attitudes and behaviors, and pedagogically effective teacher-student interactions. The presence of these positive cross-peer spillovers indicates that the overall benefits of KG attendance are likely to be even higher than previously understood.

**JEL Classification:** I21, I24, I26, J13, J24

**Keywords:** Kindergarten attendance, positive spillovers, cognitive and non-cognitive measures, mental health, middle-school, China

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## 1. Introduction

Kindergarten (KG) is critical for the holistic development of children. Studies have demonstrated that early childhood education embodied in KG can lead to enhanced cognitive development, motor skills, socioeconomic skills, language development and lower undernutrition, while it has also been shown to reduce inattention, hyperactivity, and aggression, especially among children of mothers with low education (Dean and Jayachandran, 2020; Felfe and Lalive, 2018; Yamaguchi et al., 2018; Ren 2024). KG has demonstrated long-lasting impacts that extend into adulthood (Deming, 2009; Conti et al. 2016; Almond and Currie, 2011, Behrman et al. 2024), while other studies have found short-term improvements in cognitive ability (test scores) and lasting positive consequences on non-cognitive measures (Chetty et al. 2011). While World Bank data indicates that the gross enrollment rate for pre-primary education (mostly Kindergarten) in lower and middle-income countries (LMICs) was 58 percent in 2020, a notable increase from around 30 percent in the year 2000, this is still far from the Sustainable Development Goal of universal access to quality early childhood care by 2030. Additionally, despite the well-documented benefits of KG, relatively little is known about whether early childhood education has any measurable peer effects (the few exceptions include Wang 2022 and Zhang et al. 2023). This important question is the focus of our study.

We study the peer effects of KG experience to address this gap in the literature by demonstrating that the KG attendance of classroom peers has a measurable and economically meaningful impact on cognitive and non-cognitive outcomes conditional on length of exposure to such peers, even after controlling for one's own KG experience. As far as we are aware, ours is the first study to condition on length of exposure to classroom peers in documenting sizable spillover effects. The positive externalities of KG status is a notable finding that combines two previously separate strands of work – peer effects, and effects of KG on life outcomes. In terms of the first strand, the concept of “peers” has been defined in various ways in the literature - peer cohorts within the same school (Arcidiacono and Nicholson 2005; Ammermueller and Pischke 2009; Gould et al. 2009); roommates in college dormitories (Sacerdote 2001; Chen and Hu 2024); peer groups in military academies (Carrell et al. 2009); and peers in the workplace (Jin et al. 2024). Our research defines children within the same school-grade-classroom as peers, aligning with existing classifications that delineate groups of persons exposed to one another for prolonged durations.

The peer effects literature is rich, and has examined impacts across various dimensions including gender (Gong et al 2021; Getik and Meier 2022), friends' socio-economic background (Lavy and Sand 2019), peer ability (Burke and Sass 2013; Huang and Zhu 2020; Bütikofer et al., 2022; Xu et al., 2022; Rury 2022), peer non-cognitive traits (Golsteyn et al. 2021; Eble and Hu 2022; Zhao and Zhao 2021; Hill and Zhou 2021), peer parental background (Fruehwirth and Gagete-Miranda 2019; Wang 2021), salient rank in the classroom (Megalokonomou and Zhang 2024), peer migrant status (Gould, Lavy, and Paserman 2009; Hu 2018), and personality (Shan and Zölitz, 2024), among other factors.

The second body of literature pertinent to our paper examines the impact of kindergarten on different socio-economic outcomes. Extensive research across a wide-ranging set of countries suggests that interventions in early childhood, in particular, through preschool and kindergarten education programs, have large, positive, and lasting effects across a variety of key outcomes (Heckman 2006; Berlinski et al. 2009; Chetty et al. 2011; Heckman et al. 2013; Bietenbeck 2019; Attanasio et al. 2022). In particular, using admission lotteries in Boston, United States, Gray-Lobe et al. 2022 find that public preschool enrollment raises high-school graduation, test-taking of college entrance exams, and subsequent college attendance. There are non-academic effects as well since preschool enrollment is found to reduce juvenile incarceration rates. These findings emphasize the importance of utilizing a broad lens of both academic and non-test score outcomes in evaluating the efficacy of preschool investments in the developed world.

Focusing on low and middle income countries (LMICs), we add to the large and growing literature on early childhood development (ECD) interventions in these contexts (Hazarika and Viren, 2013; Dean and Jayachandran 2020; Attanasio et al. 2022). For instance, evaluations of large-scale public preschool expansions in Latin America have found positive impacts on child development and human capital (Berlinski et al. 2009). Lassassi (2021) and Bloem and Wydick (2023) examine public preschool expansions in Algeria and the Philippines, respectively, highlighting positive outcomes on child development, whereas Brinkman et al. (2017) demonstrates that a government initiative financing the establishment of community-based preschools in Indonesia yielded beneficial effects on child development. Such benefits are especially large in rural settings where proximity to schools matters by determining access. For

instance, Jakiela et al. (2024) notes that distance to the nearest government primary school in rural Kenya is an important mediator of the association between enrollment in preschool at age 3 and development of a child's vocabulary, which is a measure of early literacy. Other studies have evaluated estimates of the impacts of preschool in LMICs from the evaluation of smaller-scale interventions in either private preschools and/or NGO-supported programs (Dean and Jayachandran 2020; Attanasio et al. 2022). We add to this growing body of work by exploring the spillover (peer) effects of such interventions using a nationally representative dataset from a large middle-income context. Our work also relates to research on access to daycare for below-5 children (Baker et al. 2019; Fort et al. 2020; Attanasio et al. 2022), and on other types of ECD interventions such as parenting education and home visits from child development specialists (Garcia et al. 2020).

While peer effects in education have been analyzed separately from the multitude of benefits that KG experience engenders, to the best of our knowledge, our study is one of the few to provide rigorous causal time-varying evidence of peer effects of KG experience. In order to accomplish this, we ask the following questions: Does a higher proportion of classmates with kindergarten education in one's classroom during adolescence (grades 7 and 8) influence own academic and non-cognitive outcomes, after controlling for own kindergarten attendance? Do impacts differ by length of exposure to classroom peers? We utilize two rounds of nationally representative data on Chinese middle-school students from the China Education Panel Survey (CEPS). A unique aspect of the CEPS dataset is that we can identify schools in which students were assigned randomly to classrooms. We leverage this random assignment to determine the impacts of peer kindergarten attendance, after controlling for an extensive array of student, parent, and school-level variables.

In contrast to the other study that evaluates peer effects of preschool (Zhang et al. 2023), we carefully differentiate impacts by length of exposure to randomly assigned classroom peers. We find that in the short term (three to six months), there are no detectable peer effects of kindergarten, which is likely because of the limited amount of time that peers have had to interact with one another. In the medium term (14 to 18 months within the same classroom), a ten-percentage-point rise in the proportion of peers with kindergarten attendance leads to a 0.07

standard deviation (SD) improvement in academic performance, as assessed by test scores in mathematics, English, and Chinese. This effect size suggests that if a student were to be moved from a class where 30 percent of their peers attended KG (lower end of our sample) to a classroom where 80 percent did (higher end of our sample), then their academic performance would improve by 0.36 SD. This effect is economically significant as this magnitude is about the 85<sup>th</sup> percentile of the effect size across various educational interventions (Evans and Yuan 2022).

Furthermore, there are positive impacts of a similar magnitude on non-cognitive outcomes such as mental health indicators (depression, sadness, and unhappiness) and social adjustment indicators (socialization, confidence, and interest in school) - a ten-percentage-point increase in the fraction of peers with KG attendance is associated with a 0.074 SD improvement in own non-cognitive outcomes. The magnitude of this positive spillover effect is about 14.8 percent of the direct effect of kindergarten on non-cognitive abilities, and the relative size is comparable to results from a study on the externality of private preschool attendance on mental health in South Korea (Shin 2024).

After documenting these effects of peer KG status on academic and non-academic outcomes, we explore heterogeneities in the observed effects of peer KG across various dimensions. The positive impacts of peer KG attendance on academic performance decline at higher quantiles, indicating that the benefits are concentrated among relatively lower ability students. Additionally, girls gain more than boys in terms of academic performance, but there are limited gender differences in non-cognitive outcomes. The impacts of peer KG attendance on social adjustment and mental health measures are particularly pronounced for children with less educated mothers (mothers without college education), and the effects are stronger for rural children as compared to those in urban areas across all outcomes. We conduct a variety of sensitivity checks to underline the robustness of these findings and collectively, the results suggest that peer effects of KG may mitigate socio-demographic inequities primarily by helping students who are among the most vulnerable.

Next, we explore different mechanisms that may be explanatory. We find that the channels through which peer KG composition influences academic and non-cognitive outcomes include (i)

improved student behavior, (ii) increased academic effort (both in-class and extracurricular), (iii) modest enhancements in individual socio-emotional skills, (iv) an improved peer/classroom environment, and (v) “higher quality” of friendship networks. We do not find evidence that effects are driven by teacher effort and/or changes in teaching pedagogy. We conduct a decomposition analysis and show that improvements in own behavior and “superior” friends network are the main factors that mediate these effects.

The positive peer effects of KG we identify imply that the social returns of KG are likely to be larger than the previously documented private benefits, which means that the overall benefits of KG attendance reported previously, given the focus on own returns alone, may be too conservative. The non-trivial magnitude of the positive spillover effects we estimate highlights two important implications: First, having a critical mass of high-quality peers during pivotal adolescence years, facilitated by increased kindergarten attendance in early childhood, is anticipated to substantially enhance individual welfare in the long term through improved performance in both academic and non-academic domains. Secondly, as the individuals who derive the greatest benefit are predominantly at-risk students—specifically, those from rural locales and those whose mothers lack a college education—who may not have had the opportunity to attend kindergarten, the positive spillover effects we observe serve a crucial compensatory and altruistic function in facilitating long-term success for some of the most vulnerable students in the classroom. Taken together, the significant positive effects of peer KG attendance on both cognitive and non-cognitive dimensions that we measure suggest that much of the current literature may underestimate the aggregate social general welfare implications of early childhood education, especially in the developing world. This has implications for educational policymakers in these settings and elsewhere who seek to guide investments in developing effective early childhood development strategies and in evaluating the performance of such policies.

The paper is organized as follows: In section 2 we discuss kindergarten in China, while in sections 3 and 4 we discuss our data and empirical strategy, respectively. Section 5 presents results related to mechanisms while sections 6 and 7 discuss the mechanism analyses and robustness checks, respectively. Section 8 concludes.



## **2. Context: Kindergarten in China**

The educational system in China consists of nine years of mandatory education, encompassing six years of primary education and three years of junior secondary education. Preschool education generally caters to children aged three to six and may span one to three years. It is not complimentary, and there exists a scarcity of affordable, high-quality public kindergartens in the country; costly private alternatives are accessible (Hong and Chen 2017). Consequently, kindergarten attendance in China exhibits significant variability. Nonetheless, preschool education has gained significant popularity with economic prosperity. Statistics indicate that the gross enrollment rate for three-year preschool education for the cohort born in 2001 was approximately 36 percent; however for the 2009 cohort, the rate rose to 50 percent. By 2014, the attendance rate exceeded 70 percent (Li et al. 2016).

In 2015, the Chinese government enacted a law for kindergarten operations, requiring adherence to rigorous personnel and qualification standards to guarantee high-quality early childhood education. Every institution must designate a principal and a deputy principal who fulfill specific criteria, including possessing a valid teaching qualification, a higher education diploma, a minimum of three years of pertinent experience, and completion of a specialized training program for principals. Kindergarten educators are required to have a valid early childhood education certificate, whilst health and hygiene professionals must possess relevant qualifications, including a "Physician's Practice Certificate" for physicians and a "Nurse's Practice Certificate" for nurses. These regulations seek to guarantee that kindergartens provide efficient and secure teaching settings for children.

Kindergarten in China generally comprises a full-day schedule from 8 am to 5 pm. Children are typically categorized by age, although several activities are designed for all age groups. Similar to primary schools, children attend multiple class sessions daily, each ranging from 15 to 40 minutes in duration, contingent upon their age. Lunch is available on-site, and parents determine whether to enroll their children for this service.

Kindergarten education in China facilitates children's transition from home to primary school by promoting their scholastic and socio-emotional development. Although it seeks to

integrate play-based and inquiry-based learning methodologies rooted in Western ideals, its execution is significantly shaped by traditional Soviet and Chinese values and culture, which prioritize conformity, discipline, obedience, behavioral regulation, and academic achievement (Bullough and Palaiologou 2019). The curriculum for kindergarten education in China lacks a standardized format; however, it is required to encompass foundational learning in topics including language, math, science, art, and physical education. In language classes, children are instructed in fundamental Chinese characters and pinyin, the Romanized representation of Chinese characters according to their sound, to equip them for primary education. Furthermore, youngsters get acquainted with English by learning basic vocabulary, including typical greetings and the names of fruits. In mathematics classrooms, pupils acquire foundational knowledge of numerals and addition.

Recently, there has been a heightened focus on cultivating social and emotional competencies throughout the curriculum. Children are organized into groups to engage in various activities designed to foster curiosity about the world and promote self-expression. Educators seek to cultivate independence in children and foster personality traits like empathy through diverse activities. The objective of KG education in China is to equip children to face future academic obstacles and interpersonal relationships with assurance and fortitude.

### **3. Data**

Our analysis utilizes two rounds of the China Education Panel Survey (CEPS) which were conducted between 2013 and 2015. The CEPS is a nationally representative survey that primarily focuses on students in junior high school (grades 7 to 9). The first wave of the survey was conducted in the 2013-2014 academic year, covering 17 counties surveyed in the Fall semester of 2013 and an additional 11 counties surveyed in the Spring semester of 2014. The survey used a stratified, multistage sampling design to select 28 counties nationwide, followed by four middle-schools in each county, and finally, two Grade 7 and Grade 9 classrooms each in every school. All students in the selected classrooms were surveyed (so we have all peers in a classroom), resulting in a total of 19,958 students across 438 classrooms and 112 schools in 28 counties. Among them, 10,279 students were in Grade 7, and 9,208 were in Grade 9. The second wave of the survey was

conducted in the 2014-2015 academic year, and tracked the cohort of Grade 7 students from the first wave who had advanced to Grade 8 in the second wave.

Our research concentrates on the cohort of Grade 7 students in the first wave who were followed in Grade 8 in the second wave. We utilize wave one data to assess the immediate or short-term impact of peers' kindergarten attendance, considering that Grade 7 students had been engaging with their new classmates for approximately three to six months at the time of the survey. Using wave two data, we assess the impact of prolonged exposure to the same peers, as these students have now been together for more than a year (since they all have been in the same classroom since the start of seventh grade). Consequently, in our research, the medium-term impacts we evaluate are predicated on 14-18 months of exposure to the same peers. This differentiation between the short-term and medium-term peer impacts of kindergarten exposure fundamentally differentiates our work from Zhang et al. (2023), which predominantly relies on wave one data alone.

The CEPS data encompasses extensive information regarding kids' familial and demographic origins, cognitive and non-cognitive skills, and classroom settings. The survey comprises distinct questionnaires for children, parents, educators, and school administrators. A crucial question in the administrators' questionnaire is whether the school distributes students to classrooms randomly. Initially, we limit our sample to 117 classes across 60 schools that satisfy two conditions: (i) students were randomly allocated to classrooms in wave one, as verified by the school headmaster, and (ii) classes were not re-assigned based on student test scores or any other criteria, as indicated by the homeroom teacher. We exclude schools that possess only a single class at a specific grade level, as we utilize within-school variation in our estimation. Following the implementation of these constraints, our sample comprises 4,352 students distributed across 96 classrooms in 48 schools. This is a panel data set containing information for the same cohort in Grade 7 (wave one) and Grade 8 (wave two). The methodology employed for sample selection substantiates the credibility of our results by mitigating concerns over endogenous sorting of students based on observable or unobservable traits, while guaranteeing adequate interaction time between students. This is akin to the strategy adopted by other peer effects studies including

Sacerdote (2001); Carrell et al (2009); Gong et al (2021); Xu and Zhou (2022); and Chen and Hu (2024).<sup>1</sup>

### 3.1. Definition of key variables

We use two main outcome variables in this study: Academic performance and non-cognitive abilities. Academic achievement is assessed using students' test results in three primary subjects: Chinese, mathematics, and English. The CEPS offers test scores for standardized examinations, with a maximum of 100 points, a mean of 70 points, and a standard deviation of 10 points. The test scores derive from a midterm examination administered during the Fall semester of the academic year. We possess exam scores for the Fall semesters in Grades 7 and 8 for the same student. For ease of interpretation, we normalize the academic performance variables by school and grade to achieve a mean of zero and a standard deviation of one. We also construct an overall index of academic performance by aggregating the three test scores using a method commonly used in the literature (Anderson 2008, Chen and Yang 2019, Gong et al. 2021).<sup>2</sup> We take the sum of the three individual standardized test scores for each student, weighting each item by the inverse of the covariance matrix of the standardized outcomes (Anderson 2008). The resulting overall index provides a composite measure of academic performance, with a higher value indicating better performance. This aggregation approach also helps address issues of multiple hypothesis testing that may arise in the case of several outcome variables; however, for the sake of completeness, we also present results using individual scores.

There are two measures of non-cognitive ability that we use in this study: Mental health and social adjustment. To assess mental health, the student survey includes ten items that ask whether the respondent has experienced certain feelings in the past seven days: Feeling blue, feeling depressed, feeling unhappy, feeling as if they do not enjoy life, having no passion to do anything, feeling sad, feeling nervous, excessive worry, feeling something bad will happen, and too energetic to concentrate in class. Students evaluate each component using a five-point Likert

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<sup>1</sup>Applying these sample selection criteria does not limit the external validity of our findings. To demonstrate this, we compare several characteristics of randomized and nonrandomized classrooms. Results indicate limited (statistically significant) differences across the two samples, suggesting that the random sample is not markedly different from the non-random sample. Hence, the criteria we apply are unlikely to affect the generalizability of our results.

<sup>2</sup> Results from the disaggregated test scores are similar. Results remain unaltered even when we create the overall z-score index following Kling et al. (2007), Deming (2009), and Xu et al. (2022).

scale, where 1 signifies "never" and 5 denotes "always." We invert the scale so that elevated scores signify improved mental health. The total degree of mental stress is determined by averaging the ten ratings and subsequently normalizing the score to achieve a mean of zero and a standard deviation of one for all students at each school-grade level.

The second dimension of non-cognitive abilities is social adjustment, which we create using the responses from four questions.<sup>3</sup> The first two questions ask about the frequency with which students visit museums, zoos, or scientific parks with classmates, and the frequency of watching movies, plays, or sports events. The answers for both questions use a five-point scale where 1 indicates "never" and 5 indicates "multiple times in a month." The other two questions measure the extent to which the student agrees with statements about their confidence regarding their future and whether school life is boring.<sup>4</sup> The questions employ a four-point scale, with 1 signifying "strongly disagree" and 4 denoting "strongly agree." To establish a comprehensive index for students' social adjustment, we employ a methodology akin to that used in the formulation of the academic success index (Anderson 2008). We standardize the scores for each question to achieve a mean of zero and a standard deviation of one for all children within each school-grade level. Subsequently, we consolidate the four z-scores, assigning weights to each item based on the inverse of the covariance matrix of the standardized results. Higher values of the overall z-score index signify enhanced levels of social adjustment.

In addition to the primary outcomes, our analysis includes an extensive set of control variables to account for factors that may affect student outcomes. These include a range of student-level characteristics such as attendance at kindergarten, gender, ethnicity, minority status, migration status, only-child status, grade repetition, grade skipping, and age. We also consider family background measures including whether the student's mother and father have a high school degree, whether any parent smokes or drinks, and the overall health of the parent. At the teacher level, we consider several covariates including the homeroom teacher's teaching experience (in years), age, gender, awards received at various levels (province, city, county, or school),

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<sup>3</sup> This index is similar in construction to the Social Acclimation and General Satisfaction Index in Gong et al. (2021).

<sup>4</sup> The original question in the survey is whether students agree school life is boring. We reverse the order so that higher values indicate more school engagement.

educational level, certification, and professional title in teaching.<sup>5</sup> Finally, at the classroom level, we control for classroom size, the fraction of female peers, and the fraction of peers who have migrated from other cities.

### **3.2. Summary statistics**

Our study is restricted to kids with complete data on kindergarten attendance and the major outcome factors. This exclusion is not limiting, as fewer than one percent of the observations are eliminated based on these criteria. Further, to ensure that student characteristics are not systematically selected when we keep only those with non-missing data, we conduct tests of correlations between characteristics and the likelihood of missing data, following the approach of Xu et al. (2022). Our results, presented in Appendix Table 1, demonstrate that student characteristics are mostly not significantly associated with the likelihood of missing values.

We present the summary statistics of the study sample by KG attendance status in Table 1. In the full sample, 85 percent of the students reported having attended kindergarten before entering primary school. Panel A shows that students who attended KG have improved academic scores and better non-cognitive abilities (both mental health and social adjustment) as compared to those who did not attend KG. Panels B and C present student demographic and other characteristics. Overall, students who attended KG have a somewhat more favorable family and socioeconomic background than those who did not attend, a finding consistent with a study on private educational institutions in preschool from South Korea (Shin 2024). In particular, the parents of those who attended KG are more likely to have completed high school and college, and the students themselves are less likely to have migrated (with statistical insignificance at the 10 percent level), more likely to be an only child, and less likely to have repeated a grade. In terms of teacher characteristics, students who attended KG have teachers with more teaching experience. As for classroom characteristics, students with KG attendance tend to be in slightly larger classrooms with more students.

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<sup>5</sup> In China, universities designated as "Normal" often focus on teacher education and training. The term "normal" originates from the French "école normale," which historically referred to organizations focused on establishing and promoting educational norms and standards.

## 4. Empirical Strategy

Following Gong et al. (2021) and Xu et al. (2022), we estimate the peer effect of KG attendance using the following specification:

$$Y_{ics} = \alpha + \beta_1 \text{PeerKG}_{-ics} + X'_{ics}\phi + W'_{ics}\tau + \lambda_s + \varepsilon_{ics} \quad (1)$$

where  $i$  denotes a student,  $c$  is classroom, and  $s$  is school.  $Y_{ics}$  is an outcome variable such as academic performance or non-cognitive abilities.  $\text{PeerKG}_{-ics}$  is the fraction of students in the classroom that have attended kindergarten, excluding student  $i$ . That is,  $\text{PeerKG}_{-ics}$  measures the KG experience of student  $i$ 's peers in the classroom. Student  $i$ 's demographic and family background as described in Section 3.1 and noted in Table 1 are in  $X'_{ics}$ .<sup>6</sup> Classroom level covariates described in Section 3.1 and listed in Table 1 are represented in  $W'_{ics}$ . School fixed effects are in  $\lambda_s$  and  $\varepsilon_{ics}$  is the error term. Standard errors are clustered at the classroom level. We run the same specification using wave one and wave two data separately to estimate the short and medium-run effects, respectively.

Given that random assignment to classrooms is a crucial component of our identification strategy, it is essential to explore it more thoroughly. Starting in early 2010s, Chinese middle schools commenced assigning pupils to classrooms in a random fashion. This differs from a system in which student allocation is determined by results from placement examinations administered prior to school admission. The random assignment was conducted by many methods, the most widespread being the utilization of a computer program. In instances where the student population was limited, parents drew chits to determine their child's placement, as in a lottery system.

To the extent that students in the estimation sample are randomly assigned to classrooms, and that this assignment remains unchanged over the study period (for which we impose sample restrictions), our sample is unaffected by concerns regarding self-selection of students to classrooms and/or peers. Nonetheless, we offer additional validity assessments as the randomization was not performed by the researchers, and relies on self-reported data from school principals and teachers. To verify random assignment, we follow the existing research and assess

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<sup>6</sup> Parent's college completion indicators are used in the heterogeneity analyses alone.

the correlation between pupils' background characteristics and the fraction attending preschools, while controlling for school fixed effects (Xu et al. 2022; Shin 2024). If students are randomly allocated to classes within a school, then, controlling for school fixed effects, there should be no systematic correlation between student attributes and the proportion of peers who attended kindergarten. Estimates in column 2 of Table 2 indicate that all student background variables are statistically insignificant, and an F-test for the joint significance of all student demographic and family characteristics is insignificant with a  $p$ -value of 0.79. Hence, these results indicate that predetermined factors are not systematically associated with the proportion of kindergarten attendance in a classroom.

Although class assignments may not be influenced by student demographics and familial attributes, schools may systematically allocate teachers to classrooms. For example, as indicated by Xu et al. (2022), if classrooms contain fewer pupils with kindergarten experience (and hence potentially lower average ability), a school may provide more experienced teachers in these cases. We evaluate this by regressing the proportion of kindergarten participants in a class against teacher attributes in that class. The findings in column 3 of Table 2 demonstrate that, after accounting for school fixed effects, teacher characteristics do not exhibit a systematic correlation with the fraction of pupils possessing KG education in the classroom. Next, we incorporate both student and teacher characteristics in column 4 of Table 2. An F-test assessing the joint significance of these variables yields a  $p$ -value of 0.87, indicating that we fail to reject the null hypothesis that these variables are collectively equal to zero. That is, they are collectively unassociated with peer KG status. We conclude that in our sample, student and teacher variables are not systematically linked to the fraction of peers who attended kindergarten.

We address two other sources of biases arising from selection that may confound our empirical estimates. First, we examine the selection of students into classrooms. To address this, we (i) limit our analysis to schools that randomly assigned children to classrooms, as previously mentioned, and (ii) further narrow our sample to school grades that were not segregated based on student results. Both (i) and (ii) guarantee that after a student selects a school, their classroom peers are assigned randomly. The second issue we address is that students may endogenously choose schools. We address this possibility by using school fixed effects. Consequently, our estimations



are derived from variations in peer kindergarten status across schools and between grades. We use additional control variables in our primary specification to enhance the accuracy of the estimates and to ensure an equilibrium among classrooms with varying numbers of pupils who attended kindergarten in their preschool years. These include students' demographic and family background information, and classroom level variables reported in Table 1.

Finally, to assess the impact of peer kindergarten attendance on individual outcomes, it is necessary to observe adequate variation in the measure of peer kindergarten attendance. As depicted in Figure 1, our sample exhibits significant variation in peer kindergarten attendance, with the measure ranging from a minimum of 0.34 to a maximum of 1.0. This is also underscored by the fact that the  $1 - R^2$  from the regression that regresses peer kindergarten proportion on school fixed effects is equal to 0.38.

## 5. Results

### 5.1. Main results

Figure 2 consists of two panels that display our outcomes of interest on the y-axis and the proportion of peers who attended kindergarten in an individual's classroom on the x-axis. We generate separate graphs for the two outcomes of interest. These plots illustrate a positive correlation between the percentage of classroom peers who attended kindergarten and students' academic performance (left panel) and non-cognitive skills (right panel) in the medium term (shown in red), in contrast to a negligible association noted in the short term (shown in blue). To model these relationships in a regression framework, we employ the specification in equation (1). Table 3 presents the short-term impact of peer kindergarten attendance on academic and non-cognitive outcomes. The estimated effect is minor and statistically insignificant, as depicted in the graphical representation. We hypothesize that this is attributable to the relatively short time that has elapsed since these peers were in the same classroom, resulting in limited opportunities to interact with and to influence one another.

Turning to the medium-run effects, we examine the impact of peers' kindergarten attendance on student performance in Grade 8. Table 4 examines academic performance, whereas

Table 5 evaluates non-cognitive performance. Table 4 systematically incorporates controls for student demographics (column 2), family characteristics (column 3), teacher qualities (column 4), and classroom variables (column 5). As we sequentially incorporate these controls, the impact of peer kindergarten attendance decreases in magnitude, while remaining statistically significant. Our preferred specification is column 5, encompassing all controls.

There are several key findings in Table 4. First, attending kindergarten during childhood positively correlates with a significant improvement in Grade 8 academic performance. Specifically, we find in column 5 that attending kindergarten in childhood is associated with an increase in own academic performance by around 20 percent of a standard deviation in Grade 8 (Table 4). These findings are in line with the extensive literature on the beneficial effects of kindergarten attendance on school performance (Behrman et al. 2024; Dean and Jayachandran 2020, Garcia et al. 2020, Hazarika and Viren, 2013). Specifically, this effect size is comparable to those found in the 40th to 50th percentile of the distribution of effects reported in 96 studies from low and middle-income countries on various interventions aimed at improving educational outcomes (Evans and Yuan 2022). Other studies that report similar magnitude of effects include the evaluation of a large pre-primary education expansion in Argentina, which found that one year of pre-primary school increased average third-grade test scores by 23 percent of a standard deviation (Berlinski et al. 2009). Additionally, a meta-analysis of twenty-two studies on early childhood education in the US showed that participation in such programs increased high school graduation rates by approximately 0.26 standard deviations (McCoy et al. 2017).

Second, across all columns in Table 4, the coefficient for the proportion of peers attending KG is statistically significant at conventional levels and positively associated with academic performance, indicating that students in classrooms with a higher proportion of peers who attended kindergarten achieve higher academically on average. In particular, we find that a one-percentage-point (approximately 0.10 standard deviation) increase in the proportion of peers who attended kindergarten leads to a 0.72 percent of a standard deviation increase in academic scores (column 5 of Table 4). This magnitude is comparable to other studies that consider classroom peer effects on test scores. For example, Xu et al (2022) finds that a one-percentage-point increase in the proportion of peers who repeated a grade decreases academic performance by almost 2.10 percent

of a standard deviation among students who have never repeated a grade. In another study, Gong et al. (2021) finds that a one-percentage-point increase in the proportion of female classmates raises a student's test score by 1.02 percent of a standard deviation.

To illustrate the significance of the effect, consider a class with the average size of 49 students in our dataset. Incorporating each additional student who attended kindergarten raises the proportion of peer kindergarten attendance by approximately 2 percent ( $1/49$ ). This means having an additional student with kindergarten experience increases peers' academic achievement by 1.44 ( $0.72*2$ ) percent of a standard deviation in Grade 8. Given that the own effect of attending kindergarten is 20 percent of a standard deviation (based on our estimation and previous studies), the externality of the positive spillover effect amounts to roughly 7.20 percent of the direct effect of kindergarten on test scores. The impact we document is noteworthy as it is essentially a positive externality of attending KG that accrues over and above the direct effects documented in the literature.

Table 5 presents the results for nonacademic outcomes using equation (1) and our preferred specification with the full set of controls. We report a positive and statistically significant effect of peer kindergarten on a composite index of non-cognitive skills, where a percentage point (approximately 0.10 SD) increase in the proportion of peers who attended kindergarten leads to a 0.74 percent of a standard deviation increase in non-cognitive abilities. This effect size implies that a one-SD increase in peer fraction with kindergarten experience improves non-cognitive abilities by 7.40 percent of a SD. This is consistent with prior research examining the influence of classroom peers on non-cognitive skills. Hill and Zhou (2021) demonstrates that a one-standard deviation rise in the proportion of classmates experiencing parental conflict elevates the unhappiness of each student by 8 percent of a standard deviation. Zhou and Wang (2023) notes that a one-standard deviation increase in classmates encountering an early childhood health shock diminishes a student's school engagement score by 10 percent of a standard deviation.

Similar to the case of peer effects on test scores, we contextualize the magnitude of the effect on non-cognitive abilities. Again, consider a class with the mean class size (49 students in our sample). Adding one more student who attended kindergarten increases the fraction of peer

kindergarten attendance by about 2 percent. This means having an additional student with kindergarten experience increases peers' non-cognitive achievement by 1.48 ( $0.74 \times 2$ ) percent of a standard deviation in Grade 8. Given that the own effect of attending kindergarten is 10 percent of a standard deviation (second row, column 5, Table 5), the magnitude of the positive spillover effect amounts to roughly 14.8 percent of the direct effect of kindergarten on non-cognitive abilities. This relative size is comparable to findings from a study on the externality of private preschool attendance on mental health in South Korea (Shin 2024).

The index outcomes presented in Tables 4 and 5 are derived by aggregating multiple underlying factors as per Anderson (2008). Appendix Figure 1 illustrates the results of the influence of peer kindergarten on each individual component factor; notably, we find a beneficial effect of peer kindergarten attendance on the majority of these outcomes. The effects are more pronounced for social acclimation, a key component of the non-cognitive abilities. Moreover, an increased proportion of peers with kindergarten experience is associated with a higher likelihood of students participating in extracurricular activities such as visits to museums, zoos, or scientific parks, as well as engaging in cultural events such as movies, plays, or sports. The effects are also statistically significant for Chinese and math subjects. Overall, the benefits of peer kindergarten attendance are larger for non-cognitive skills than for academic performance, consistent with existing literature on classroom peer effect (Zhou and Wang 2023).

## **5.2. Heterogeneous impacts**

We will now focus on our medium-term outcomes, starting with an analysis of heterogeneities across many dimensions, including the student's gender and their household's socioeconomic position (mother's education, rural-urban hukou classification, and migrant status).

Studies indicate that boys are more vulnerable to social pressures and generally do poorly in adverse circumstances. Boys from fractured households exhibit comparatively inferior academic performance than girls (Bertrand and Pan 2013). Additionally, two early-life intervention programs in the United States targeting underprivileged children, specifically the Perry Preschool Project (PPP) and the Carolina Abecedarian Project (ABC), had significant gender-specific benefits on adult outcomes (Conti et al. 2016). In our dataset, we find that the proportion of

classmates who attended kindergarten positively influences most outcomes for both male and female students, with the exception of male academic performance, as indicated in Panel A of Table 6. The difference in coefficients between the two genders is not statistically significant however, indicating comparable impacts of peer kindergarten by gender.

We delve deeper into gender heterogeneity. We split the main peer KG variable into two components: The proportion of female peers who attended kindergarten and the proportion of male peers who attended kindergarten. This is motivated by existing research indicating that friendship networks in middle-school often exhibit significant homophily with respect to gender and social background (An 2022). We present the results of this analysis in Appendix Table 2, where we regress academic performance and non-cognitive outcomes separately for female and male subsamples of students on peer KG attendance differentiated by gender. Our results indicate that the peer kindergarten effect on academic performance for females in column 1 is largely driven by their female peers (a significant coefficient of 0.55); alternatively, the coefficient for male peers in this column is statistically insignificant. Similarly, male peers have a large significant effect on male students in terms of non-cognitive outcomes in column 4. These results confirm homophily and indicate that peers of the same gender exert stronger influences on an individual's outcomes, consistent with past evidence (Laniado et al. 2016, An 2022).

We next explore whether effects vary by distribution of the outcome variable. That is, whether the effect of peer kindergarten on academic performance and non-cognitive outcomes is different for individuals with varying levels of ability. The effect on academic performance falls at higher quantiles, implying that students with better academic performance benefit less (left panel, Figure 3). This result is intuitive as individuals with higher academic performance may have less to gain from higher-quality peers. It's worth noting, however, that these differences are not statistically significant at the tails of the distribution. We observe a similar pattern for peer effects on non-cognitive abilities in the right-hand panel of Figure 3, although in this case, primarily the estimates in the middle of the distribution are statistically significant. Overall, these findings suggest that the effect of peer kindergarten on academic performance and non-cognitive outcomes fall with ability.

We investigate whether maternal characteristics influence how peer KG attendance affects student outcomes. A study in Japan substantiates the advantageous impacts of early education on children from challenging home environments, indicating that early childcare enhances language development and mitigates inattention, hyperactivity, and aggression, particularly in offspring of mothers with little educational attainment (Yamaguchi et al. 2018). We divide our sample based on mother's education (following Gong et al. 2021, we consider whether a student's mother completed college or not). Results in Panel B of Table 6 indicate significant differences in effects of peer KG on academic performance, with children of mothers who did not complete college benefiting more. This is also true when we consider non-cognitive outcomes. While the difference in effects across the two groups is not statistically significant for academic performance, it is statistically significant at the one percent level for non-cognitive outcomes. The finding of greater effect among children with low educated mothers is likely because peer KG substitutes for parenting quality and knowledge (Yamaguchi et al. 2018).

We also examine whether peer effects differ based on school location. Panel C of Table 6 reveals that while both rural and urban students benefit from peer KG attendance in terms of non-cognitive outcomes, the effects are significant for academic performance only in the case of rural students. This is in line with our earlier observations that disadvantaged students (those with low ability or those with mothers who have not completed college) benefit more from peer KG effects. However, we again refrain from drawing strong conclusions due to the absence of stark statistical differences.

Relatedly, we explore whether students from migrant households (internal migrants within China) experience differential effects. This is important given the significant scale of internal migration in China, which has increased dramatically from less than 7 million in 1982 to around 221 million in 2010 (Duan et al. 2013). Our results, reported in Panel D of Table 6, indicate that non-migrants in particular benefit from peer KG effects in terms of academic performance, and the difference across groups is statistically significant at the one percent level. This may be because peer effects are stronger in terms of academics when students know each other well, which is more likely in classrooms with a larger share of non-migrant students. While both migrants and non-

migrants benefit when non-cognitive outcomes are considered, the difference in effects across these groups is not significant.

## **6. Mechanisms**

We explore several mechanisms that might drive medium run effects of peer KG on academic and non-academic outcomes. We classify these into different categories following the aggregation approach in Anderson (2008), and discuss each of them in a different sub-section. Details regarding the various measures we use in each category are provided in Appendix Table 3. Although we create several composite indices, we also present results for each individual component in Appendix Table 4, some of which are discussed below.

### **6.1. Student behavior and effort**

We begin by considering various indicators of student behavior and effort reported in Panel A of Table 7. We create four different variables here – negative behavior index, smoking/drinking alcohol, going to arcades, and a homework related index. We regress each of these variables on peer KG attendance, controlling for the full set of covariates. We find that peer KG experience reduces negative behavior (such as use of bad language, fighting with others, and having a violent temper) and lowers rates of smoking and alcohol consumption. This is consistent with other evidence that documents a negative association between academic performance and smoking (Alqahtani et al. 2023), and alcohol consumption (Hjarnaa et al. 2023) among school students. Additionally, we find that students in classrooms with higher peer KG attendance are likely to invest more time and effort into completing homework, especially doing well on perseverance and effort measures such as finishing homework even though it is distasteful or is taking a long time (columns 11 and 12 in Panel A of Appendix Table 4). In summary, having classroom peers with KG experience positively impacts many of the student behavior and effort indicators that determine success in school. Our results also indicate that peer KG characteristics in the classroom affect how students allocate their time outside of the classroom; they spend less time on visiting net bars or video arcades. This is likely to be another contributory factor to the positive effects on academic scores that we observe, and may independently improve mental health (Tortolero et al. 2014).

## **6.2. Student socio-emotional abilities**

Other factors that might be explanatory in our context are measures of a student's socio-emotional maturity, which can affect both their academic performance and emotional well-being. We investigate the effect of peer KG attendance on these outcomes in Panel B of Table 7. In general, having a higher proportion of peers with kindergarten increases student measures of resilience (columns 1 and 4), confidence, awareness, and emotional development (columns 2-3). Confidence, measured by the ability to engage in conversation with adults effortlessly, and maturity, defined by the capacity to apologize for unintentional harm, exhibit the largest effects in the presence of a higher proportion of peers with kindergarten. This is broadly consistent with other studies evaluating effects of ECD (Heckman et al. 2013).

## **6.3. Teaching tools, teacher effort, and student-teacher interactions**

We explore two dimensions across which teachers could plausibly mediate the observed effects: (i) teaching inputs and (ii) teacher effort/quality. We evaluate these outcomes to understand whether they vary depending on classroom composition. Educators may modify their pedagogical approaches, communication techniques, or feedback mechanisms according to the kindergarten experiences of students, which can positively influence student outcomes by fine-tuning teaching standards to align with student capabilities, or negatively if they disproportionately prioritize high-ability students at the expense of those with lower abilities.

To evaluate effects of teacher inputs, we consider usage of multimedia in the classroom and total working hours as reported by teachers in columns 1 and 2 in Panel C of Table 7. Previous studies have shown that the use of multimedia by teachers can enhance learning outcomes. The insignificance of multimedia usage in column 1 may be largely attributable to a school's infrastructure level, which is likely to be unaffected by peer kindergarten status. Our analysis reveals that the presence of peers with kindergarten experience has no impact on teacher effort, as indicated by their total working hours in column 2. The results are reassuring as they suggest that the impact on academic scores can be more accurately ascribed to the presence of classmates with kindergarten experience, rather than to the possibility that teachers alter their pedagogical approaches or vary their effort in classrooms with students who have had greater kindergarten exposure in their preschool years.



We further examine effects on teaching effort/quality through two composite indices: One measuring the inclusion of “discussion and interaction” in their teaching, and the other related to “students' perception of the teacher’s style.” We find positive effects on the latter (column 4 in Panel C of Table 7). Probing individual components of the aggregate measure in column 4 further, we find that having peers with kindergarten exposure reduces a student’s perception that their teacher would ignore or isolate them (column 5 in Panel C of Appendix Table 4), or criticize them publicly (column 6 in Panel C of Appendix Table 4). It also increases a student’s view that their teacher would engage their parents in resolving the challenges they were facing (column 9 in Panel C of Appendix Table 4). Beyond these effects, peer KG has no statistically discernible impact in our evaluation of changes in teacher effort and teacher-student interactions.

#### **6.4. Friends/peer characteristics**

We investigate how peer KG composition might affect the nature of the classroom, which, in turn, may affect academic and non-cognitive outcomes. Studies have found that the classroom environment has an important bearing on student outcomes (Feld and Zolitz 2017). In particular, having disruptive peers can have a negative effect on academic performance. Carrell and Hoekstra (2010) estimate that children exposed to domestic violence at home adversely affect the reading and math test results of their peers by misbehaving and by heightening the probability of classroom disruptions. Similarly, Lavy et al. (2012) ascertains that low-ability pupils diminish the accomplishment of their peers by influencing teachers' pedagogical practices and increasing violence and disruption in classrooms. Zhao and Zhao (2021) identifies that children of alcoholic dads exert adverse effects on peers, mostly manifested through heightened classroom disobedience, alterations in teaching practices, and reductions in time allocated to homework.

Considering the above, we evaluate a detailed set of outcomes related to characteristics of friends and peers in the classroom. These results are presented in Panel D of Table 7. A measure of classroom environment is how friendly (or conducive to learning) the class is. We measure classroom friendliness using an index that aggregates students’ responses to two statements: “*My classmates are nice to me*” and “*My class has a good atmosphere.*” Estimates indicate that peer KG has significant positive effects on a class’s atmosphere (column 1 in Panel D of Table 7).

We next consider friends' engagement and dedication in school through outcomes noted in column 2 in Panel D of Table 7. As evident, peer KG has a positive effect on this measure. In considering the underlying individual components that range from friends studying hard to expecting to go to college, a higher proportion of peers with KG experience has beneficial effects on these measures of student engagement in school (Panel D of Appendix Table 4).

The remaining columns in Panel D of Table 7 consider behaviors of one's friends in terms of skipping classes and violating other school rules (details on their construction are in Appendix Table 4). We find that these undesirable behaviors decline with peers who have KG experience. In terms of the individual components in particular, and as noted above, we find that effects of KG exposed peers are most evident in terms of reduced smoking or drinking, as well as a lower likelihood of attending net bars and arcades (Panel D in Appendix Table 4). In summary, our findings in Panel D of Table 7 and Panel D of Appendix Table 4 resonate with other evidence in the peer effects literature that underlines the importance of classroom environment and peer quality in guaranteeing student success.

### **6.5. Attributing effects to different mechanisms**

We further explore the explanatory power of each channel (discussed above) by conducting a decomposition analysis following methods in Heckman et al. (2013) and Gelbach (2016). Figure 4 plots the proportions of all the explanatory mechanisms that underlie KG peer effects that we consider. To summarize, these mechanisms include student behavior, student socio-emotional skills, teacher-related mechanisms, friends' behaviors, as well as other factors. We find that for the effect on academic test scores, student behavior explains approximately 13.50 percent, while friends behaviors/attitudes explains around 17.40 percent. Including the other factors, the mechanisms are able to explain a combined 35.50 percent of KG peer effects on academic test scores.

We next consider the contribution of the various mechanisms on the effect of peer KG on non-cognitive outcomes. The pattern here is a little different; we find that a much higher proportion of the total effect is explained (66.20 percent), and that socio-emotional development contributes

in a major way (22.60 percent). This is consistent with our findings as there is likely to be a high degree of correlation between socio-emotional skills that we explore and the non-cognitive outcomes that we evaluate. Additionally, friends' attitudes and behaviors also contribute significantly (18.80 percent), while students' own improved behavior (10.50 percent) and teacher attributes (14.20 percent) are other key components.

Since a fairly large proportion of the effect on non-cognitive outcomes is explained by the mechanisms we consider, we probe further. We conduct a decomposition analysis for the two components of our non-cognitive outcome index: Social acclimation and mental health. We find that the mechanisms we examine explain around 66.90 percent and 86.80 percent of the peer KG effect on social acclimation and mental health, respectively. For social acclimation, a quarter of the effect of peer KG is mediated through socio-emotional skills, followed by friends' attitudes/behaviors (24.80 percent) and teacher attributes (10.70 percent). For mental health, the highest proportion of the effect is explained by student's own behavior (26.30 percent), followed by teacher attributes (26.10 percent) and socio-emotional skills of the students (22.90 percent).

## **7. Robustness Checks**

### **7.1. Sorting on teacher characteristics**

A potential issue touched on before is that the effects could be driven by differential teacher characteristics and teaching practices, which may lead to spurious correlations between test scores and KG peers. To address this, we take several steps. First, in Appendix Table 5, we regress various teacher characteristics (experience, awards received, age, gender, education, experience, and certification) on peer kindergarten shares, and find that there are few significant effects. Hence peer KG does not affect key teacher characteristics. Regardless, we include these teacher controls in all models and find that our results remain unaltered.

Second, the fact that we find significant impacts across both Chinese and Math in Appendix Figure 1 is reassuring. This is because Math is likely to have more objective components which lowers the likelihood that teacher characteristics can influence grades. That is, the objectivity of Math reduces the scope for teachers to use their discretion in the math grading process, as compared to subjects like Chinese and English, thus reducing their subjective influence.

Third, we note that there are limited differences in content creation, grading procedures, and other practices across teachers of the same grade within a school; this limits the fact to which differences in teacher characteristics and effort can influence our findings. Uniformity in content and procedures throughout grades arises from compulsory schooling regulations, wherein the middle school curriculum is established by a central authority, the National Ministry of Education. All educational institutions are required to adhere to the same curriculum for each grade, and educators lack autonomy about the content of the courses they instruct. Generally, educators within each institution establish teaching groups according to grade levels and disciplines, and on regular instructional days, they collaboratively discuss and develop educational materials and tasks. Furthermore, several cities use standardized examinations and evaluations at the grade-subject tier. These procedures afford minimal latitude for teacher discretion on syllabi, instructional hours, course difficulty, volume of material addressed in a particular academic year, and examination grading. During examinations (mid-year and finals), educators instructing a specific grade level within a school allocate grading responsibilities such that each question is generally assessed by the same instructor utilizing a uniform rubric, collaboratively established by all teachers. Grading practices are also double-blind; identifying information related to a student (name, class, and ID) is hidden from the grader. Correspondingly, a student does not know which of the teachers in their grade was responsible for grading their exam. Considering all these factors, we conclude that our results are unlikely to originate solely due to differences in teaching practices and grading styles.

## **7.2. Functional form of test score and non-cognitive outcomes**

In the previous analyses, our two main variables, namely academic performance and non-cognitive abilities, are aggregated from several underlying variables following the approach in Anderson (2008). As a robustness check, we now use another widely adopted approach to generate the index outcomes (Kling et al. 2007). In this method, we first normalize the scores of each component to have a mean of zero and a standard deviation of one. We then take the simple average of the z-scores for each category to generate the index outcome. The main difference from the Anderson (2008) approach lies in the second step, in that we do not weight based on the covariance matrix of the standardized outcomes. We then re-estimate the main regression and report the results in the Appendix Table 6. As shown in columns 1 and 2, the results are statistically significant at

the 5 percent level and generally in the same ballpark in terms of magnitude as those in the main results of Tables 4 and 5, especially for academic performance. Therefore, our results are not driven by the particular manner in which our index outcomes are constructed.

### **7.3. Effects from spillovers in students' ability**

Given the literature establishing the positive effect of kindergarten attendance on students' test scores in primary and middle-school (Heckman et al. 2013), a potential issue is that the effects we observe could arise from spillover effects of kindergarten students' academic ability and performance. To address this, we control for the academic ability of both KG and non-KG peers in all specifications. In our primary specification, we account for the fraction of peers who have repeated or skipped a grade in primary school, both of which are measures of baseline ability. As evident from Appendix Table 7, the effect of peers with KG experience on non-cognitive outcomes is robust to these controls. However, while own KG experience still has beneficial effects, peer KG status now loses significance when we consider academic performance. We conclude that peer KG effects on non-cognitive outcomes in particular are not solely due to spillovers of kindergarten students' ability; there is some evidence that for academic outcomes however, this may be a factor.

### **7.4. Dropping two schools at a time**

To test whether our results are driven by a selected set of schools, we randomly exclude two schools at a time from our sample of 48 schools and re-estimate our main specification. The intuition is to check if our results are impacted by dropping a significant proportion ( $2/48$ , which is about 4 percent of our sample schools). We estimate 1128 regressions ( $C_2^{48}$  regressions) for each outcome, and plot the distributions of the estimated coefficients in Appendix Figure 2. The figure shows that for both academic and non-cognitive indices (the same measure as in the main results of Table 4 and 5), the coefficient of interest almost always retains its positive sign and rarely loses significance. For the non-cognitive score, none of the regressions (out of 1128 regressions) yield an impact that has a negative sign, while for academic performance, that fraction is trivial at 0.44 percent (5 out of 1128 regressions). These findings underscore that our results are robust to the exclusion of specific schools.

## **8. Discussion and Policy Implications**

While there is ample evidence of the positive effects of kindergarten attendance on own educational outcomes, few studies have considered the influence of peer effects from kindergarten attendance. This study addresses a gap in the literature by examining the impact of peer kindergarten attendance on students' cognitive and non-cognitive development in adolescence (middle school). Using nationally representative data from the China Education Panel Survey, we leverage random assignment of students into classrooms to demonstrate that peer kindergarten attendance has a significant and economically meaningful effect on both cognitive and non-cognitive outcomes. Specifically, a ten percent point increase in the fraction of peers who attended kindergarten raises test scores in math, English, and Chinese by 7.24 percent of a standard deviation. We also find comparable effects on non-cognitive outcomes, including mental stress indicators and social adjustment indicators. Overall, our results suggest that peer kindergarten attendance has significant impacts on students' academic and personal development, net of own individual kindergarten attendance.

We examine heterogeneity in the observed effects and find statistically distinct beneficial effects primarily for students whose mothers have not completed college, and for those who are non-migrants. The results for those with less educated mothers in particular suggest that peer KG attendance may help reduce socio-demographic inequities and improve opportunities. We then explore mechanisms underlying these effects. We find evidence in support of improved student effort towards learning - more time spent working on homework and less time spent on leisure activities like going to net bars or video arcades. Additionally, students report feeling more engaged at school and experiencing a classroom environment with a good atmosphere. A larger fraction of classroom peers who attended KG also leads to more favorable views about classroom teachers. We find limited evidence that teachers change their teaching style or effort in response to classroom composition. We demonstrate that our results are robust to a variety of methodological and specification checks. While previous studies have documented the positive effects of KG attendance on own individual development indicators, our research shows that accounting for the positive externalities of peers with KG experience is crucial.

When considering the costs and benefits of early childhood care policies, the substantial and economically significant effects on individual skill development resulting from having peers

who attended kindergarten are likely to further tip the scales in favor of investing in this form of early childhood development. The results from our analyses in China, a lower-middle-income country with resource constraints that disproportionately affect rural and under-served areas, support the case for expanding access to kindergarten to all eligible populations. However, it is important to note that the quality of this early childhood education is critical. If sub-par, these policies may lead to few benefits for child development and may even lead to worse outcomes than home-based care (Britto et al. 2011; Rosero and Oosterbeek 2011; Schady et al. 2015; Fort et al. 2020). Overall, our findings underline that educational policymakers should consider the positive externalities of peer effects when designing and evaluating investments in early childhood education programs.

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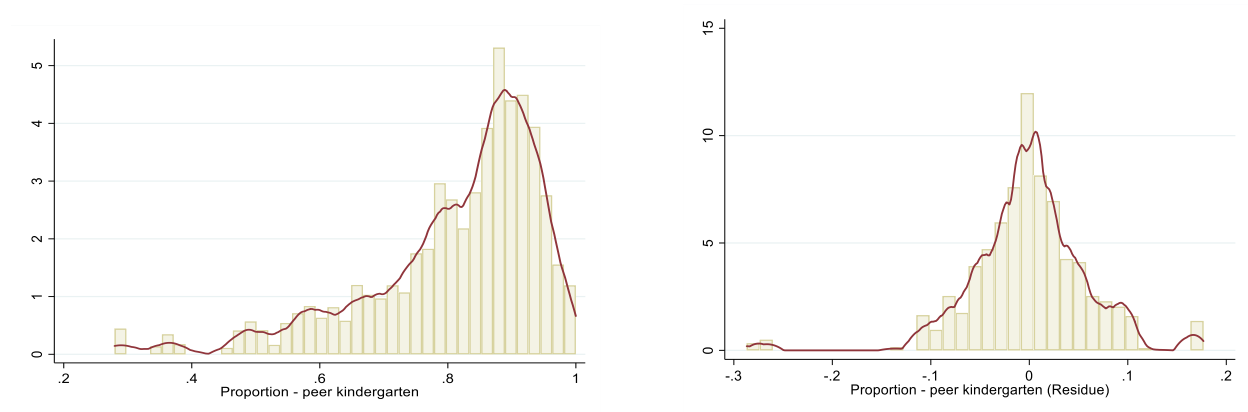
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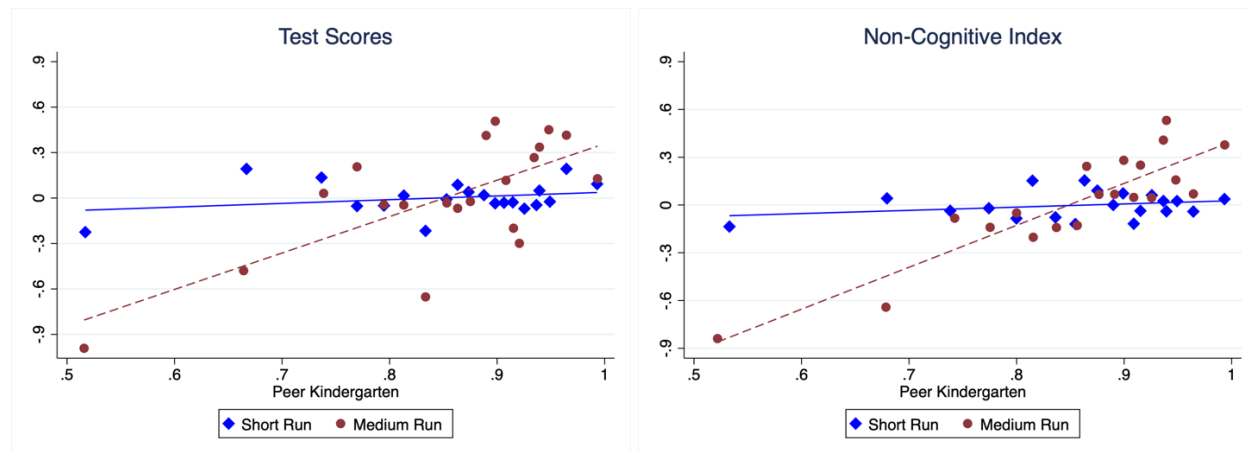
## Figures and Tables

**Figure 1. Variation in the level of peer kindergarten levels in the sample**



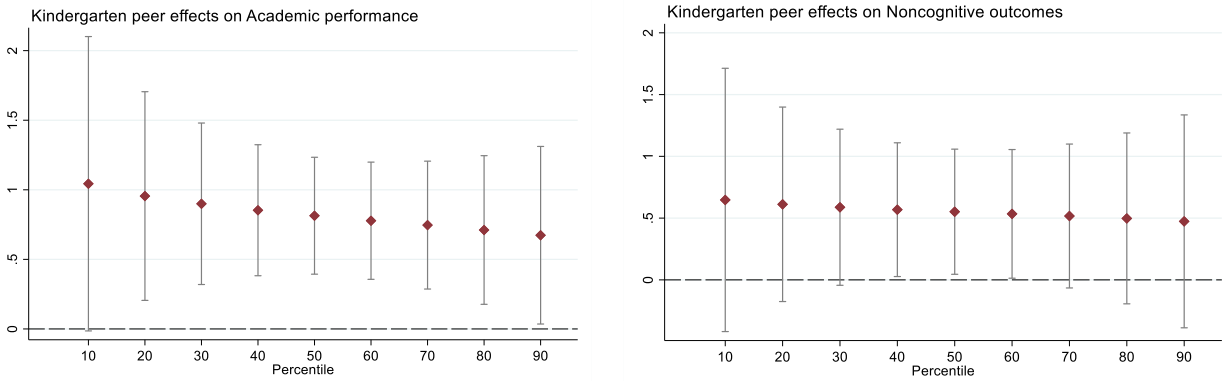
Notes: Authors' calculations. The second graph plots the density of the residuals of the fraction of peer kindergarten attendance. We obtain the residual by regressing peer kindergarten attendance on school fixed effects.

**Figure 2. Relationship between peer kindergarten and academic (non-cognitive) outcomes in the short and medium run.**



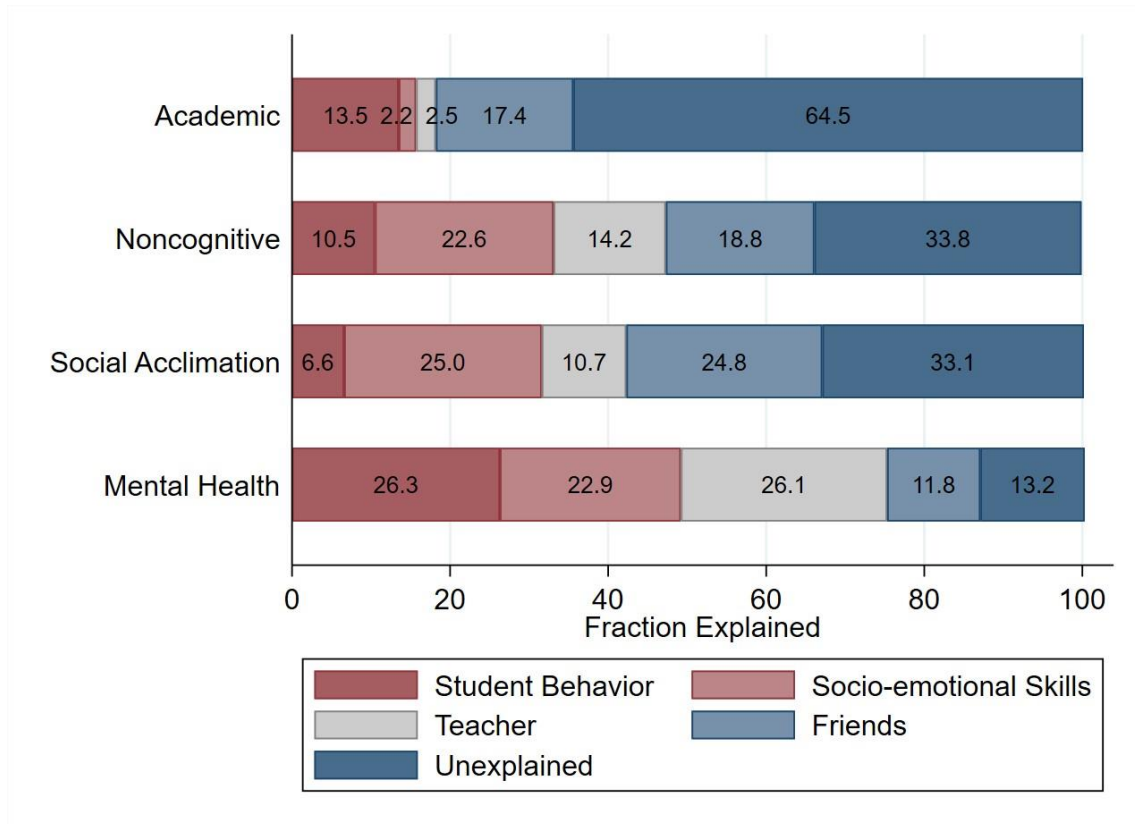
Notes: Authors' calculations. The lines represent the respective regressions estimated in each case.

**Figure 3. Quantile effects**



Notes: Authors' calculations. Each estimate comes from a separate regression, and the confidence intervals are at the 95 percent level of significance.

**Figure 4. Proportions of the explanatory mechanisms that underlie KG peer effects**



Note: This figure plots the estimated decomposition of kindergarten peer effects on five mechanisms, including student behavior, student socio-emotional skills, teacher-related mechanisms, friends' behaviors, as well as other factors (following methods in Heckman et al. 2013; Gelbach 2016). We separately conduct the decomposition analysis for each student outcome.



**Table 1. Descriptive statistics of student demographics by kindergarten attendance**

|   | (1)<br>No-KG<br>Students | (2)<br>KG<br>students | (3)<br>Full sample | (4)<br>Diff: (2) – (1) |
|---|--------------------------|-----------------------|--------------------|------------------------|
| <i>A. Outcome variables</i>               |                          |                       |                    |                        |
| Academic performance                      | -0.276<br>(1.043)        | 0.144<br>(0.879)      | 0.0836<br>(0.916)  | 0.267***<br>(0.038)    |
| Non-cognitive outcomes                    | -0.185<br>(1.076)        | 0.136<br>(0.956)      | 0.0900<br>(0.980)  | 0.139**<br>(0.045)     |
| Social adjustment                         | -0.187<br>(1.081)        | 0.141<br>(0.957)      | 0.0939<br>(0.982)  | 0.142**<br>(0.044)     |
| Standardized mental health                | -0.0812<br>(1.017)       | 0.0598<br>(0.973)     | 0.0394<br>(0.981)  | 0.102*<br>(1.017)      |
| <i>B. Student and family backgrounds</i>  |                          |                       |                    |                        |
| Peer Kindergarten                         | 0.784<br>(0.147)         | 0.861<br>(0.102)      | 0.849<br>(0.113)   | 0.006*<br>(0.003)      |
| Female dummy                              | 0.493<br>(0.500)         | 0.502<br>(0.500)      | 0.500<br>(0.500)   | 0.006<br>(0.024)       |
| Migrant status: non local                 | 0.256<br>(0.437)         | 0.212<br>(0.409)      | 0.218<br>(0.413)   | -0.035<br>(0.018)      |
| Minority                                  | 0.152<br>(0.359)         | 0.092<br>(0.289)      | 0.101<br>(0.301)   | 0.011<br>(0.011)       |
| Student age                               | 13.190<br>(1.074)        | 12.890<br>(0.835)     | 12.940<br>(0.881)  | -0.184***<br>(0.028)   |
| Are you the only child?                   | 0.408<br>(0.492)         | 0.569<br>(0.495)      | 0.545<br>(0.498)   | 0.057**<br>(0.021)     |
| Repeat grade between 1 and 6              | 0.200<br>(0.400)         | 0.070<br>(0.255)      | 0.089<br>(0.285)   | -0.076***<br>(0.013)   |
| Skip grade between 1 and 6                | 0.026<br>(0.158)         | 0.010<br>(0.100)      | 0.012<br>(0.111)   | -0.012*<br>(0.005)     |
| Mother has at least completed high school | 0.289<br>(0.454)         | 0.476<br>(0.500)      | 0.448<br>(0.497)   | 0.065**<br>(0.020)     |
| Father has at least completed high school | 0.374<br>(0.484)         | 0.527<br>(0.499)      | 0.504<br>(0.500)   | 0.044*<br>(0.020)      |
| Mother has completed college              | 0.104<br>(0.306)         | 0.209<br>(0.407)      | 0.193<br>(0.395)   | 0.035*<br>(0.017)      |
| Father has completed college              | 0.152<br>(0.359)         | 0.243<br>(0.429)      | 0.229<br>(0.421)   | 0.012<br>(0.018)       |
| Parent smokes                             | 0.321<br>(0.467)         | 0.256<br>(0.437)      | 0.266<br>(0.442)   | -0.000<br>(0.021)      |
| Parent drinks                             | 0.449<br>(0.498)         | 0.433<br>(0.496)      | 0.435<br>(0.496)   | 0.003<br>(0.024)       |

|   |                    |                    |                    |                    |
|---|--------------------|--------------------|--------------------|--------------------|
| Parent in good or very good health                | 0.681<br>(0.466)   | 0.723<br>(0.448)   | 0.717<br>(0.451)   | 0.010<br>(0.022)   |
| <i>C. Teacher and classroom characteristics</i>   |                    |                    |                    |                    |
| Homeroom teacher's experience (years)             | 13.490<br>(8.921)  | 14.950<br>(7.889)  | 14.730<br>(8.068)  | 0.513*<br>(0.232)  |
| Homeroom teacher has province-level award         | 0.073<br>(0.261)   | 0.117<br>(0.321)   | 0.110<br>(0.313)   | 0.012<br>(0.010)   |
| Homeroom teacher has city-level award             | 0.330<br>(0.471)   | 0.407<br>(0.491)   | 0.396<br>(0.489)   | 0.010<br>(0.017)   |
| Homeroom teacher has county-level award           | 0.668<br>(0.471)   | 0.688<br>(0.463)   | 0.685<br>(0.465)   | 0.029<br>(0.017)   |
| Homeroom teacher has school-level award           | 0.773<br>(0.419)   | 0.748<br>(0.434)   | 0.752<br>(0.432)   | -0.004<br>(0.016)  |
| Age of homeroom teacher                           | 35.540<br>(7.347)  | 36.760<br>(6.634)  | 36.580<br>(6.759)  | 0.391*<br>(0.183)  |
| Homeroom Teacher female                           | 0.625<br>(0.485)   | 0.705<br>(0.456)   | 0.693<br>(0.461)   | 0.016<br>(0.016)   |
| Homeroom teacher edu: Adult higher education      | 0.469<br>(0.499)   | 0.528<br>(0.499)   | 0.519<br>(0.500)   | 0.002<br>(0.016)   |
| Homeroom teacher edu: College or higher           | 0.037<br>(0.188)   | 0.038<br>(0.191)   | 0.038<br>(0.190)   | -0.012<br>(0.007)  |
| Homeroom Teacher graduated from a normal univ.    | 0.945<br>(0.228)   | 0.952<br>(0.214)   | 0.951<br>(0.216)   | -0.001<br>(0.008)  |
| Homeroom Teacher has a teacher certification      | 1.000<br>(0.000)   | 1.000<br>(0.000)   | 1.000<br>(0.000)   | 0.000<br>(.)       |
| Homeroom teacher's professional title in teaching | 1.515<br>(0.815)   | 1.808<br>(0.787)   | 1.764<br>(0.798)   | 0.042<br>(0.024)   |
| Techer-Student same gender                        | 0.509<br>(0.500)   | 0.510<br>(0.500)   | 0.510<br>(0.500)   | 0.010<br>(0.024)   |
| Number of students in class                       | 48.280<br>(13.620) | 49.600<br>(12.860) | 49.400<br>(12.980) | 0.480**<br>(0.155) |
| Fraction of female peers in the classroom         | 0.482<br>(0.077)   | 0.485<br>(0.068)   | 0.485<br>(0.069)   | 0.001<br>(0.002)   |
| Fraction of migrant peers in the classroom        | 0.243<br>(0.256)   | 0.231<br>(0.200)   | 0.232<br>(0.209)   | -0.000<br>(0.003)  |
| Observations                                      | 546                | 3088               | 3634               |                    |

Note: Column 4 reports the difference in control variables between the kindergarten group (column 2) and the no-kindergarten group (column 1), controlling for school level fixed-effects. That is, we regressed the outcome variable on the kindergarten attendance indicator, controlling for school fixed-effects.

**Table 2. Testing random assignment of students to classrooms**

|   | (1)  | (2)               | (3)               | (4)                |
|---|--|-------------------|-------------------|--------------------|
|   | Dep. Var.: Fraction of peers who attended kindergarten |                   |                   |                    |
| Female dummy                                      | 0.001<br>(0.001)                                       | 0.001<br>(0.001)  |                   | 0.000<br>(0.001)   |
| Migrant status: non local                         | 0.003<br>(0.004)                                       | 0.003<br>(0.004)  |                   | 0.003<br>(0.004)   |
| Minority  | 0.018<br>(0.014)                                       | 0.018<br>(0.014)  |                   | 0.010**<br>(0.004) |
| Student age                                       | -0.002<br>(0.003)                                      | -0.002<br>(0.003) |                   | 0.000<br>(0.001)   |
| Are you the only child?                           | 0.006<br>(0.004)                                       | 0.005<br>(0.003)  |                   | 0.003<br>(0.002)   |
| Repeat grade between 1 and 6                      | -0.013<br>(0.009)                                      | -0.013<br>(0.009) |                   | -0.009*<br>(0.004) |
| Skip grade between 1 and 6                        | -0.002<br>(0.009)                                      | -0.002<br>(0.008) |                   | -0.002<br>(0.007)  |
| Mother has at least completed high school         |  | 0.002<br>(0.002)  |                   | 0.002<br>(0.002)   |
| Father has at least completed high school         |  | 0.003<br>(0.005)  |                   | -0.001<br>(0.002)  |
| Parent smokes                                     |  | -0.003<br>(0.005) |                   | -0.000<br>(0.002)  |
| Parent drinks                                     |  | 0.001<br>(0.002)  |                   | 0.002<br>(0.002)   |
| Parent in good or very good health                |  | 0.002<br>(0.004)  |                   | -0.001<br>(0.002)  |
| Homeroom teacher's teaching experience (years)    |  |                   | -0.002<br>(0.004) | -0.002<br>(0.004)  |
| Homeroom teacher has province-level award         |  |                   | 0.005<br>(0.050)  | 0.006<br>(0.049)   |
| Homeroom teacher has city-level award             |  |                   | 0.003<br>(0.023)  | 0.003<br>(0.023)   |
| Homeroom teacher has county-level award           |  |                   | 0.029<br>(0.024)  | 0.029<br>(0.024)   |
| Homeroom teacher has school-level award           |  |                   | -0.003<br>(0.020) | -0.003<br>(0.020)  |
| Age of homeroom teacher                           |  |                   | 0.004<br>(0.005)  | 0.004<br>(0.005)   |
| Homeroom Teacher female                           |  |                   | 0.031<br>(0.033)  | 0.030<br>(0.033)   |
| Homeroom teacher edu: Adult higher education      |  |                   | -0.003<br>(0.030) | -0.002<br>(0.030)  |
| Homeroom teacher edu: College education or higher |  |                   | -0.081            | -0.080             |

|   |       |       |         |         |
|---|-------|-------|---------|---------|
|   |       |       | (0.068) | (0.068) |
| Homeroom Teacher graduated from a normal university |       |       | -0.033  | -0.032  |
|   |       |       | (0.045) | (0.045) |
| Homeroom teacher's professional title in teaching   |       |       | 0.009   | 0.009   |
|   |       |       | (0.028) | (0.028) |
| Teacher-Student same gender                         |       |       | 0.002   | 0.002   |
|   |       |       | (0.001) | (0.001) |
| Number of students in class                         |       |       | 0.007*  | 0.007*  |
|   |       |       | (0.004) | (0.004) |
| R-squared   | 0.726 | 0.726 | 0.788   | 0.789   |
| <i>p</i> -value of F-stat                           | 0.768 | 0.792 | 0.723   | 0.871   |
| Observations  | 3,634 | 3,634 | 3,634   | 3,634   |

Note: The dependent variable in all columns is the fraction of peers who attended kindergarten. Column 1 regresses the fraction of peers who attended kindergarten on students' background characteristics. Column 2 adds family background. Column 3 includes homeroom teacher characteristics as control variables. Column 4 combines student variables in column 2 and teacher characteristics in column 3. All regressions include school fixed effects. Robust standard errors clustered at the class level are shown in parentheses. \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

**Table 3. Peer effect of kindergarten attendance in the short-term**

| Variables                | (1)<br>Academic<br>Performance | (2)<br>Non-cognitive<br>outcomes | (3)<br>Social<br>adjustment | (4)<br>Mental<br>Health |
|--------------------------|--------------------------------|----------------------------------|-----------------------------|-------------------------|
| Peer Kindergarten        | 0.333<br>(0.369)               | 0.301<br>(0.239)                 | 0.230<br>(0.220)            | 0.266<br>(0.246)        |
| Attended<br>Kindergarten | 0.185***<br>(0.042)            | 0.086*<br>(0.043)                | 0.075*<br>(0.042)           | 0.115***<br>(0.043)     |
| Dep. Var. Mean           | 0.044                          | 0.036                            | 0.039                       | 0.009                   |
| R-squared                | 0.115                          | 0.227                            | 0.237                       | 0.082                   |
| Observations             | 4427                           | 4171                             | 4285                        | 4400                    |
| School FE                | Yes                            | Yes                              | Yes                         | Yes                     |
| Child Controls           | Yes                            | Yes                              | Yes                         | Yes                     |
| HH Controls              | Yes                            | Yes                              | Yes                         | Yes                     |
| Teacher Controls         | Yes                            | Yes                              | Yes                         | Yes                     |
| Peer Controls            | Yes                            | Yes                              | Yes                         | Yes                     |

Note: The outcome variables use data when students were in Grade 7. The dependent variable in column 1 is an overall index of academic performance that aggregates the test scores of three main subjects (Chinese, math and English) (following the method by Anderson 2008). The outcome in column 2, non-cognitive abilities, is aggregated from two dimensions: mental stress and social adjustment. The outcome in column 3, mental health, is an average of ten questions asking the frequency that the respondent experienced the following feelings in the past seven days: Feeling blue, feeling depressed, feeling unhappy, feeling as if they do not enjoy life, having no passion to do anything, feeling sad, feeling nervous, excessive worry, feeling something bad will happen, too energetic to concentrate in class. Higher values indicate a high risk of mental health problems. The outcome in column 4, social acclimation, is an aggregate index of four questions-- (1) The frequency with which students go to museums, zoos or scientific parks with classmates, (2) the frequency with which students watch a movie, play, or go to sports events, (3) the extent to which the student agrees that he/she is confident about his/her future, and (4) the extent to which the student agrees that school life is not boring. Higher value of the social acclimation index indicates more positive outcomes. Robust standard errors clustered at the class level are shown in parentheses. \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

**Table 4. Peer effect of kindergarten attendance on academic performance in the medium run**

|                                  | (1)                 | (2)                 | (3)                 | (4)                 | (5)                 |
|----------------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| <b>Dep. Var.: Academic Index</b> |                     |                     |                     |                     |                     |
| Peer Kindergarten                | 1.632**<br>(0.628)  | 1.421**<br>(0.573)  | 1.379**<br>(0.546)  | 1.057***<br>(0.382) | 0.724**<br>(0.331)  |
| Attended kindergarten            | 0.256***<br>(0.044) | 0.208***<br>(0.043) | 0.203***<br>(0.043) | 0.199***<br>(0.041) | 0.192***<br>(0.041) |
| Dep. Var. Mean                   | 0.056               | 0.056               | 0.056               | 0.056               | 0.056               |
| R-squared                        | 0.317               | 0.382               | 0.388               | 0.399               | 0.403               |
| Observations                     | 3634                | 3634                | 3634                | 3634                | 3634                |
| School FE                        | Yes                 | Yes                 | Yes                 | Yes                 | Yes                 |
| Child Controls                   |                     | Yes                 | Yes                 | Yes                 | Yes                 |
| HH Controls                      |                     |                     | Yes                 | Yes                 | Yes                 |
| Teacher Controls                 |                     |                     |                     | Yes                 | Yes                 |
| Peer Controls                    |                     |                     |                     |                     | Yes                 |

Notes: The outcome variables use data when students were in Grade 8. The dependent variable in all columns is an overall index of academic performance that aggregates the test scores of three main subjects (Chinese, math and English) (following the method by Anderson 2008). We report the results for individual indices in Appendix Figure 1. Robust standard errors clustered at the class level are shown in parentheses. \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

**Table 5. Peer effect of kindergarten on non-cognitive outcomes in the medium run**

|                                       | (1)                 | (2)                 | (3)                 | (4)                 | (5)                 |
|---------------------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| <b>Dep. Var.: Non-cognitive index</b> |                     |                     |                     |                     |                     |
| Peer Kindergarten                     | 1.035***<br>(0.286) | 0.937***<br>(0.264) | 0.898***<br>(0.236) | 0.832***<br>(0.170) | 0.743***<br>(0.197) |
| Attended Kindergarten                 | 0.137***<br>(0.043) | 0.108**<br>(0.043)  | 0.099**<br>(0.043)  | 0.103**<br>(0.042)  | 0.101**<br>(0.042)  |
| Dep. Var. Mean                        | 0.086               | 0.086               | 0.086               | 0.086               | 0.086               |
| R-squared                             | 0.195               | 0.206               | 0.220               | 0.228               | 0.228               |
| Observations                          | 3473                | 3473                | 3473                | 3473                | 3473                |
| School FE                             | Yes                 | Yes                 | Yes                 | Yes                 | Yes                 |
| Child Controls                        |                     | Yes                 | Yes                 | Yes                 | Yes                 |
| HH Controls                           |                     |                     | Yes                 | Yes                 | Yes                 |
| Teacher Controls                      |                     |                     |                     | Yes                 | Yes                 |
| Peer Controls                         |                     |                     |                     |                     | Yes                 |

Notes: The outcome variables use data when students were in Grade 8. The dependent variable in all columns is an overall index of non-cognitive abilities that aggregate from two dimensions: mental stress and social adjustment (following the method by Anderson 2008). Specifically, the first dimension, mental health is an average of ten questions asking the frequency that the respondent experienced the following feelings in the past seven days: Feeling blue, feeling depressed, feeling unhappy, feeling as if they do not enjoy life, having no passion to do anything, feeling sad, feeling nervous, excessive worry, feeling something bad will happen, too energetic to concentrate in class. Higher values indicate a high risk of mental health problems. The second dimension, social acclimation, is an aggregate index of four questions - (1) The frequency with which students go to museums, zoos or scientific parks with classmates, (2) the frequency with which students watch a movie, play, or go to sports events, (3) the extent to which the student agrees that he/she is confident about his/her future, and (4) the extent to which the student agrees that school life is not boring. We report the results for individual indices in Appendix Figure 1. Robust standard errors clustered at the class level are shown in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

**Table 6. Heterogeneous impacts of peer KG along different dimensions**

| Dependent Variables                                | (1)<br>Academic<br>performance    | (2)<br>Academic<br>performance | (3)<br>Non-cognitive<br>outcomes  | (4)<br>Non-cognitive<br>outcomes |
|--|-----------------------------------|--------------------------------|-----------------------------------|----------------------------------|
| <b><u>Panel A: By Gender</u></b>                   |                                   |                                |                                   |                                  |
|  | <i>Female</i>                     | <i>Male</i>                    | <i>Female</i>                     | <i>Male</i>                      |
| Peer Kindergarten                                  | 0.869***<br>(0.268)               | 0.512<br>(0.433)               | 0.701**<br>(0.269)                | 0.862***<br>(0.290)              |
| <i>p</i> -value (H0: equality across groups)       |                                   | 0.231                          |                                   | 0.670                            |
| Dep. var. mean                                     | 0.266                             | -0.155                         | 0.157                             | 0.013                            |
| R-squared  | 0.437                             | 0.366                          | 0.255                             | 0.229                            |
| Observations                                       | 1818                              | 1816                           | 1748                              | 1725                             |
| <b><u>Panel B: By Mother's Education</u></b>       |                                   |                                |                                   |                                  |
|  | <i>Mother without<br/>college</i> | <i>Mother with<br/>college</i> | <i>Mother without<br/>college</i> | <i>Mother with<br/>college</i>   |
| Peer Kindergarten                                  | 0.683*<br>(0.373)                 | 0.512<br>(0.486)               | 0.729***<br>(0.193)               | -0.653<br>(0.537)                |
| <i>p</i> -value (H0: equality across groups)       |                                   | 0.724                          |                                   | 0.003                            |
| Dep. var. mean                                     | -0.044                            | 0.473                          | -0.010                            | 0.471                            |
| R-squared  | 0.391                             | 0.396                          | 0.229                             | 0.156                            |
| Observations                                       | 2931                              | 703                            | 2784                              | 689                              |
| <b><u>Panel C: By Rural-Urban Hukou Status</u></b> |                                   |                                |                                   |                                  |
|  | <i>Rural</i>                      | <i>Urban</i>                   | <i>Rural</i>                      | <i>Urban</i>                     |
| Peer Kindergarten                                  | 0.955*<br>(0.493)                 | 0.273<br>(0.433)               | 0.614*<br>(0.346)                 | 0.602**<br>(0.248)               |
| <i>p</i> -value (H0: equality across groups)       |                                   | 0.110                          |                                   | 0.974                            |
| Dep. var. mean                                     | -0.120                            | 0.187                          | -0.177                            | 0.277                            |
| R-squared  | 0.401                             | 0.414                          | 0.231                             | 0.187                            |
| Observations                                       | 1554                              | 2080                           | 1461                              | 2012                             |
| <b><u>Panel D: By Migrant Status</u></b>           |                                   |                                |                                   |                                  |
|  | <i>Migrants</i>                   | <i>Non-Migrants</i>            | <i>Migrants</i>                   | <i>Non-Migrants</i>              |
| Peer Kindergarten                                  | -0.809<br>(0.748)                 | 0.885***<br>(0.296)            | 1.183*<br>(0.680)                 | 0.601***<br>(0.218)              |
| <i>p</i> -value (H0: equality across groups)       |                                   | 0.010                          |                                   | 0.328                            |
| Dep. var. mean                                     | 0.026                             | 0.064                          | 0.101                             | 0.081                            |
| R-squared  | 0.465                             | 0.417                          | 0.280                             | 0.234                            |
| Observations                                       | 794                               | 2840                           | 740                               | 2733                             |
| Child controls                                     | Yes                               | Yes                            | Yes                               | Yes                              |
| HH controls  | Yes                               | Yes                            | Yes                               | Yes                              |
| Teacher controls                                   | Yes                               | Yes                            | Yes                               | Yes                              |

Note: The dependent variable in columns 1-2 is an overall index of academic performance that aggregates the test scores of three main subjects (Chinese, math and English). The dependent variable in columns 3-4 is an overall index of non-cognitive abilities that aggregate from two dimensions: mental stress and social adjustment. All regressions include a full set of control variables as in the last column of Table 4. Robust standard errors clustered at the class level are shown in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.



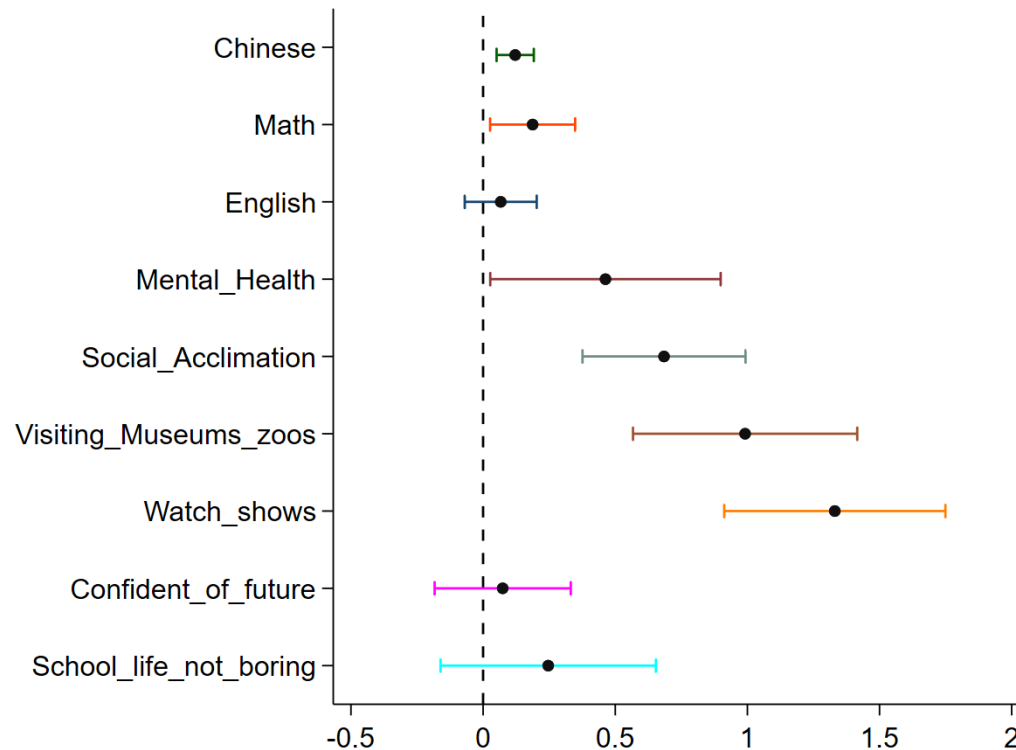
**Table 7. Mechanisms**

| <b>Panel A: Student behavior and effort</b>                     |                                 |                                 |                                   |  |
|---|---------------------------------|---------------------------------|-----------------------------------|--|
|   | (1)                             | (2)                             | (3)                               | (4)  |
|   | Violent Behavior Index          | Smoking or drinking alcohol     | Going to net bars or video arcade | Homework Index                             |
| Peer KG   | -0.587***<br>(0.218)<br>[0.014] | -0.361***<br>(0.066)<br>[0.000] | -0.376***<br>(0.103)<br>[0.001]   | 0.513**<br>(0.219)<br>[0.031]              |
| Obs.  | 3555                            | 3604                            | 3604                              | 3588                                       |
| <b>Panel B: Student socio-emotional abilities</b>               |                                 |                                 |                                   |  |
|   | (1)                             | (2)                             | (3)                               | (4)  |
|   | Deal with negative feelings     | Ease of communication index     | Have role models                  | Deal with tough situations                 |
| Peer KG   | 0.171<br>(0.186)<br>[0.408]     | 0.568***<br>(0.155)<br>[0.001]  | 0.592**<br>(0.279)<br>[0.045]     | 0.441**<br>(0.205)<br>[0.045]              |
| Obs.  | 3594                            | 3560                            | 3590                              | 3573                                       |
| <b>Panel C: Teaching tools and teacher-student interactions</b> |                                 |                                 |                                   |  |
|   | (1)                             | (2)                             | (3)                               | (4)  |
|   | Multimedia in teaching          | Total working hours             | Discussion and Interactions Index | Students perceive having a helpful teacher |
| Peer KG   | 0.066<br>(0.316)<br>[0.865]     | -1.913<br>(11.291)<br>[0.865]   | 1.129<br>(0.911)<br>[0.265]       | 0.718***<br>(0.198)<br>[0.001]             |
| Obs.  | 3681                            | 3681                            | 3439                              | 3563                                       |
| <b>Panel D: The characteristics of friends/peers</b>            |                                 |                                 |                                   |  |
|   | (1)                             | (2)                             | (3)                               | (4)  |
|   | Class atmosphere                | Friends Academic Index          | Friends skipping class            | Friends' - violating school rules          |
| Peer KG   | 0.818***<br>(0.292)<br>[0.012]  | 0.823***<br>(0.276)<br>[0.008]  | -0.496**<br>(0.198)<br>[0.022]    | -0.694***<br>(0.222)<br>[0.006]            |
| Obs.  | 3589                            | 3555                            | 3565                              | 3555                                       |

Notes: Each outcome variable in this table is aggregated from several components following the approach by Anderson et al. (2008). Appendix Table 3 provides the details of the aggregation and definitions of individual components. Robust standard errors clustered at the class level are shown in parentheses. We report the adjusted  $p$ -values in square brackets to address the concern on multiple hypotheses testing (Simes 1986).

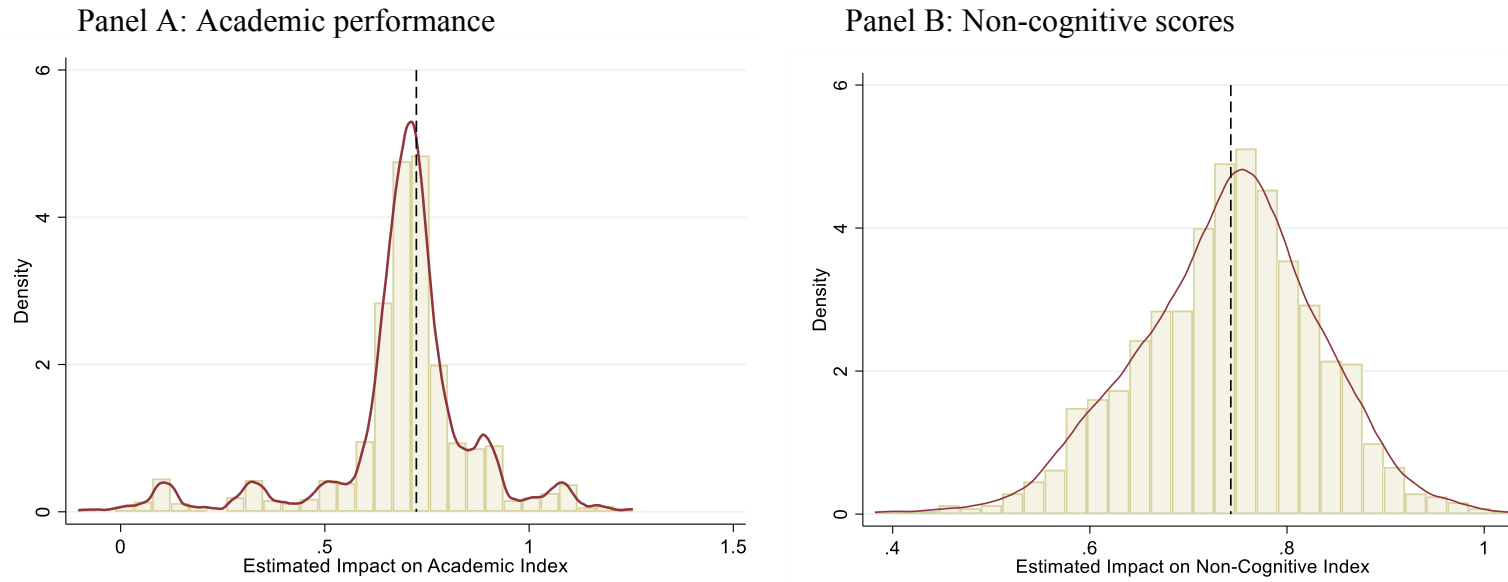
## Appendix Figures and Tables

**Appendix Figure 1. Peer effect of kindergarten attendance on individual components of academic and non-cognitive index**



Note: The dependent variables in rows 1-3 are individual components of academic scores. The dependent variable in row 4 is mental health index that aggregates from ten items (following the method by Anderson 2008). Specifically, mental health is an average of ten questions asking the frequency that the respondent experienced the following feelings in the past seven days: Feeling blue, feeling depressed, feeling unhappy, feeling as if they do not enjoy life, having no passion to do anything, feeling sad, feeling nervous, excessive worry, feeling something bad will happen, and too energetic to concentrate in class. Higher values indicate a high risk of mental health problems. The dependent variable in row 5 is the social acclimation index that aggregates from four items (following the method by Anderson 2008). These four items are respectively the dependent variables in rows 6-9 which include (1) The frequency with which students go to museums, zoos or scientific parks with classmates, (2) the frequency with which students watch a movie, shows, or go to sports events, (3) the extent to which the student agrees that he/she is confident about his/her future, and (4) the extent to which the student agrees that school life is not boring. All regressions include a full set of control variables as in Table 4. Confidence intervals are at the 95 percent level.

**Appendix Figure 2. Distribution of estimated coefficients when two schools were randomly removed at a time**



Note: This figure plots the distributions of the coefficients from 1128 regressions when two schools were randomly removed at a time. Vertical dashed lines indicate our baseline estimates for the respective outcome variable.

**Appendix Table 1. Missing patterns of key outcome variables**

| Variables             | (1)<br>Academic performance | (2)<br>Non-cognitive outcomes | (3)<br>Social adjustment | (4)<br>Mental health |
|-----------------------|-----------------------------|-------------------------------|--------------------------|----------------------|
| Peer Kindergarten     | -0.030<br>(0.032)           | -0.075<br>(0.047)             | -0.060*<br>(0.036)       | -0.037<br>(0.044)    |
| Attended kindergarten | 0.012<br>(0.010)            | -0.001<br>(0.012)             | 0.000<br>(0.013)         | 0.001<br>(0.011)     |
| Observations          | 3832                        | 3832                          | 3832                     | 3832                 |
| R-squared             | 0.102                       | 0.113                         | 0.130                    | 0.104                |
| School Fixed Effects  | Yes                         | Yes                           | Yes                      | Yes                  |
| Full Controls         | Yes                         | Yes                           | Yes                      | Yes                  |

Note: The dependent variable in each column is an indicator of whether a student is missing information in this outcome. All regressions include a full set of control variables as in the last column of Table 3. Robust standard errors clustered at the class level are shown in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

**Appendix Table 2. Heterogeneous impacts by gender (testing presence of homophily)**

| Variables               | (1)                            | (2)                          | (3)                              | (4)                            |
|-------------------------|--------------------------------|------------------------------|----------------------------------|--------------------------------|
|                         | Academic performance<br>Female | Academic performance<br>Male | Non-cognitive outcomes<br>Female | Non-cognitive outcomes<br>Male |
| Peer KG (among females) | 0.546**<br>(0.250)             | -0.241<br>(0.396)            | 0.295<br>(0.278)                 | 0.095<br>(0.279)               |
| Peer KG (among males)   | 0.233<br>(0.335)               | 0.794<br>(0.532)             | 0.427<br>(0.332)                 | 0.840**<br>(0.366)             |
| Observations            | 1818                           | 1816                         | 1748                             | 1725                           |
| R-squared               | 0.436                          | 0.367                        | 0.255                            | 0.230                          |
| School FE               | Yes                            | Yes                          | Yes                              | Yes                            |
| Controls                | Yes                            | Yes                          | Yes                              | Yes                            |

Note: All regressions include a full set of control variables as in Table 4. Robust standard errors clustered at the class level are shown in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

**Appendix Table 3. Grouping and definitions of mechanism variables**

| <b>Groups</b>  | <b>Variables in Table 7</b>                                | <b>Corresponding Components of each index variable (Variables in Appendix Table 4)</b> | <b>Questions in the questionnaire and Scales of each item</b>  |
|--|--|--|--|
| <b>Panel A:<br/>Student behavior and effort</b>        | Violent Behavior Index                                     | Cursing or saying swearwords   | How often did you do [ITEM] in past year? [1 never, 2 seldom, 3 sometimes, 4 often, 5 always]                                      |
|  |  | Quarreling with others   |  |
|  |  | Having a fight with others   |  |
|  |  | Bullying the weak  |  |
|  |  | Having a violent temper  |  |
|  |  | Unable to concentrate on one thing   |  |
|  | Smoking or drinking alcohol                                | Smoking or drinking alcohol  |  |
| Going to net bars or video arcade                      | Going to net bars or video arcade                          | Same as above (original coding reversed)   |  |
| Homework Index   | Not Copy homework from others or cheat in exams            |  |  |
|  | Try to finish homework even dislike it                     |  |  |
|  | Try to finish homework even taking long time               |  |  |
| <b>Panel B:<br/>Student socio-emotional abilities</b>  | Deal with negative feelings                                | Usually I can recover from negative feelings soon by myself                            | How much do you agree with the following statement (1 strongly disagree, 2 somewhat disagree, 3 somewhat agree, 4 strongly agree)  |
|  |  | Usually I can recover from negative feelings with the help of others                   |  |
|  | Ease of communication index                                | I'm not shy  | Same as above (original coding reversed)   |
|  |  | Usually I would join others rather than sit alone                                      |  |
|  |  | I often talk when I'm with schoolmates   |  |
|  | Have role models   | I can chat with adults easily  | How much do you agree with the following statements (1 strongly disagree, 2 somewhat disagree, 3 somewhat agree, 4 strongly agree) |
|  | Deal with tough situations                                 | There are some adults I respect and admire   |  |
|  |  | I would apologize if I hurt others unintentionally                                     |  |
| I would try to find other ways if I do something wrong |  |  |  |
|  | I can stay calm even in bad situations                     | Usually I have confidence in my ability to fulfill my task                             |  |
|  | Usually I have confidence in my ability to fulfill my task |  |  |
| <b>Panel C:<br/>Tools and teacher-</b>                 | Multimedia in teaching                                     | Multimedia in teaching   | The fraction of subject teachers (Chinese, Math and English) that often use multimedia in teaching.                                |

|  |   |  |   |
|--|---|--|---|
| <b>student interactions</b>  | Total working hours                             | Total working hours  | The number of total working hours last week, averaged across three subject teachers.  |
|  | Discussion and Interactions Index               | Discussion and Interactions  | We first average the two variables indicating group discussions and interactions between teachers and students for each subject (Chinese, Math and English), and then take the average of three subjects. |
|  |   | Hours of comm. btw homeroom teacher & students   | The number of hours that the homeroom teacher spent on communicating with students after class everyday   |
|  | Students perceive having a helpful teacher      | If I have the feelings mentioned above (i.e. negative feelings), My teacher would not ignore and isolate me  | How much do you agree with the following statements (1 strongly disagree, 2 somewhat disagree, 3 somewhat agree, 4 strongly agree) (original coding reversed)   |
|  |   | If I have the feelings mentioned above (i.e. negative feelings), My teacher would not criticize me in public |   |
|  |   | If I have the feelings mentioned above (i.e. negative feelings), My teacher would not criticize me privately |   |
|  |   | If I have the feelings mentioned above (i.e. negative feelings), My teacher would try to help me             | How much do you agree with the following statements (1 strongly disagree, 2 somewhat disagree, 3 somewhat agree, 4 strongly agree)  |
| If I have the feelings mentioned above (i.e. negative feelings), My teacher would ask my parents to help me together |   |  |   |
| <b>Panel D: The characteristics of friends/peers</b>   | Class atmosphere                                | Most of my classmates are nice to me   | How much of your best friends fit in the following description? (1 none of them, 2 one or two of them, 3 most of them)  |
|  |   | My class has a good atmosphere   |   |
|  | Friends Academic Index                          | Friends: Doing well in academic performance  |   |
|  |   | Friends: Studying hard   |   |
|  |   | Friends: Expecting to go to college  |   |
|  | Friends skipping class                          | Friends: Skipping classes  |   |
|  |   | Friends: Dropped out of school   |   |
|  | Friends' other behaviors violating school rules | Friends: Criticized or punished for violating school rules   |   |
|  |   | Friends: Always fighting with others   |   |
|  |   | Friends: Smoking or drinking alcohol   |   |
|  |   | Friends: Always going to net bars or video arcade  |   |
|  | Friends: Having had or is having a romance      |  |   |

Note: This table provides the individual components of each index variable used in the mechanism analysis (Table 7). We aggregate the components into different categories following the aggregation approach by Anderson et al. (2008).

**Appendix Table 4. Mechanisms (detailed table with all the individual outcomes)**

**Panel A: Student behavior and effort**

|         | (1)                                    | (2)                           | (3)                              | (4)                            | (5)                            | (6)  | (7)                          | (8)                                  | (9)  | (10)   | (11)  | (12)   |
|---------|--|-------------------------------|----------------------------------|--------------------------------|--------------------------------|--|------------------------------|--------------------------------------|--|--|---|--|
|         | Cursing<br>or saying<br>swearwor<br>ds | Quarrelin<br>g with<br>others | Having a<br>fight with<br>others | Bullying<br>the weak           | Having a<br>violent<br>temper  | Unable to<br>concentra<br>te on one<br>thing | Skipping<br>classes          | Smoking<br>or<br>drinking<br>alcohol | Going to<br>net bars<br>or video<br>arcade | Not<br>Copy<br>homewor<br>k from<br>others or<br>cheat in<br>exams | Try to<br>finish<br>homewo<br>rk even<br>dislike it | Try to<br>finish<br>homewor<br>k even<br>taking<br>long time |
| Peer KG | -0.412*<br>(0.217)<br>[0.097]          | -0.185<br>(0.180)<br>[0.302]  | -0.411***<br>(0.121)<br>[0.003]  | -0.290**<br>(0.114)<br>[0.027] | -0.405**<br>(0.196)<br>[0.077] | -0.238<br>(0.203)<br>[0.262]                 | -0.163<br>(0.100)<br>[0.124] | -0.361***<br>(0.066)<br>[0.000]      | -0.376***<br>(0.103)<br>[0.002]            | 0.267*<br>(0.158)<br>[0.121]                                       | 0.298*<br>(0.161)<br>[0.097]                        | 0.448***<br>(0.169)<br>[0.024]                               |
| Obs.    | 3600                                   | 3599                          | 3596                             | 3600                           | 3599                           | 3585   | 3600                         | 3604                                 | 3604                                       | 3593   | 3603  | 3601   |
| R2      | 0.104                                  | 0.080                         | 0.112                            | 0.054                          | 0.053                          | 0.081  | 0.081                        | 0.046                                | 0.113                                      | 0.135  | 0.064   | 0.069  |

**Panel B: Student socio-emotional abilities**

|         | (1)  | (2)  | (3)                          | (4)   | (5)   | (6)                                    | (7)   | (8)  | (9)  | (10)  | (11)  |
|---------|--|--|------------------------------|---|---|--|---|--|--|---|---|
|         | Usually I<br>can<br>recover<br>from<br>negative<br>feelings<br>soon by<br>myself | Usually I<br>can<br>recover<br>from<br>negative<br>feelings<br>with the<br>help of<br>others | I'm not<br>shy               | Usually I<br>would<br>join<br>others<br>rather<br>than sit<br>alone | I often<br>talk when<br>I'm with<br>schoolmat<br>es | I can chat<br>with<br>adults<br>easily | There<br>are some<br>adults I<br>respect<br>and<br>admire | I would<br>apologize<br>if I hurt<br>others<br>unintentionally | I would<br>try to find<br>other<br>ways if I<br>do<br>something<br>wrong | I can<br>stay<br>calm<br>even in<br>bad<br>situations | Usually<br>I have<br>confiden<br>ce in my<br>ability to<br>fulfill<br>my task |
| Peer KG | 0.104<br>(0.155)<br>[0.552]  | 0.168<br>(0.168)<br>[0.435]  | -0.202<br>(0.152)<br>[0.405] | 0.404**<br>(0.179)<br>[0.089]                                       | -0.083<br>(0.197)<br>[0.673]                        | 0.867***<br>(0.156)<br>[0]             | 0.592**<br>(0.279)<br>[0.094]                             | 0.486***<br>(0.133)<br>[0.001]                                 | 0.189<br>(0.166)<br>[0.435]  | 0.199<br>(0.189)<br>[0.435]                           | 0.130<br>(0.173)<br>[0.552]   |
| Obs.    | 3599   | 3595   | 3599                         | 3589  | 3591  | 3589                                   | 3590  | 3584   | 3596   | 3595  | 3599  |
| R2      | 0.071  | 0.059  | 0.063                        | 0.047   | 0.041   | 0.085                                  | 0.074   | 0.061  | 0.064  | 0.064   | 0.068   |

**Panel C: Tools and teacher-student interactions**

|         | (1)                         | (2)                           | (3)                         | (4)  | (5)  | (6)   | (7)   | (8)                             | (9)   |
|---------|-----------------------------|-------------------------------|-----------------------------|--|--|---|---|---------------------------------|---|
|         | Multimedia in teaching      | Total working hours           | Discussion and Interactions | Hours of comm. btw homeroom teacher & students | My teacher would not ignore and isolate me | My teacher would not criticize me in public | My teacher would not criticize me privately | My teacher would try to help me | My teacher would ask my parents to help me together |
| Peer KG | 0.066<br>(0.316)<br>[0.911] | -1.913<br>(11.291)<br>[0.911] | 0.040<br>(0.286)<br>[0.911] | -0.109<br>(0.983)<br>[0.911]                   | 0.679***<br>(0.152)<br>[0]                 | 0.991***<br>(0.156)<br>[0]                  | 0.045<br>(0.174)<br>[0.911]                 | 0.379<br>(0.231)<br>[0.227]     | 0.409**<br>(0.204)<br>[0.137]                       |
| Obs.    | 3681                        | 3681                          | 3681                        | 3439   | 3592                                       | 3594  | 3593  | 3591                            | 3587  |
| R2      | 0.847                       | 0.785                         | 0.839                       | 0.724  | 0.060                                      | 0.070                                       | 0.059                                       | 0.080                           | 0.085   |

**Panel D: The characteristics of friends/peers**

|         | (1)                                  | (2)                            | (3)   | (4)                          | (5)                                 | (6)                            | (7)                            | (8)  | (9)                                  | (10)                                 | (11)  | (12)                                       |
|---------|--------------------------------------|--------------------------------|---|------------------------------|-------------------------------------|--------------------------------|--------------------------------|--|--------------------------------------|--------------------------------------|---|--|
|         | Most of my classmates are nice to me | My class has a good atmosphere | Friends: Doing well in academic performance | Friends: Studying hard       | Friends: Expecting to go to college | Friends: Skipping classes      | Friends: Dropped out of school | Friends: Criticized or punished for violating school rules | Friends: Always fighting with others | Friends: Smoking or drinking alcohol | Friends: Always going to net bars or video arcade | Friends: Having had or is having a romance |
| Peer KG | 0.189<br>(0.143)<br>[0.188]          | 0.996***<br>(0.313)<br>[0.004] | 0.267*<br>(0.151)<br>[0.101]                | 0.375**<br>(0.175)<br>[0.05] | 0.574***<br>(0.141)<br>[0.001]      | -0.226**<br>(0.089)<br>[0.023] | -0.089<br>(0.055)<br>[0.122]   | -0.303***<br>(0.093)<br>[0.004]                            | -0.256***<br>(0.087)<br>[0.007]      | 0.294***<br>(0.076)<br>[0.001]       | -0.208**<br>(0.098)<br>[0.050]                    | -0.194<br>(0.123)<br>[0.127]               |
| Obs.    | 3597                                 | 3595                           | 3573  | 3568                         | 3563                                | 3570                           | 3569                           | 3573   | 3571                                 | 3571                                 | 3568  | 3568                                       |
| R2      | 0.072                                | 0.166                          | 0.097                                       | 0.130                        | 0.145                               | 0.085                          | 0.057                          | 0.100  | 0.095                                | 0.072                                | 0.132   | 0.072                                      |

Notes: Robust standard errors clustered at the class level are shown in parentheses. We report the adjusted  $p$ -values in square brackets to address the concern on multiple hypotheses testing (Simes 1986).



**Appendix Table 5. Checking for systematic differences in teacher characteristics**

|                   | (1)  | (2)                                       | (3)                                   | (4)                                     | (5)                                     | (6)                     |
|-------------------|--|---|---------------------------------------|---|---|-------------------------|
|                   | Homeroom teacher's teaching experience (years) | Homeroom teacher has province-level award | Homeroom teacher has city-level award | Homeroom teacher has county-level award | Homeroom teacher has school-level award | Age of homeroom teacher |
| Peer Kindergarten | 17.361*<br>(8.636)                             | 0.254<br>(0.410)                          | 0.336<br>(0.621)                      | 1.081<br>(0.831)                        | 0.342<br>(0.930)                        | 11.780<br>(7.036)       |
| Observations      | 3634   | 3634                                      | 3634                                  | 3634                                    | 3634                                    | 3634                    |
| R-squared         | 0.666  | 0.606                                     | 0.480                                 | 0.444                                   | 0.431                                   | 0.699                   |

|                   | (7)                     | (8)  | (9)   | (10)  | (11)  |
|-------------------|-------------------------|--|---|---|---|
|                   | Homeroom Teacher female | Homeroom teacher edu: Adult higher education | Homeroom teacher edu: College education or higher | Homeroom Teacher graduated from a normal university | Homeroom teacher's professional title in teaching |
| Peer Kindergarten | 0.857<br>(0.866)        | -0.287<br>(1.032)                            | -0.324<br>(0.303)                                 | -0.047<br>(0.163)                                   | 1.265<br>(1.074)                                  |
| Observations      | 3634                    | 3634   | 3634  | 3634  | 3634  |
| R-squared         | 0.524                   | 0.568  | 0.486   | 0.460   | 0.634   |

Note: All regressions include a full set of control variables as in Table 4. Standard errors clustered at the class level are in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

**Appendix Table 6. Robustness to using the aggregations index developed by Kling et al. (2007)**

|                   | (1)                  | (2)                    | (3)                 | (4)              |
|-------------------|----------------------|------------------------|---------------------|------------------|
|                   | Academic performance | Non-cognitive outcomes | Social adjustment   | Mental health    |
| Peer Kindergarten | 0.624**<br>(0.301)   | 0.346**<br>(0.164)     | 0.523***<br>(0.117) | 0.276<br>(0.206) |
| Control Mean      | 0.034                | 0.026                  | 0.049               | 0.017            |
| Observations      | 3641                 | 3606                   | 3606                | 3603             |
| R-squared         | 0.408                | 0.116                  | 0.254               | 0.072            |
| School FE         | Yes                  | Yes                    | Yes                 | Yes              |
| Controls          | Yes                  | Yes                    | Yes                 | Yes              |

Note: The dependent variables include the same set of variables as in the main results, but aggregated using the method developed by Kling et al. (2007). We first normalize each index to have a mean zero and standard deviation of one, then take the simple average of the normalized variables. All regressions include a full set of control variables as in the last column of Table 4. Standard errors clustered at the class level are shown in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

**Appendix Table 7. Robustness to controlling for peers' abilities**

|   | (1)                  | (2)                    | (3)                  | (4)               |
|---|----------------------|------------------------|----------------------|-------------------|
|   | Academic performance | Non-cognitive outcomes | Social adjustment    | Mental health     |
| Peer Kindergarten                                   | 0.169<br>(0.321)     | 0.667***<br>(0.221)    | 0.595***<br>(0.198)  | 0.460<br>(0.314)  |
| Attended kindergarten                               | 0.179***<br>(0.041)  | 0.099**<br>(0.043)     | 0.104***<br>(0.039)  | 0.075<br>(0.047)  |
| Fraction of classroom peers having repeated a grade | -2.406***<br>(0.445) | -0.153<br>(0.316)      | -0.233<br>(0.320)    | -0.031<br>(0.393) |
| Fraction of classroom peers having skipped a grade  | -0.623<br>(0.936)    | -1.863***<br>(0.551)   | -1.661***<br>(0.587) | 0.149<br>(0.602)  |
| Observations  | 3634                 | 3473                   | 3542                 | 3534              |
| R-squared   | 0.409                | 0.229                  | 0.236                | 0.070             |
| School Fixed Effects                                | Yes                  | Yes                    | Yes                  | Yes               |
| Full Controls                                       | Yes                  | Yes                    | Yes                  | Yes               |

Note: Regressions include all controls as in the last column of Table 4. Standard errors clustered at the class level in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.