

# Essays on Social Capital and Peer Effects

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(ABSTRACT)

In Chapter 2, I employ the educational production function to identify the different effects of making a friend with the same gender and the opposite gender in a school network. Unlike other gender peer effects literature that only quantifies the causal effects of the proportion of girls in an aggregated level, such as other students in the same class, grade, or dorm, I study the gender of the five best friends nominated by the student. I address the endogeneity of friendship composition by employing a novel set of instrumental variables for the number of same-gender and opposite-gender friends. We find that having more friends, especially in the early accumulation stage, lowers the test scores. We also explore the mechanisms. In Chapter 3, I investigate the role of social learning in enrollment decisions for a public pension scheme. All else equal, if a qualified rural resident moves from a community where no other co-villagers participate in the new pension scheme to a community that is fully covered by the pension scheme, the probability of an individual enrolling by 0.541 percentage point. We use robustness checks to illustrate that the estimated peer effects are not driven by the common unobserved factors, but social interactions. In Chapter 4, we use the survey data on Chinese middle students and the instrumental variables method to explore the different effects of making friends with the same gender and the opposite gender in a school network on mental health. The empirical results find that having a larger number of same-gender friends improves mental health but having a larger number of opposite-gender friends hurts mental health.

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(GENERAL AUDIENCE ABSTRACT)

We need human connections. Along with other assets, such as money and skills, networks and relationships are resources that could help with economic outcomes in our daily lives. The rapid development of the Internet and the intelligentization of digital devices such as mobile phones have made it easier to establish relationships with others. They also generate much more data nowadays that makes it possible to study social relationships. In this dissertation, we mainly discuss two aspects of social network. First, we use popularity as a measure of social capital and study how social capital influence middle school students' academic outcomes and mental health outcomes using Chinese data. Given that middle school students are in the embryonic stage of personal emotional development, we distinguish friends by of the same gender or not. We find that popularity with the same gender and the opposite gender differently impact the outcomes. Second, it is intuitive that under the influence or pressure of a group, an individual tends to make his or her speech and behavior consistent with the group. Therefore, we are interested in if an individual's choice will be driven by other people's choices in the same group. We consider the adoption of a newly introduced pension program for rural residents in China. Besides demographic characteristics, a person's decision is also influenced by those around them. If a higher proportion of his or her co-villagers choose to join the pension plan, he or she is more likely to join.

# Dedication

*To my beloved father and grandfather*

# Acknowledgments

To this day, I can still recall the first time I walked into the Pamplin Hall with anticipation six years ago. The first year was hard for me. For someone like me who never took economics courses before Ph.D. program, the first year was tough. At the same time, I was diagnosed with severe psoriasis, an immune system problem, leading to my leaving at the end of the first year. At one point, I thought my academic career would come to an end. One year later, my condition was under control. When I tentatively asked if I had a chance to return to the program, I received the warmest welcome from all the faculty, staff, and other graduate students. Although being sick was not a pleasant experience, it made me get to know two classes of Ph.D. students and become good friends with them. When I look back this experience, my heart is full of gratitude. I would like to express my most sincere thanks to my advisor, Dr. Xu Lin. I have been impressed by her knowledge, professionalism, and caring for students since I got to know her. Her class in my second year convinced me to choose applied microeconomics as my research area. She is the person I have had the closest contact with for the past three years. She has been supporting me in research, teaching and life. I would also like to extend my thanks my committee members for their comments on my dissertation. Additionally, I appreciate Dr. Ali Habibnia for his guidance in my career choices. I appreciate Dr. Suqin Ge and Dr. Susan Chen for their recommendation letters. I would not get those interview opportunities without the recommendations. My thanks also go to my parents, grandparents, and

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# Chapter 1

## Introduction

The idea of social capital is widely explored in social science. The definition of social capital in economics starts from “trust” where experimental economics emphasizes a lot ([Rabin, 1993](#)). It extends to interpersonal networks as trust may be built in networks. Interpersonal networks are beneficial to both members and society as a whole ([Dasgupta, 2005](#)). In this dissertation, we use the number of friends as a measure to explore the effect of social capital on middle school students’ academic performance and mental health. We also investigate the peer effects in the network as a channel of information dissemination.

Chapter 2 investigates the effects of same-sex and opposite-sex friends on academic achievement in the context of China. To address the endogeneity of friendship formation, we rely on the variations in school-level average numbers of same-gender and opposite-gender friends, the share of opposite-gender schoolmates and parents’ strictness with friends making to obtain exogenous variations in the numbers of same-gender and opposite-gender school friends for a student. Since I include both the number and the gender of friends in the model, on top of how gender affects academic outcomes, the effect of being integrated into a social network is measured.

The results indicate that having one additional same-gender friend reduces scores in all three individual subjects, i.e., Chinese, math and English, and the total scores, while having an additional opposite-gender friend reduces scores only in Chinese, English and the total scores, not in math. We conduct several robustness checks and find that our results are robust against alternative specifications. We also show that the negative effects are especially strong for female students. We explore the possible channels through which the gender of friends affects academic achievement and find that building friendship increases the time spent on social interactions, which crowds out activities that improve academic performance. Furthermore, being popular with peers of the other gender raise the possibility of being in a romantic relationship substantially, while being popular with schoolmates of the same gender improves students' feelings about school climate.

Chapter 3 studies the influence of social networks on a newly introduced public pension scheme adoption in rural China using data from CHARLS and County Level Social and Economic Statistical Yearbook. The problem of omitted variable bias is addressed using a two-step model estimating static games of incomplete information. According to our model, all else equal, if a qualified rural resident moves from a community where no other co-villagers participate in the new pension scheme to a community that is fully covered by the pension scheme, the probability of an individual enrolling by 0.541 percentage point. We also investigate the possible non-linearity of the social learning effect and confirm that the effect is linear. Numerous robustness tests are employed to support the validity of the identification by providing support for the theory of social learning by showing that the social learning

effect is weaker when the peers' distance becomes larger or the individuals have more access to information.

Chapter 4 investigate how social capital affects middle school students' mental health. We use number of friends as a measure of social capital. To take gender into consideration, we divide friends into friends of the same gender and friends of the opposite gender. We use a novel set of instrumental variables to eliminate the endogeneity bias. We prove the validity of the instrumental variables by doing multiple tests. We find that having one more same-gender friend decreases the frequency of having negative feelings across different questions. However, having one more opposite-gender friend increases the frequency of feeling depressed. As our sample consists of two cohorts, we find that more social capital with the same gender benefits younger middle school students. At the same time, the effect of social capital with the opposite gender is only significant for students in the 9th grade. Combing with the relationships with parents, we find that the benefits from the same-gender friends are larger for students who are not close to their mothers or close to their fathers. Nevertheless, if a student is not close to his or her mother, being popular with the opposite gender hurts more. On the other side, a close relationship with either parent provides a buffer that prevents negative emotions generating from having more opposite-gender friends.

# Chapter 2

## Does Friends' Gender Matter for Students' Academic Performance?

### 2.1 Introduction

Academic performance is an essential determinant of higher wages ([Moretti, 2004](#)), better health ([Cutler and Lleras-Muney, 2006](#)), and other positive outcomes ([Arrow, 1997](#)). [Coleman \(1968\)](#) is the first to relate various inputs affecting students' learning outcomes to students' outputs in the Coleman Report, and [Bowles \(1970\)](#) applies the economic concept of a production function to the field of education. Since then, extensive research has attempted to employ the educational production function to identify the factors influencing students' academic performance. Besides the individual-level factors, school factors ([Sweetland and Hoy, 2000](#)), family factors ([Gonzales et al., 1996](#)), peer factors ([Hanushek et al., 2003](#); [Gonzales et al., 1996](#)), and neighborhood factors ([Ainsworth, 2002](#)) have also been shown to affect academic performance.

In the peer effects literature, the effect of gender composition has been widely studied

due to its significant policy relevance. Among them, extensive research has attempted to quantify the causal effect of peers' gender composition on educational outcomes. Peers of a student are defined using the unweighted linear mean of an aggregated level in most cases, such as classmates (Ladd et al., 2008; Lee et al., 2014; Gong et al., 2019), grade (Dewan et al., 2017) or dorm (Sacerdote, 2001). However, such a broad reference group specification cannot capture the effects generated from social interactions among the students. It is possible that a student's response to peers may vary by peer type. (Patacchini et al., 2017) Students self-select into friendship networks and choose with whom to make friends. Therefore, students are likely to be more significantly influenced by their friends, rather than equally by every other member in the same class, grade or dorm (Lin, 2010).

Especially during the transition from childhood to adulthood, friends help adolescents understand and adapt to the biological changes they are experiencing (Douvan et al., 1966). And spending time with friends rather than family members help adolescents build social identity (Csikszentmihalyi et al., 1977; Fuligni et al., 2001; Cook et al., 2007). More importantly, having both same-sex and opposite-sex friends allows teenagers to interact with people from more diverse background, which help meet the growing psychological needs and cultivate optimism. Different from previous studies on opposite-gender peer effects, which focus on love psychology and behavior (Knox and Wilson, 1981, Lefkowitz et al., 2004), sexual behavior (Billy and Udry, 1985; Jaccard et al., 2005), contraception and STD prevention (Pouget et al., 2010; Ali and Dwyer, 2011), and the like, we try to identify the different effects generated by same-gender and opposite-gender friends on academic outcomes. In particular, in

addition to the frequently used measure of "female share in a class" , we introduce the numbers of same- gender and opposite-gender friends in a school-level friendship network into the model to investigate how a student is affected differently by his/her friends and classmates.

Understanding the spillover effects generated by peers is vital for developing countries including China, where the limited resources necessitate more effective use of educational inputs, including peers. Studying the causal effect of friends' gender is of particular policy relevance in China as few teenagers have brothers or sisters to interact with in their families due to the One-child Policy. We divide a student's friends in the same school into two groups, i.e., same-gender and opposite-gender friends, and identify the impacts of same-gender and opposite-gender friends on students' achievements respectively. As pointed out by [Manski, \(1993\)](#), the fundamental challenge for peer effects estimation is the non-random formation of the peer groups. For example, outgoing students may actively participate in extracurricular activities, resulting in more gender-balanced friendship groups, and these personal characteristics may also have a direct effect on grades. In order to overcome the endogeneity of peer group formation, many studies rely on randomized experiments ([Hoxby, 2000](#); [McKenzie, 2003](#); [Sacerdote, 2001](#); [Duflo et al., 2011](#); [Carrell et al., 2013](#); [Lee et al., 2014](#); [Feld and Zölitz, 2017](#); [Gong et al., 2019](#)).

In this paper, we employ an instrumental variable (IV) approach to address the endogeneity of friends' gender composition, relying on the variations of school-level average numbers of same-gender and opposite-gender friends, the share of opposite-gender schoolmates and parents' strictness with friends making. This obtains exoge-

nous variations in the numbers of same-gender and opposite-gender school friends after controlling for the county fixed effect. A student is more likely to make opposite-gender friends in the school network if many students in the same school have opposite-gender friends or if he/she is in a school with a higher share of opposite-gender schoolmates. The gender composition of schoolmates and the school-level average number of same- or opposite-gender friends, on the other hand, do not directly influence academic achievement. Parents' strictness with friends making is also associated with the gender composition of an adolescent's friends. Under the influence of Confucianism in China, it is generally the case that the stricter the parents are with their child's friendship choice, the less likely the child has opposite-gender friends.<sup>1</sup>

Data come from the China Education Panel Survey (CEPS), which contains detailed information on a sample of nearly 20,000 middle school students in China. For our purpose, the most unique and valuable feature of the data is that students were asked to list up to five best friends along with friends' gender. Although linkable friends' identifiers are not available, we do have information on friends' gender for each respondent. Therefore, unlike previous studies which specify peers at a broad level of class, grade or dorm, our peers are specified based on the real friendship networks within a school, and as a result, the peer effects we identified are due to direct social interactions among the friendship network members.

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<sup>1</sup>A possible concern is that if a child performs well (poorly) academically, then a parent may become less (more) restrictive on a child's activity. We take advantage of the rich information in our data to demonstrate that parents' strictness on friends making has no direct effect on a child's academic performance except indirectly through the child's friendship choice. More detailed discussions on this are provided in Section 2.4.

Consistent with previous cohort gender effect studies using the same dataset (Gong et al., 2019), which normally indicates that a higher proportion of girls is associated with better academic achievements, we find evidence for the beneficial effect of the share of girls in a class in the OLS estimates. In contrast, in the IV estimates, the share of female classmates only appears to positively affect the Math score. More importantly, we demonstrate that one standard deviation increase in the number of same-gender friends leads to approximately one-fifth of standard deviation decline in standardized total score. And having one more same-gender friend decreases Chinese, Mathematics, and English by 1.0782, 1.2194 and 1.3629 points, respectively, while having an additional opposite gender friend lowers Chinese, English and total scores by 1.9793, 2.4147 and 5.2456 points, respectively. The findings indicate that it is important to make a distinction between classmates and friends when analyzing gender peer effects.

We also find that students in Grade 7 or female students are more vulnerable. Furthermore, we explore the possible channels through which the gender of friends affects academic achievement. We find that an increase in the number of friends, regardless of gender, largely reduces the time spent on coursework-related activities and increases hours spent on hanging out with friends, implying that building and maintaining friendships are time-consuming and crowd out activities that improve academic performance. Moreover, being popular with the opposite gender significantly increases the probability of falling in love at an early age. On the other side, being popular with the same gender benefits students' feelings about the class and school, which positively impacts academic performance. This channel provides

an explanation why the negative influence of same-sex friends is smaller than it is of opposite-sex friends. Understanding the mechanisms through which gender peer effects operate is meaningful for students, teachers, parents and policymakers.

The rest of the paper is organized as follows. Section 2.2 reviews the literature. Section 2.3 introduces the primary education in China and describes the data. Section 2.4 discusses the empirical strategy. Empirical results are presented in Section 2.5. Section 2.6 conducts several robustness checks, and Section 2.7 presents the heterogeneous effects based on the grade level and gender. Section 2.8 explores the potential mechanisms through which gender peer effects might operate. Section 2.9 concludes.

## 2.2 Literature Review

Existing studies investigating gender peer effects on academic outcomes mostly focus on the proportion of girls in a relevant group. The publications cover almost all educational stages: elementary school (Hoxby, 2000), middle school (Lu and Anderson, 2014; Gong et al., 2019), high school (Lavy and Schlosser, 2011; Hill, 2015) and college (Hill, 2017). However, there is no consistent definition for the relevant group in the literature and the conclusions are mixed. Many studies define the relevant group as classmates, grademates or schoolmates due to data availability, implicitly assuming a student is equally affected by everyone else in the group. For example, given that girls' math skill is about the same as boys', Hoxby (2000), a pioneer in the research of gender peer effects, shows that in courses with a higher ratio of females,

both males and females fare better in math. [Whitmore \(2005\)](#) claims that female students had a favorable influence on both male and female learners' achievement in kindergarten through second grade, based on data from Tennessee's Project STAR program. In third grade, however, male pupils who are in a class with a higher ratio of female students do poorly. [Lavy and Schlosser \(2011\)](#) also find that having a higher number of female students in a classroom enhances both boys' and girls' cognitive outcomes. However, [Antecol et al. \(2016\)](#), on the other hand, find no effect of female proportion in the classroom on achievement, regardless of the gender of the pupils. Based on data from a randomized study, [Eren \(2017\)](#) indicates that having a larger proportion of female classmates in the classroom improves girls' math test performance only in lower grades. [Dewan et al. \(2017\)](#) find that the number of female peers in a student's cohort has a strong and sizable positive effect on both male and female students' grade levels, using a new administrative dataset with an all-India presence. Furthermore, there is evidence of non-linearity in the peer effect, as children's test scores are found to be concavely related to the proportion of female peers. [Goulas et al. \(2018\)](#) exploit within-school and neighborhood idiosyncratic variations in gender composition share and finds that a higher share of females in a school or neighborhood improves both genders' scholastic performance. Other studies focus on roommates. [Stinebrickner and Stinebrickner \(2006\)](#), for example, use the administrative data from Berea college and defines roommates as peers. They show that college students spend 21.66 hours per week with his/her roommates on average, along with a positive relationship between a student's ACT score and his/her peers' ACT scores.

For studies targeting students in China, [Lu and Anderson \(2014\)](#) use a Chinese middle school's random seat assignment to estimate how the gender of nearby students influences a student's academic achievement, and they find that being surrounded by more female students raises girls' test scores. The increased presence of female pupils, on the other hand, has little effect on or even harms boys. Using the same dataset as in our paper, [Gong et al. \(2019\)](#) defines peer group as all the other students in the same class. It relies on schools with random assignment to identify the effects of the female share in a class, resulting in significant observation loss.

Several recent studies have switched to an individual's friendship network using Add Health data. [Calvó-Armengol et al. \(2009\)](#) find that increasing centrality in the network leads to a significant increase in academic achievement. [Mihaly \(2009\)](#) finds a negative relationship between student popularity and academic achievement using the interaction of individual demographic characteristics and the grade by gender composition of these characteristics as instrumental variables. [Hill \(2015\)](#) found that having more opposite-gender school buddies lowers academic attainment. [Skiera et al. \(2015\)](#) find students located in densely connected networks earn better grades. [Patacchini et al. \(2017\)](#) point out that the existing heterogeneous peer effects only show how peer influences alter depending upon the type of person (e.g. males versus females, hispanic versus non-hispanic, etc), but not touch different types of peers. According to their definitions, a short-lived relationship (the friendship lasts less one year) does not influence the long-run educational outcomes while a long-lived relationship (the friendship lasts more than one year) positively affects them.

Many studies also try to uncover the channels through which gender peer effects on

academic achievement might operate. [Stinebrickner and Stinebrickner \(2006\)](#) discover that a student's effort in studying, as well as his or her time usage and beliefs, can be influenced by classmates' behaviors and beliefs. In addition, females may be more accepting of roommates from different backgrounds. As a result, they may spend more time with their assigned roommates than males. When instructors are randomly assigned to a class of high-achieving pupils vs a class of low-achieving students, [Duflo et al. \(2011\)](#) discover that they put in more effort, as assessed by teacher absenteeism, in Kenyan primary schools. Lower levels of classroom disruption and violence, improved inter-student and student-teacher relationships, and less teacher fatigue all contribute to academic gains, according to [Lavy and Schlosser \(2011\)](#). [Feld and Zölitz \(2017\)](#) show that peer effects on group functioning exist, but not on teacher performance. [Eren \(2017\)](#) proposes two possible explanations: lower gender stereotype influences and changes in gender-specific attitudes toward competition. According to [Gong et al. \(2019\)](#), plausible reasons include changes in teacher conduct, classroom atmosphere, and student behavior as a result of more female pupils.

## 2.3 Middle School Education in China and Data Summary

In China, the nine-year compulsory education includes six years of primary education (elementary school), starting at age six or seven, and three years of middle school

education for ages 12 to 15. According to the Ministry of Education of the People's Republic of China, the Gross Enrollment Ratio (GER) of middle schools in China is 100.9% in 2018.<sup>2</sup> Middle school education focuses on Chinese, Mathematics, English, Physics, and Chemistry. Chinese and Mathematics are introduced in the first year of primary education. English is usually introduced in the 3rd grade of elementary school. After students finish primary education, Physics is usually introduced in the second year and Chemistry in the third year of middle school education. An academic year runs from September in a calendar year to June in the next calendar year. Students are given a midterm and a final test on all subjects taught in that semester during all three years of junior middle school. In China, the score is not only an important indicator of student academic performance, but also the only factor that determines whether students progress to higher education.

The Senior High School Entrance Examination, or Zhongkao, is held every year in June, around the conclusion of grade 9, which is the final year of junior middle school. This exam is not only a comprehensive evaluation of the nine-year compulsory education, but it is also a requirement for admission to almost all senior high school education institutions, including common senior high schools, secondary skill schools, vocational high schools, and technical high schools. Chinese society places an extraordinarily high value on education, students must devote a significant amount of time and effort to Zhongkao preparation. For many junior middle kids, getting into good high schools becomes the most essential goal in their education. Our analysis focuses on the test scores on Chinese, Mathematics and English, the

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<sup>2</sup>The GER is the proportion of students who live in that country to those who are eligible for that grade level.

three subjects that attract the most attention from students, teachers and parents (Wu, 2015), as these three subjects are taught in all three years and account for a large proportion in Zhongkao.

The China Education Panel Survey (CEPS) is a nationally representative sample of approximately 20,000 Chinese middle school students in 438 classrooms and 112 schools throughout 28 counties or metropolitan districts,<sup>3</sup> conducted by the National Survey Research Center (NSRC) at Renmin University of China. The baseline survey was conducted in the 2013-2014 academic year, including 19,487 students from two cohorts: 10,279 students from the 7th grade and 9,208 students from the 9th grade respectively. The follow-up survey was conducted in the subsequent academic year to track the students' educational progress. The overall follow-up rate is 91.5%. The baseline sample's 7th students were in their 8th grade, and the baseline sample's 9th graders had completed compulsory education and left the original school. Up to now, only data that track the 7th graders in the baseline sample have been released. CEPS has 5 questionnaires that were given to students, parents, head teachers, teachers and principals, respectively.

There are several advantages of the CEPS. First of all, it provides detailed information on students' demographic characteristics. All students are asked questions on their relationship with parents, teachers and classmates, which enables us to adjust for observable characteristics that affect outcomes, and study the mechanisms through which the peer gender effects work. Secondly, it contains standardized scores

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<sup>3</sup>Normally, we use counties in rural areas and district in urban areas. We use counties for the rest of the paper to describe both.

in three core subjects, i.e., Chinese, Mathematics and English. Each of the three has an average of 70 and a standard deviation of 10, making scores across schools comparable.<sup>4</sup> Thirdly, all students are asked information about their best five friends, including basic demographics such as friends' gender, *hukou* status, and whether he/she is in the same school and class as the respondent.<sup>5</sup> Friends' behaviors, such as studying hard, expecting to go to college, skipping classes, criticized or punished for violating school rules, etc., are also available. Last but not least, students in the sample are from junior middle school. On the one hand, compared with high school students and college students, the factors affecting the academic outcomes of junior middle school students are relatively simple. On the other hand, compared with primary school students, the self-awareness of junior middle school students is enhanced, which tends to foster more friendships. After deleting the observations with missing key information (e.g., all friends' gender information), we have 18,457 observations in the final sample. We primarily focus on data from Wave 1 of the survey.<sup>6</sup>

We first present some general evidence from the CEPS data for the important role played by friends among teens. Table 2.1 summarizes the respondents' answers to the question: "who will be the first one for you to turn to in the following situations?".

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<sup>4</sup>In contrast, raw scores of these exams are based on school-specific tests and not comparable across schools.

<sup>5</sup>As in many surveys, there is a restriction on the maximum number of friend nominations. This restriction, although standard and facilitates subjects' responses, may cause some bias in our estimation due to censoring in the data. However, we perform some robustness checks by including additional types of friends, i.e. non-school friends, and find that our results are robust. More details can be found in Section 2.6. Therefore, the potential bias induced by this restriction should not be a serious concern in our sample.

<sup>6</sup>The second wave is being utilized to look into the impact of friends' gender on school performance in the following academic year.

Situations consist of when you want to chat with someone, when you are in trouble and when you need help. A large percentage (83.17%) of students choose to turn to their schoolmates or good friends to chat. About a half of students choose to turn to their schoolmates or good friends when they are in trouble or when they need help. It shows that adolescents begin to rely on more and more on their friends when coping with stress.

Table 2.2 cross-tabulates the nominated friends and friends in the same school. Figure 2.1 visualizes Table 2.2, and the bars show the number of friendship nominations. Most students nominate five friends. Student nominating zero friends are dropped from the sample. The greyscales in the bars exhibit how many friends out of the nominations are from the same school. The percentage values are listed. For example, for those who nominate five friends, 56.43% of students have all five friends from the same school. Only 3.41% of students nominate five friends but have no school friends. In Figure 2.2, the left panel gives the number of friendship nominations within a school. Zero friends in the figure results from restricting friendships to the same school. The right panel of Figure 2.2 shows the distribution of the share of friendship nominations within a school. We see that almost 60% of the friends are from the same school. The frequency distributions of the numbers of both same-gender and opposite-gender friends are shown in Figure 2.3. The number of same-gender friends has an uptrend while the number of opposite-gender friends has a downtrend. More than 80% of the students do not have friends of the opposite sex.

Table 2.3 describes the descriptive statistics of the variables for the analysis sample.

On average, a student has 3.3868 same-sex school friends and has 0.2593 opposite-sex school friends. The dependent variables considered are standardized midterm scores for three core subjects: Chinese, Mathematics and English, as well as the total score. Each score is standardized to have a mean of 70 and a standard deviation of 10, and the total score has a mean of 210.6265 and a standard deviation of 25.5769. Thanks to comprehensive information contained in the data, we are able to include a wide range of variables that may significantly impact friendship formation and academic outcomes at various levels, including individual, class and school levels.

With regard to individual characteristics, our covariates include grades, gender, ethnic identity, *hukou* status,<sup>7</sup> parents' strictness with grades, whether the only child in the family, family socioeconomic status, highest years of schooling of parents, parents' strictness with grades, baseline cognitive ability and whether attended preschool. Grade 9 is an indicator for the 9th grade, it will be 1 if a student is in the 9th grade, and 0 if in the 7th grade. Gender is a binary variable with male denoting 1 and female meaning 0. About 50.72% of the sample are male students. The ethnic majority in China is the Han population, which makes up about 92% of the sample. The non-Han Chinese population are ethnic minorities in China. Agricultural or non-agricultural *hukou* types, as well as whether or not their *hukou* is local, were reported by survey respondents. "Rural *hukou*" is a binary variable with 1 representing agricultural and 0 indicating non-agricultural *hukou*. 54.88% of the students are from rural areas according to the *hukou* system. "Local *hukou*" is a dummy variable

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<sup>7</sup>*Hukou* system is a unique feature in China, which was introduced in 1958 as the only means of population registration. Each citizen is classified as agricultural or non-agricultural *hukou*. Accessing many public services, including compulsory education, is linked to household registration.

with 1 denoting non-migrants and 0 meaning migrants. 82.34% of the students in our sample are local. We also include whether a respondent is the only child in the family.<sup>8</sup> In our sample, about 43.51% of the students are from only-child families.

With regard to family socioeconomic status, students were asked to choose one of the five categories: very poor (3.70%), poor (17.23%), average (73.05%), rich (5.70%) and very rich (0.31%). Parents' strictness with grades is recoded into three categories including strict, care but not strict and not care, which enables the comparison of the average grade for each strictness level to that of the reference group of "not care". 47.25% of respondents' parents do care but are not strict with grades, and almost 50% of the parents are strict with their children's grades. Baseline cognitive ability is the standardized scores from the cognitive assessment. The number ranges from -2.0290 to 2.7099, with a lower number indicating worse performance. Attended preschool is a dummy variable indicating whether a student has ever attended a kindergarten/preschool.<sup>9</sup> In the sample, about 4 out of 5 students have attended kindergarten/preschool. For parents' education, we use the years of schooling completed (none = 0; elementary school = 6; junior high school = 9; vocational/high school = 12; junior college = 15; bachelor's degree = 16; master's or higher = 19).<sup>10</sup>

In addition, we also control a wide range of characteristics at the class and school levels. Specifically, the average class size is 48.4938 with a minimum of 9 and a maximum of 88. Class ranking is a categorical variable with 5 levels: among the

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<sup>8</sup>Under the One-child Policy, a couple usually can only has one child in China. However, in certain areas, a second child is allowed (Ebenstein, 2010).

<sup>9</sup>China requires kindergartens to accept children aged 3-6. Some studies show that attending kindergarten program is beneficial to children's development (Lau and Li, 2018).

<sup>10</sup>We take the higher level of the parents' educational achievement for each student.

worst, below average, average, above average and among the best. About 3.33% of classes are in the category of “among the worst”, which is also the reference level. The other four categories are “below average”, “average”, “above average” and “among the best”, consisting of 13.33%, 34.84%, 37.58% and 10.92% in the sample. [Gong et al. \(2019\)](#) shows that head teachers’ gender plays an important role in students’ performance. About 36.7% of the head teachers in our sample are male. On average, they are 37.2229 years old, with 15.6415 years of experience. Middle school students spend most of their time within the classroom. Therefore, we include the share of female students in a class as a control variable. The average proportion of girls in a class is 48.51%. Other peers’ characteristics included in the class-level are the average proportion of non-immigrants (82.26%) and the average proportion of rural *hukou* (54.91%).

At the school level, although the number of private schools in China is growing, only 7.29% schools are private in our sample. Similar to class ranking, school ranking is an indicator of a school’s quality, which consists of five levels as well: among the worst, below average, average, above average and among the best, accounting for 0.90%, 6.77%, 11.52%, 58.14% and 22.66% of the schools.

## 2.4 Empirical Strategy

Consider a reduced-form specification of an education production function given as:

$$y_{ics} = \alpha_0 + \alpha_1 \text{FSS}_{ics} + \alpha_2 \text{FOS}_{ics} + X'_{ics} \alpha_3 + C'_{cs} \alpha_4 + S'_s \alpha_5 + \alpha_{\text{county}} + \varepsilon_{ics}, \quad (2.1)$$

where  $y_{ics}$  is outcome of interest for student  $i$  in class  $c$  and school  $s$ , which refers to students' standardized scores in Chinese, Mathematics or English or the total score of the three core subjects.  $FSS_{ics}$  is the number of same-gender friends from the same school. It also ranges from 0 to 5.  $FOS_{ics}$  specifies the number of opposite-gender friends from the same school, ranging from 0 to 5.  $X_{ics}$  is a vector of observable variables for individual  $i$ , which include grade, gender, academic ranking in primary school, ethnic identity, *hukou* status, whether the only child in the family, family socioeconomic status, parents' education, parents' strictness with grades, baseline cognitive ability, and whether attended preschool/kindergarten, as listed in Table 2.3.  $C_{cs}$  is a vector of observable class-level characteristics, including the female share, which is the key measurement for gender peer effect in several previous studies, as well as class size, teacher experience, and the like (Gong et al., 2019).  $S_s$  is a vector of observable school-level characteristics, such as public or private, school ranking, and so on.  $\alpha_{\text{county}}$  is county fixed effects. To account for possible correlations in outcomes among students in the same class, standard errors are clustered at the class level.

The most challenging problem that plagues the empirical research on the effects of friends is endogeneity, induced by individuals selecting friends based on unobserved characteristics, including parental inputs, personality traits, noncognitive skills, among others. Suppose these unobserved factors also affect academic outcomes, for example, parents who are supportive may encourage their children to participate in a variety of extracurricular activities, resulting in more gender-balanced social groups and higher academic accomplishment. (Hill, 2015), OLS results may

be biased.

An instrumental variable strategy allows the identification of causal relationships via an instrument that influences the independent variable but does not directly affect the outcome, except through its effect on the independent variable. The model can be estimated using the two-stage least squares (2SLS) estimator. The first stage equation is given by running an OLS regression for each of the endogenous variables, FSS and FOS, on all instrumental variables and exogenous variables:

$$\text{FSS}_{ics} = \eta_0 + \eta_1 Z_{ics} + X'_{ics} \eta_2 + C'_{cs} \eta_3 + S'_s \eta_4 + \eta_{\text{county}} + u_{ics}, \quad (2.2)$$

$$\text{FOS}_{ics} = \theta_0 + \theta_1 Z_{ics} + X'_{ics} \theta_2 + C'_{cs} \theta_3 + S'_s \theta_4 + \theta_{\text{county}} + v_{ics}, \quad (2.3)$$

where  $Z_{ics}$  denoting a vector of instruments for the gender composition in the friendship network for student  $i$  in class  $c$  and school  $s$ . The predicted FSS and FOS are then inserted into regression equation (2.1) to carry out a 2SLS estimation to identify the gender peer effects on students' academic achievement.

The second stage equation is given by:

$$y_{ics} = \alpha_0 + \alpha_1 \widehat{\text{FOS}}_{ics} + \alpha_2 \widehat{\text{FSS}}_{ics} + X'_{ics} \alpha_3 + C'_{cs} \alpha_4 + S'_s \alpha_5 + \alpha_{\text{county}} + \epsilon_{ics}. \quad (2.4)$$

## 2.5 Results

In this section, we systematically examine the effects of having friends of the same gender and opposite gender on middle school students' academic achievement. As a starting point, we carry out the ordinary least squares (OLS) estimates after controlling the individual, class and school level characteristics, as well as the county fixed effect. Next, we deal with the endogenous friendships network formation with an instrumental variable (IV) strategy and quantify the causal effects of same-gender and opposite-gender school friends on students' academic achievement.

### 2.5.1 OLS Results

Table 2.4 shows the OLS results from the baseline model, with each column representing a specific outcome. The coefficients on the number of opposite-gender friends are all positive and most are significant at the 1% or 10% level. The coefficients on the number of same-gender friends are positive and significant for English scores at the 1% level and the total score at the 10% level. Having an additional friend in the same school is associated with better performance in English and total scores regardless of the gender of the friend. As for the female share in a class, we find it is positively and significantly associated with Mathematics, English, and the total score. The magnitudes are also similar to the results in [Gong et al. \(2019\)](#).

For the individual demographic characteristics, all estimated coefficients have the expected signs. Boys perform worse than girls academically, which is consistent with

previous studies (Arnot et al., 1999; Rowe and Rowe, 2002; Van de gaer et al., 2004). Being the only kid in the family does not significantly affect Chinese grades, but improves the grades in the other two subjects and the total grades. With regard to household income, students from poor or average income family perform better than students from the reference group of very poor income families in general. But students from very rich families perform much worse than all the other groups. Ethnicity does not appear to have a significant impact, while students with rural or non-local *hukou*, or attended kindergarten tend to have better grades on average. Parents' education level is also positively correlated with the academic achievement of a student. Students with parents strict with their grades perform better in Chinese, compared to students with parents not caring about their grades. But students with more moderate strict parents do not appear to benefit. Baseline cognitive ability also plays an important role: higher baseline cognitive ability is associated with better academic performance in middle school. In order to control for the possible confounding effects generated by various factors at different levels, we also incorporate class-level characteristics including the head teacher's gender, age and teaching experience and class size, class ranking, proportion of girls, local *hukou* and rural *hukou*; school-level characteristics including school ranking, private or public school as well as the county fixed effect all model specifications.

## 2.5.2 IV Results

As discussed in Section 2.4, OLS estimators are likely to be biased due to the endogeneity of friendship formation. In order to identify the causal effect of friends' gender on academic outcomes, we need a set of instruments that are correlated with friendship network formation but are not directly associated with students' academic outcomes. We consider four instrumental variables: parents' strictness with friends making, the share of opposite gender schoolmates, school-level average number of same-gender friends and school-level average number of opposite-gender friends.

### 2.5.2.1 Validity of the IVs

We rely on the variations within the county in the set of instrumental variables to obtain exogenous variations in the number of friends, both same gender and opposite gender. First, the gender composition of schoolmates is random as compulsory education in China is largely based on students' *hukou* registration. Therefore, it is not likely for parents to choose a school based on the gender ratio in the district. Second, friendship is a mutual relationship. Students in a school where most people make friends with the opposite gender are more likely to have more opposite-gender friends and vice versa. Last, parents are likely to influence their children's friendship networks through their reactions to the children's social behaviors, and the values they convey through their relationships with others (Rubin and Sloman, 1984).

We demonstrate the validity of the proposed instrumental variables in several steps. First, in the survey, students also answer "do your parents care and are they strict

with you about your homework and exams”, which we believe is directly related to students’ academic outcomes. We include parents’ strictness with grades in all models. Correlations between these eight strictness measures are listed in Table A.1 in the Appendix. It shows that the correlation between parents’ strictness on homework and parents’ strictness on friends’ choice is low, suggesting that parental strictness on friendship networks captures a certain dimension of parents’ strictness which is not likely to be directly related to students’ academic performance. Second, if the assumption that the instrumental variables only influence the students’ grades through making friends is correct, then the relationship between instrumental variables and outcomes should not exist for students who do not have school friends. We undertake this falsification test using a subset of 460 observations who do not have a school friend. Given the small sample size, we only control for county fixed effects and composition-related class-level variables, e.g. female share, local share, and rural share. Table A.4 reports the reduced-form estimates of the relationship between parental strictness with making friends and the four outcomes with county fixed effects only. As expected, the estimates are statistically insignificant. It provides evidence that the endogenous variables are the only channels through which the instrumental variables affect the academic outcomes. Third, from the first-stage results reported in Table A.3, where Column (1) presents the results of regressing the number of same-gender friends on the instruments along with other controls, Column (2) presents the results of regressing the number of opposite-gender friends on the instruments and other variables, we find that the proposed instrumental variables are significant, with the F statistics of the first stage regressions being 57.984 and

36.909, respectively.<sup>11</sup> The overidentification test statistics reported in the last row of Table 2.5 confirm the validity of our instrumental variables.

Table 2.3 also provides details on the instrumental variables. On average, the school-level number of same-gender friends is 3.3755 while the number of opposite-gender friends is 0.2588. The average share of opposite-gender schoolmates is 0.4943. Similar to parents' strictness with grades, parents' strictness with friends has three levels. 18.98% of respondents' parents are "not care". 49.66% of respondents' parents do care but are not strict with making friends, and 31.35% of the parents are strict with their children's decisions to make friends.

### 2.5.2.2 IV Results

We report IV estimates for each of the academic performance in Table 2.5. Column (4) reveals that an additional same-gender friend reduces the standardized total score by 3.6113 points. Given the standard deviations for the number of same-gender friends and standardized total score are 1.5402 and 25.5760, respectively, the estimated coefficient of -3.6113 means that 1 standard deviation increase in the number of same-gender friends causes approximately one-fifth standard deviation decline in the standardized total score. Similarly, one additional same-gender friend reduces Chinese, Mathematics and English by 1.0782, 1.2194, and 1.3629 points, which are about 0.1711, 0.1909, and 0.2135 of their standard deviation, respectively.

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<sup>11</sup>As a robustness check, we also include other strictness measures in the analysis in Section 2.6. Furthermore, as demonstrated in Figure 2.4, the proposed instrumental variables exhibit considerable amount of variations.

At the same time, an additional opposite-gender friend reduces standardized total score by 5.2456 points, indicating that 1 standard deviation increase in the number of opposite-gender friends causes 0.05 standard deviation decline in standardized total score. Similarly, one additional opposite gender friend reduces Chinese and English by 1.9793 and 2.4147 points, respectively, which are about 0.05 of their standard deviation as well. The effect on standardized Mathematics scores is not significant.<sup>12</sup> The findings support earlier research that suggests peer influences are more closely connected with verbal or language test scores than with math test scores (Contini, 2013; Zimmerman, 2003). The difference between the 2SLS and OLS estimations of the effects of friends' gender is substantial: they are consistently of the opposite sign, with the 2SLS estimates being larger in magnitude.<sup>13</sup> The OLS-IV difference provides evidence for the validity of our IV strategy in controlling for the possible endogeneity of peer group formation as well as other confounding effects. There are no significant changes in coefficients of the other covariates after instrumenting.

It is worth noting that we also include the share of girls in a class as a class level control variable, as many previous studies on gender peer effect use it as a measure of the peer group. Our results indicate that after controlling for the numbers of opposite gender and same-gender friends, the effect of girls share in a class is only significant for the math score, not for the other subjects or the total score, which is in sharp contrast with previous findings that more girls in a class benefit both boys

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<sup>12</sup>Given that more than 80% of individuals do not report opposite-gender friends, these estimates should capture the effect of having at least one friend compared to not having one at all, to a large extent.

<sup>13</sup>The OLS results could be (upward) biased due to self-selection, or (downward) biased due to measurement errors.

and girls.<sup>14</sup> In Table 2.5, we find that when controlling for other characteristics and the county fixed effect, a 10-percentage-point increase in the proportion of female classmates raises a student's math score by 0.224 points.<sup>15</sup>

## 2.6 Robustness Checks

We run multiple robustness checks in this section to see how sensitive our results are to different model configurations.

### 2.6.1 Alternative Sample

Previous studies using CEPS data primarily focus on the subset of schools which randomly assign students into classes at the beginning of grade 7 and no further re-assignment. Those schools which do not have random classes assignment are dropped out of the analysis. In contrast, in this paper, we exploit the instrumental strategy to deal with the endogeneity of friendship formation, and as a result, both schools with and without random classes assignment can be included in our analysis. To gauge the sensitivity of the results with respect to alternative sample construction, we conduct a robustness check using only the subsample of students from schools with random classes assignment. As a result, the sample size drops from 18,457 to

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<sup>14</sup>For instance, [Gong et al. \(2019\)](#) finds that the effect of girls proportion in a class is positive and significant at the 1% level across all subjects.

<sup>15</sup>The coefficient only shows the association, not causation.

12,286.<sup>16</sup> As shown in Table 2.6, the results are consistent with the findings of the baseline model in Table 2.5 except for regressing the standardized math scores on the number of same-gender friends. This may result from the smaller sample size. As for the coefficients for female share, they are positive but not significant.

### 2.6.2 Alternative Friends

In this paper, we focus on the effects generated by school friends. However, as summarized in Table 2.2, students list not only their school friends, but also non-school friends in the survey. In this subsection, we evaluate the effect of having friends, including school friends and non-school friends, of the same and opposite sex on the academic outcomes. We estimate the baseline model with school friends replaced by the total numbers of same-sex friends and opposite-sex friends and report the results in Table 2.7. In all the specifications, having more friends has a negative and statistically significant impact on grades. These results are consistent with those of the baseline model in Table 2.5. In addition to them, Table 2.7 shows that the female share has a positive impact on all columns but only significant for English and the total score.

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<sup>16</sup>The survey anonymously asked school administrators and teachers questions about rules that how they replaced students into classrooms. First, the school officials were asked which one of the following methods they used to assign students into classrooms at the beginning of grade 7. We keep schools with random assignment. Second, the principle confirmed that school will not rearrange the students in grade 8 or 9 into different classes.

### 2.6.3 Additional Controls

We additionally control for individuals' characteristics and the characteristics of friends. The results in Table 2.8 shows that the baseline results are unaffected by the addition of new control variables.

#### 2.6.3.1 Friend gender or friend quality

One concern is that the gender peer effects could be confounded with spillover effects from peers' ability. In Figure 2.5, we plot the distribution of grades by gender with girls represented by the blue lines and boys by the red lines. Girls outperform boys in Chinese, English and the total scores, whereas girls and boys perform similarly in Mathematics. Therefore, for female students, having friends of the opposite gender implies that it is highly likely to have a friend with worse academic performance as male students tend to perform worse than female students. Consequently, the effects generated by friends' gender may capture the spillover of female students' academic ability and performance. In order to control for the academic ability of friends, we use a question in the students' questionnaire that "How many of your best friends mentioned above (up to 5) doing well in academic performance?". Students could circle one of the following three: "None of them", "One or two of them", "or Most of them".<sup>17</sup> We extend the model to control for friends' quality and present the results in Column (2) of Table 2.8. We replicate the baseline IV results in Column (1) for comparison.

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<sup>17</sup>"None of them" is assigned a value of 1. "One or two of them" is assigned a value of 2. "Most of them" is assigned a value of 3.

Consistent with our baseline results, the coefficients of the number of same-gender friends remain to be negative and statistically significant across all subjects and the total grade, the coefficients of the number of opposite-gender friends remain to be negative and statistically significant for math grade, suggesting that friends' gender impacts students' academic achievements, independent of friends' ability.

### 2.6.3.2 Other strictness measures

CEPS provides parents strictness measures in eight dimensions: grades, behaviors at school, school attendance, when to go home after school, making friends, daily clothing, using the Internet and watching TV. All strictness measures have three levels. "Not care" is assigned a value of 1, "Care but not strict" is assigned a value of 2, and "Strict" is assigned a value of 3. Among them, strictness with grades is already included in the model as it is expected to directly influence students' academic performance. Parents' strictness with friends making is used as one of the instruments and we have shown that it does not affect academic performance except indirectly through its impact on friendship networks. Now we add the rest six strictness measures to the model to probe the robustness of the results, as well as the impacts of these strictness measures on academic achievements. As shown in Column (3) in Table 2.8, the effects of the number of same-sex friends and the number of opposite-sex friends are quite robust, remaining to be negative and statistically significant, except for the effect of the number of the opposite sex friends on Mathematics.

## 2.7 Heterogeneous Effects

In this section, we investigate whether and how the effects of having one additional same-gender and opposite-gender friend vary by grade level and gender.

### 2.7.1 Grade level

We first explore how the effects of friends' gender vary by grade level. CEPS covers two grade levels, i.e., Grade 7 and Grade 9, and the differences between the two cohorts arise from two aspects: age and familiarity with schoolmates. First, students in Grade 7 are younger and thus are more likely to be immature in friendship. Immature adolescents may get upset more easily. Especially for making friends with the opposite gender, younger students feel stranger. If a student is the only person who makes friends with the opposite sex, he or she may feel stressed and even be teased by other students. Second, students in Grade 7 are still in transit from primary school to middle school. Most classmates or schoolmates are new to them. However, students in Grade 9 have already had at least two years to be familiar with other people in the same school.

Panels A, B and C in Table 2.9 represent the results for seventh graders (2013-2014 academic year), seventh graders in the following academic year (2014-2015 academic year), and ninth graders (2013-2014 academic year) respectively.<sup>18</sup> For Grade 7 students (2013-2014 academic year), we find similar results as the baseline

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<sup>18</sup>The main results in Table 2.5 are replicated in the top panel of Table 2.9 for comparison. The results on all coefficients are reported in Tables A.5 - A.7.

results but in larger magnitude. Specifically, having one more same-gender friend lowers the Chinese, math and English scores by 1.0782, 1.2194 and 3.6113 points respectively, whereas having one more opposite-gender friend lowers Chinese score by 1.9793 points and English score by 2.4147 points. Moreover, having an additional same-gender friend significantly lowers the total score by 3.6113 points. Having an additional opposite-gender friend significantly lowers the total score by 5.2456 points. Nevertheless, none of these effects of having an additional same-gender friend are found to be significant for Grade 7 students in the following academic year, as shown in Panel B. But the effects of having an additional opposite-gender friend are still significant for Chinese, English and total scores. From Panel C of Table 2.9, we can see none of these effects are found to be significant for Grade 9.

The results provide evidence that the impacts of friends of different gender appear to be different for students of different ages. Younger students are more severely impacted by their friends. The results also suggest that the negative impacts of friends only occur when building friendships but not when maintaining friendships, especially for friends of the same gender. The relationship between female share and the outcomes by the grade level are shown in the table note.

### 2.7.2 Gender

As demonstrated in several studies (Richards et al., 1998), boys and girls have different development patterns and may experience heterogeneous impacts generated by friendship networks. From Figure 2.5, we can see that girls have better grades in

Chinese, English and the total scores, but boys and girls tend to perform similarly in Mathematics.

Table 2.10 reports the heterogeneous effects of friends' gender on girls and boys.<sup>19</sup> We can see that the signs of the effects of friends' gender on girls do not differ from the baseline results, but the magnitudes are larger except for the effect of one additional same-sex friend on the Chinese score. Particularly, one additional male friend leads to a decrease of 2.3369 points in Chinese, 2.7144 points in English, and 6.6234 points in the total score for girls, compared to a decrease of 1.9793 in Chinese, 2.4147 in English, and 5.2456 in the total score with one additional opposite-gender friend in the whole sample. One additional female friend leads to a decrease of 0.8606 points in Chinese, 1.9118 points in Mathematics, 1.3908 points in English, and 4.1185 points in the total score for girls, compared to a decrease of 1.0782 in Chinese, 1.2194 in Mathematics, 1.3629 in English, and 3.6113 points in the total score with one additional same-gender friend in the whole sample. However, friends' gender does not appear to affect boys' academic performance. Therefore, it appears that female students are more vulnerable to friendships building and maintenance. The relationship between female share and the outcomes by the gender are shown in the table note.

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<sup>19</sup>The main results in Table 2.5 are replicated in the top panel of Table 2.10 for comparison. The full sets of results are reported in Tables A.8 - A.9

## 2.8 Mechanisms

In this section, we investigate several possible channels through which friends' gender impacts students' grades. We consider hours students allocate on different activities, students' activities and behaviors, and how students feel about class and school environment. To study the channels through which having friends of the same and opposite gender might affect academic achievement, we estimate Equation (2.4) with the outcomes being possible mechanisms, i.e.,

$$m_{ics} = \gamma_0 + \gamma_1 \widehat{\text{FOS}}_{ics} + \gamma_2 \widehat{\text{FFS}}_{ics} + X'_{ics} \gamma_3 + C'_{cs} \gamma_4 + S'_s \gamma_5 + \gamma_{county} + r_{ics}, \quad (2.5)$$

where  $m_{ics}$  are the possible mechanisms that are affected by friends' gender, which in turn impact academic performance. A significant estimate of  $\gamma_1$  ( $\gamma_2$ ) identifies the mechanism through which the number of same-/opposite-gender friends operates. We investigate several candidate mechanisms for  $m_{ics}$ , including hours students allocate on different activities, students' activities and behaviors, and how students feel about class and school environment. Table 2.11 provides the summary statistics of these potential mechanisms, and Table 2.12 summarizes the estimated results.<sup>20</sup>

### 2.8.1 Time allocation

Socializing with friends affects the time use of a student (Stinebrickner and Stinebrickner, 2006). The information about how many hours students allocate to a

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<sup>20</sup>The full sets of results are reported in Table A.10, Table A.11 and Table A.12.

certain activity is reported in the top panel of Table 2.11. Students were asked, “How much time on average did you spend on the following activities from Monday to Friday last week?” and “How much time on average did you spend on the following activities last weekend?” in the survey. We use hours per week as the measurement in our estimation by converting minutes to hours and then times days. We trim values of hours following the IQR criterion.<sup>21</sup> Activities include doing homework assigned by teachers at school, doing homework assigned by parents, taking cram schools related to schoolwork, playing sports, reading (not including textbook), watching TV, surfing on the Internet and playing video games, and helping with housework. From Table 2.11, we can see that, for example, the average time spent on homework assigned by teachers at school is 16.4237 hours per week, and the average hours spent on helping with housework each week is 5.2040.

The first mechanism for the effects of making friends operate on academic performance can be described as follows: it takes time to build and maintain friendships, for instance, watching TV, surfing the Internet and playing games with friends, which crowds out other activities related to coursework and could negatively impact academic performance. From Panel A of Table 2.12, we can see that an additional same-gender friend leads to an increase of 0.7370 hours in watching TV and of 0.3675 hours in surfing the Internet and playing games. Moreover, an additional same-gender friend leads to a decline of 1.1379 hours in helping with housework. In addition, one more opposite-gender friend leads to a significant decrease of 3.1983 hours in doing homework assigned by teachers at school per week and a significant

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<sup>21</sup>A data point is an outlier if it is more than  $1.5 \times \text{IQR}$  above the third quartile or below the first quartile.

reduction of 1.3362 hours in playing sports. It also positively influences the hours spent on surfing the Internet and playing games; negatively influences the hours spent on helping with housework. But being popular with the opposite gender results in increased hours spent on reading, on average 1.0323 hours per week. There is no significant effect on the hours of doing homework assigned by parents and taking cram schools related to schoolwork.

### **2.8.2 Activities and behaviors**

A second possible mechanism is that being popular tends to affect what activities or behaviors students perform after school. To measure the frequencies of activities student might do, we use the answers to the questions: “What hobbies do you have?”, “How often do you visit museums, zoos, science museums, etc., either alone or with your schoolmates?” and “ How often do you go out to watch movies, shows, sports games, etc., either alone or with your schoolmates?”. The hobbies include playing musical instruments, vocal or/and dance performance, Chinese calligraphy, drawing, chess, sports or others. The average number of hobbies in our sample is 1.6096, with a minimum value of 0 and a maximum value of 7. For the other two questions, we divide the frequencies into five categories, with never (1), once every year (2), every six months (3), every month (4), and more than once a month (5). The average number of visiting museums and zoos is 1.9293, while the mean number of watching movies and games is 2.2887 in the sample. We also take the answers to the question that asks each student if he/she often takes part in the class or school activities.

The answers are categorized into: strongly disagree (1), some what disagree (2), somewhat agree (3), and strongly agree (4). The average value of the answers is 2.7546.

With respect to behaviors, we use two measures of misbehaviors in the class, one for the probability of being involved in a romantic relationship, as well as one for the sleeping time. Two questions in CEPS are asked students to rate how much they agree with, "I am often late for class." and "I often skip class.", on a scale from strongly disagree (1) to strongly agree (4). As the survey did not collect information about whether a student was in a romantic relationship, we use the answers to the question "How many of your best friends have had or are having a romantic relationship" as a proxy. Students could circle one of the following three: "None of them", "One or two of them" or, "Most of them". "None of them" is assigned a value of 1. "One or two of them" is assigned a value of 2. "Most of them" is assigned a value of 3. It implicitly assumes that a student is more likely to have a romantic relationship if more of his/her friends have had a romantic relationship. Regarding sleeping time, we use the self-reported sleeping time in hours per night. Students in the sample sleep for about 8 hours on average.

Being popular with friends, regardless of gender, increases the involvement with the activities together with friends listed in Columns (10) and (11) in Panel B of Table 2.12, including visiting museums, zoos, science museums, etc. and going out to watch movies, shows, sports games, etc. However, being popular does not affect the number of hobbies. In particular, having an additional friend increases the frequency of visiting museums, zoos, science museums, etc. by 0.5171 if of the same gender,

and by 0.1171 if of the opposite gender. And having one additional friend increases the frequency of watching movies, shows, sports games, etc. by 0.1816 if of the same gender, and by 0.6210 if of the opposite gender. Being popular with the opposite gender also increases the frequency of taking part in the class or school activities while being popular with the same gender does not.

With respect to behaviors, Columns (13) and (14) show that having more friends is not related to misbehaviors in the classroom. However, having more opposite-gender friends significantly increases the probability of being in a romantic relationship as shown in Column (15). Specifically, one additional opposite-gender friend raises the probability of being in a romantic relationship by 0.1648. At the same time, having one more opposite-gender friend decreases the sleeping time by 0.2415 hours.

### 2.8.3 Class and school environment

[Feld and Zölitz \(2017\)](#) discuss how peer composition affects students' feelings about the school environment. The bottom panel of Table 2.11 includes questions of how students feel in or about the class and school: "Most of my classmates are nice to me."; "I think I am easy to get along with."; "My class is in good atmosphere."; "I feel close to people in this school."; "I feel bored in this school."; "I hope that I could transfer to another school.". Each of these statements has four categories: strongly disagree (1), somewhat disagree (2), somewhat agree (3), and strongly agree (4). With an average number of about 3 for the first four questions with positive description and an average number of about 1.5 for the last two questions with negative description,

indicating most students feel positive about school.

Panel C of Table 2.12 shows that being popular with the opposite gender does not necessarily impact how a student feels about the class and school. In contrast, being popular with the same gender significantly impacts how a student feels about the class and school in all six aspects, which provides evidence why the negative impacts from same-sex friends are smaller than opposite-sex friends. Although building and maintaining friendships with both gender crowd out time that would be spent on coursework-related activities, being popular with the same gender improves students' feelings about school, which in turn positively impacts academic performance.

With regard to the effects of female share in a class, for example, in Table A.10, higher share of female in a class is positively associated with the time spent on assignment, watching TV, and doing housework, but negatively with time spent on sports. These findings are different from previous cohort gender effect studies, e.g., Gong et al. (2019) illustrate that students describe a substantially more friendly and satisfying classroom environment when more female peers are present, according to the first and third items. It is noteworthy that previous studies (e.g., Gong et al., 2019) do not control for the effects of friends, which are explicitly controlled for in our model.

## 2.9 Conclusion

It is well documented that students' social networks are important for educational outcomes. Gender peer effects on adolescents' academic outcomes have been extensively studied, mostly in the context of class, grade or school groups. Instead of measuring gender peer effects based on the gender proportion in a reference group, we use a nationally representative survey in China to evaluate the impacts of a student's same-gender and opposite-gender friends on his/her academic outcomes. The academic outcomes under exploration include the standardized scores of three core subjects that all middle school students are required to take in China as well as the total score based on them.

The nonrandom formation of friendship networks makes it difficult to fully assess the influence, as it is difficult to distinguish whether friends influence the academic outcomes, or whether students select friends who are similar to them in respect to grades. In order to deal with the endogeneity of friendship networks formation, we rely on the plausibly exogenous variations from the combination of parents' strictness on students' friendship networks, school-level numbers of same-gender and opposite-gender friends, and the share of opposite-gender schoolmates. Our IV estimates consistently show that being popular with the same gender and the opposite gender adversely influences students' academic performance, while the OLS estimates have the opposite signs in all specifications. The coefficients of being popular with the opposite gender are larger than those of being popular with the same gender. Having one more friend of the opposite gender does not impact math scores significantly.

In particular, the results indicate that having one more friend of the same gender decreases each subject (Chinese, math and English) by 1-1.5 points and the total score by 3.6113 points, while having one additional opposite-sex friend lowers Chinese and English scores, each by about 2 points and the total score by 5.2456 points. The results are robust against alternative model specifications. The heterogeneity effect analysis reveals that the students are less hurt by being popular as growing up. The effects are also insignificant for males.

The main avenue of the negative effects can be explained by the “crowding out effect of time”. Given the fixed time students have, students who are more popular spend more time with friends on after-school activities, such as surfing the Internet, playing video games, etc. Popular students also have high frequencies to hang out with friends and are more active in class and school activities. Time spent on studying is crowded out by social interactions. Our heterogeneous results also suggest that building friendships is more time-consuming than maintaining friendships. Further research could be performed to investigate whether social interactions benefit a broader group of students academically in the following academic year as more follow-up data become available. Another important reason for the negative effects of being popular with the opposite gender could be the increased probability of being in a romantic relationship, which adversely influences academic performance. On the other hand, we find that being popular with the same gender improves the class and school environment and helps students develop good feelings about schools, which partially offsets the negative “crowding out effect”. The identified mechanisms could be the underlying reason why the negative effects of opposite-gender friends

are significantly larger than that generated by same-gender friends.

Some of our findings are in contrast with those from studies focusing on cohort-composition effects (Gong et al., 2019). These differences come from essential distinction between the social interactions among friends versus the interactions with the classmates. As shown in Gong et al. (2019), classmate characteristics, such as the female proportion, affect an individual's academic outcomes through the teachers' responses and the student's observation on the surface. Our results suggest that friends affect the academic outcomes through the time they spend together. It is interesting to see that in Gong et al. (2019), when there are more female classmates, students spend more time on homework and tutorials, implying that when there are more female peers, students feel more peer pressure to study hard as well. However, we do not find such avenues from friends. Instead, our results indicate that students spend more time on watching TV, surfing the Internet, and playing video games when they have more friends.

Our findings are of significant practical relevance, especially for parents, teachers and policymakers who seek to efficiently allocate the related resources to improve the academic performance of the students. It is worth noting that although the negative effects of making friend, especially with the opposite gender on academic achievement are identified in our sample of middle school students in China, it does not rule out the idea that friends have good benefits on physical and/or mental health, happiness, stress reduction, self-confidence and self-worth, trauma recovery, and so on. And the negative effects identified in this study may not carry over to other age groups and/or other samples.

## Tables

Table 2.1: Who will be the first one for you to turn to in the following situations?

	Schoolmates or friends	Parents	Relatives	Teachers	No one
Have a talk	16,130 (83.17)	2,158 (11.13)	212 (1.09)	81 (0.42)	813 (4.19)
In trouble	8,106 (41.90)	9,013 (46.59)	277 (1.43)	1,103 (5.70)	846 (4.37)
Need help	10,822 (55.92)	6,660 (34.41)	236 (1.22)	999 (5.16)	636 (3.29)

Note: The data used is all students in the survey, not limited to the final sample. Percentage in parentheses.

Table 2.2: Frequency distribution of friends and school friends

		Number of friends						
		0	1	2	3	4	5	
Number of school friends	0	522 (100.00)	129 (22.32)	112 (11.17)	88 (5.52)	46 (3.35)	492 (3.41)	1,389 (7.13)
	1		449 (77.68)	217 (21.64)	180 (11.29)	96 (6.99)	483 (3.35)	1,425 (7.31)
	2			674 (67.20)	335 (21.02)	177 (12.88)	983 (6.82)	2,169 (11.13)
	3				991 (62.17)	284 (20.67)	1,728 (11.99)	3,003 (15.41)
	4					771 (56.11)	2,595 (18.00)	3,366 (17.27)
	5						8,135 (56.43)	8,135 (41.75)
		522 (2.68)	578 (2.97)	1,003 (5.15)	1,594 (8.18)	1,374 (7.05)	14,416 (73.98)	19,487 (100.00)

Note: Students have no friends are excluded in the sample. Percentage in parentheses.

Table 2.3: Descriptive statistics of variables

	N	Mean	St. Dev.	Min	Max
School FSS	18,457	3.3868	1.5402	0	5
School FOS	18,457	0.2593	0.6506	0	5
<b>Outcomes:</b>					
Chinese	18,441	70.2265	9.7054	6.1645	98.4746
Mathematics	18,427	70.1514	9.8401	8.4217	145.1149
English	18,426	70.1941	9.8343	11.3495	107.8161
Total	18,386	210.6265	25.5760	55.4928	293.9303
<b>Covariates:</b>					
Grade 9	18,457	0.4683	0.4990	0	1
Male	18,457	0.5072	0.5000	0	1
Han	18,415	0.9157	0.2779	0	1
Rural Hukou	18,457	0.5488	0.4976	0	1
Local Hukou	18,457	0.8234	0.3814	0	1
Only child in the family	18,457	0.4351	0.4958	0	1
Family SES: poor	18,413	0.0370	0.1889	0	1
Family SES: somewhat poor	18,413	0.1723	0.3777	0	1
Family SES: moderate	18,413	0.7305	0.4437	0	1
Family SES: somewhat rich	18,413	0.0570	0.2318	0	1
Family SES: rich	18,413	0.0031	0.0560	0	1
Parental education	18,429	10.8478	3.0655	0	19
Parental strictness with grades: no	18,437	0.0280	0.1651	0	1
Parental strictness with grades: moderate	18,437	0.4725	0.4993	0	1
Parental strictness with grades: serious	18,437	0.4995	0.5000	0	1
Baseline cognitive ability	18,457	0.0196	0.8567	-2.0290	2.7099
Attended preschool	18,354	0.7991	0.4007	0	1
<b>Covariates (class-level):</b>					
Class size	18,457	48.4938	12.7627	9	88
Male (Head teacher)	18,457	0.3660	0.4817	0	1
Age (Head teacher)	18,292	37.2229	6.8115	19	60
Teaching experience (Head teacher)	17,968	15.6415	7.4784	0	38
% of girls	18,457	0.4851	0.0795	0.1111	0.7500
% of local Hukou	18,457	0.8226	0.2038	0	1
% of rural Hukou	18,457	0.5491	0.2901	0	1

Table 2.3: Descriptive Statistics of Variables (cont'd)

Class rankings: among the worst	18,457	0.0333	0.1793	0	1
Class rankings: below average	18,457	0.1333	0.3399	0	1
Class rankings: average	18,457	0.3484	0.4765	0	1
Class rankings: above average	18,457	0.3758	0.4843	0	1
Class rankings: among the best	18,457	0.1092	0.3119	0	1
<b>Covariates (school-level):</b>					
Private school	18,458	0.0729	0.2600	0	1
School rankings: among the worst	18,457	0.0090	0.0947	0	1
School rankings: below average	18,457	0.0677	0.2512	0	1
School rankings: average	18,457	0.1152	0.3193	0	1
School rankings: above average	18,457	0.5814	0.4933	0	1
School rankings: among the best	18,457	0.2266	0.4187	0	1
<b>Instruments:</b>					
School-level average school FSS	18,457	3.3755	0.3234	2.3125	4.0920
School-level average school FOS	18,457	0.2588	0.0889	0	0.5625
% of opposite gender schoolmates	18,457	0.4943	0.0540	0.2455	0.7545
Parents' strictness with friends: no	18,457	0.1898	0.3922	0	1
Parents' strictness with friends: moderate	18,457	0.4966	0.5000	0	1
Parents' strictness with friends: serious	18,457	0.3135	0.4639	0	1

Table 2.4: OLS estimates of friends on grades

	Chinese (1)	Mathematics (2)	English (3)	Total (4)
School FSS	0.0678 (0.0525)	0.0089 (0.0535)	0.1596*** (0.0512)	0.2339* (0.1375)
School FOS	0.3400*** (0.1131)	0.2171* (0.1143)	0.3593*** (0.1141)	0.8944*** (0.2953)
Grade 9	-0.3015 (0.2300)	-0.1971 (0.2501)	-0.3895 (0.2600)	-0.8805 (0.6493)
Male	-5.7654*** (0.1589)	-1.1530*** (0.1627)	-5.6508*** (0.1599)	-12.5205*** (0.3945)
Han	-0.1991 (0.4001)	-0.2439 (0.4189)	-0.4671 (0.3564)	-0.9209 (0.9969)
Rural hukou	0.3383* (0.1735)	0.5247*** (0.1785)	0.0040 (0.1692)	0.8493* (0.4428)
Local hukou	-1.3075*** (0.2316)	-0.9308*** (0.2184)	-0.4671** (0.2154)	-2.6556*** (0.5672)
Only child in the family	0.2082 (0.1819)	0.3701** (0.1856)	0.4866*** (0.1686)	1.0487** (0.4579)
Family SES: somewhat poor	1.0499** (0.4112)	0.7399* (0.4459)	0.3013 (0.3938)	1.9550* (1.0761)
Family SES: moderate	0.7880* (0.4171)	0.7012 (0.4546)	0.3780 (0.4013)	1.7380 (1.0977)
Family SES: somewhat rich	0.7978 (0.5057)	0.1381 (0.5532)	0.0157 (0.4863)	0.8134 (1.3360)
Family SES: rich	-6.5557*** (2.0923)	-5.4735*** (1.8350)	-3.4499** (1.7183)	-15.0284*** (5.1706)
Parental education	0.2616*** (0.0321)	0.2472*** (0.0321)	0.2978*** (0.0336)	0.8107*** (0.0854)
Parental strictness with grades: moderate	0.3302 (0.5121)	-0.0460 (0.4564)	-0.2460 (0.4402)	-0.1000 (1.2188)
Parental strictness with grades: serious	1.0118** (0.5146)	0.5124 (0.4677)	0.7208 (0.4582)	2.0692* (1.2485)
Baseline cognitive ability	3.8400*** (0.1191)	5.0684*** (0.1348)	4.0522*** (0.1149)	12.9463*** (0.3352)
Attend preschool	0.5656*** (0.1839)	0.7224*** (0.2028)	0.3526* (0.1870)	1.6917*** (0.4926)
Female share (Class control)	1.4111 (1.1917)	2.9587** (1.2089)	3.4634*** (1.1901)	7.6823** (3.0402)
Observations	17,609	17,596	17,593	17,556
$R^2$	0.2062	0.1891	0.2123	0.2466
Other class controls	✓	✓	✓	✓
School controls	✓	✓	✓	✓
County FE	✓	✓	✓	✓

Note: Other class controls include class size, head teacher's gender, age, and years of experience, local *Hukou* students' proportion, rural *Hukou* students' proportion, and class ranking. School controls include private school and school ranking. Standard errors are clustered at class level in brackets.

\* 10%, \*\* 5%, \*\*\* 1%.

Table 2.5: IV estimates of friends on grades

	Chinese (1)	Mathematics (2)	English (3)	Total (4)
School FSS	-1.0782*** (0.3556)	-1.2194*** (0.3661)	-1.3629*** (0.3613)	-3.6113*** (0.9218)
School FOS	-1.9793* (1.0335)	-0.8215 (1.0637)	-2.4147** (1.0586)	-5.2456* (2.7056)
Grade 9	-0.2805 (0.2057)	0.0090 (0.2121)	-0.3765* (0.2098)	-0.6628 (0.5369)
Male	-5.8353*** (0.1421)	-1.1796*** (0.1458)	-5.7387*** (0.1447)	-12.7041*** (0.3695)
Han	-0.3381 (0.3464)	-0.3809 (0.3558)	-0.6313* (0.3528)	-1.3524 (0.9003)
Rural hukou	0.3256* (0.1731)	0.5178*** (0.1776)	-0.0131 (0.1760)	0.8145* (0.4490)
Local hukou	-1.5414*** (0.2272)	-1.1359*** (0.2329)	-0.7506*** (0.2312)	-3.3710*** (0.5891)
Only child in the family	0.3138* (0.1714)	0.4725*** (0.1759)	0.6132*** (0.1744)	1.3814*** (0.4449)
Family SES: somewhat poor	1.1000*** (0.3872)	0.7664* (0.3972)	0.3736 (0.3939)	2.1024** (1.0080)
Family SES: moderate	0.8464** (0.3691)	0.7480** (0.3787)	0.4579 (0.3755)	1.9167** (0.9608)
Family SES: somewhat rich	0.7156 (0.4627)	0.0841 (0.4746)	-0.0753 (0.4707)	0.5854 (1.2023)
Family SES: rich	-6.9001*** (1.2644)	-5.5220*** (1.2852)	-3.8480*** (1.2975)	-15.8288*** (3.3070)
Parental education	0.2581*** (0.0290)	0.2495*** (0.0298)	0.2930*** (0.0295)	0.8037*** (0.0754)
Parental strictness with grades: moderate	0.2083 (0.4149)	-0.2468 (0.4241)	-0.3699 (0.4204)	-0.5480 (1.0758)
Parental strictness with grades: serious	0.7861* (0.4225)	0.1932 (0.4316)	0.4701 (0.4278)	1.2764 (1.0952)
Baseline cognitive ability	3.7998*** (0.0903)	5.0433*** (0.0927)	4.0038*** (0.0918)	12.8312*** (0.2343)
Attend preschool	0.5237*** (0.1749)	0.6653*** (0.1795)	0.3044* (0.1779)	1.5503*** (0.4539)
Female share (Class control)	0.8692 (1.2293)	2.2358* (1.2559)	1.7710 (1.2357)	4.6684 (3.1702)
Observations	17,609	17,596	17,593	17,556
Other class controls	✓	✓	✓	✓
School controls	✓	✓	✓	✓
County FE	✓	✓	✓	✓
Diagnostics				
First-stage F statistic	57.984	57.984	57.984	57.984
	36.909	36.909	36.909	36.909
Sargan test	2.582	3.544	0.238	0.809

Note: Other class controls include class size, head teacher's gender, age, and years of experience, local *Hukou* students' proportion, rural *Hukou* students' proportion, and class ranking. School controls include private school and school ranking. Standard errors are clustered at class level in brackets.

\* 10%, \*\* 5%, \*\*\* 1%.

Table 2.6: Robustness Checks: Estimates using schools with random assignment

	Chinese (1)	Mathematics (2)	English (3)	Total (4)
School FSS	-1.3255** (0.6351)	-0.4720 (0.5713)	-1.4828** (0.6105)	-3.1712** (1.4894)
School FOS	-4.1998** (1.7636)	0.3980 (1.5761)	-2.9107* (1.7225)	-6.9505* (4.2039)
Grade 9	-0.9280* (0.4908)	0.4112 (0.4411)	-0.5482 (0.4753)	-1.0540 (1.1677)
Male	-5.9100*** (0.2724)	-1.0137*** (0.2436)	-5.7324*** (0.2637)	-12.5983*** (0.6438)
Han	-0.8868* (0.4862)	-0.4754 (0.4356)	-1.0602** (0.4667)	-2.3302** (1.1383)
Rural hukou	0.1962 (0.2529)	0.4648** (0.2260)	-0.1712 (0.2427)	0.5150 (0.5915)
Local hukou	-2.0266*** (0.4353)	-0.7876** (0.3885)	-1.2530*** (0.4187)	-3.9421*** (1.0188)
Only child in the family	0.5270* (0.2719)	0.4334* (0.2421)	1.0024*** (0.2592)	1.9651*** (0.6333)
Family SES: somewhat poor	0.8236 (0.6157)	0.0917 (0.5484)	-0.3146 (0.5893)	0.5694 (1.4364)
Family SES: moderate	0.9420 (0.5817)	0.3242 (0.5182)	0.0333 (0.5575)	1.2484 (1.3593)
Family SES: somewhat rich	0.7142 (0.7317)	0.0251 (0.6518)	-0.3819 (0.7011)	0.3206 (1.7090)
Family SES: rich	-8.4533*** (1.9812)	-6.8651*** (1.7667)	-4.1546** (1.9187)	-18.3230*** (4.6735)
Parental education	0.2280*** (0.0479)	0.3057*** (0.0427)	0.3083*** (0.0462)	0.8481*** (0.1125)
Parental strictness with grades: moderate	0.0225 (0.6090)	-0.7957 (0.5404)	-0.3645 (0.5823)	-1.1852 (1.4274)
Parental strictness with grades: serious	0.1554 (0.6495)	-0.4580 (0.5759)	0.0615 (0.6185)	-0.2764 (1.5219)
Baseline cognitive ability	3.5716*** (0.1507)	4.9346*** (0.1345)	3.9300*** (0.1456)	12.4335*** (0.3559)
Attend preschool	0.4861* (0.2626)	0.8103*** (0.2339)	0.2683 (0.2515)	1.6095*** (0.6128)
Female share (Class control)	2.1234 (1.4074)	0.5817 (1.4307)	0.4343 (1.4054)	3.3317 (3.5852)
Observations	11,700	11,696	11,697	11,676
Other class controls	✓	✓	✓	✓
School controls	✓	✓	✓	✓
County FE	✓	✓	✓	✓

Note: Other class controls include class size, head teacher's gender, age, and years of experience, local *Hukou* students' proportion, rural *Hukou* students' proportion, and class ranking. School controls include private school and school ranking. Standard errors are clustered at class level in brackets.

\* 10%, \*\* 5%, \*\*\* 1%.

Table 2.7: Robustness checks: Estimates of all friends on grades

	Chinese (1)	Mathematics (2)	English (3)	Total (4)
School FSS	-2.0401*** (0.6811)	-1.7599*** (0.6824)	-2.5320*** (0.7227)	-6.2869*** (1.8222)
School FOS	-2.3336*** (0.8454)	-1.5608* (0.8533)	-2.8984*** (0.9061)	-6.7976*** (2.2826)
Grade 9	0.0745 (0.2823)	0.3017 (0.2836)	0.0621 (0.3005)	0.4140 (0.7597)
Male	-5.7015*** (0.1484)	-1.0863*** (0.1484)	-5.5727*** (0.1575)	-12.3043*** (0.3979)
Han	-0.1593 (0.3715)	-0.2104 (0.3719)	-0.3879 (0.3952)	-0.7569 (0.9969)
Rural hukou	0.2841 (0.1879)	0.4869*** (0.1878)	-0.0597 (0.1993)	0.7139 (0.5024)
Local hukou	-1.3588*** (0.2305)	-0.9640*** (0.2303)	-0.5172** (0.2445)	-2.7695*** (0.6160)
Only child in the family	0.2777 (0.1834)	0.4276** (0.1837)	0.5726*** (0.1949)	1.2855*** (0.4927)
Family SES: somewhat poor	0.6504 (0.4375)	0.4047 (0.4359)	-0.1878 (0.4637)	0.7235 (1.1739)
Family SES: moderate	0.3563 (0.4228)	0.3449 (0.4202)	-0.1532 (0.4479)	0.4021 (1.1345)
Family SES: somewhat rich	-0.1414 (0.5892)	-0.5793 (0.5854)	-1.1387* (0.6246)	-1.9993 (1.5770)
Family SES: rich	-7.6752*** (1.4185)	-6.1080*** (1.4004)	-4.8165*** (1.5169)	-18.1762*** (3.8241)
Parental education	0.2267*** (0.0340)	0.2247*** (0.0342)	0.2520*** (0.0363)	0.7082*** (0.0913)
Parental strictness with grades: moderate	-0.1616 (0.4942)	-0.5545 (0.4875)	-0.7798 (0.5165)	-1.6203 (1.3137)
Parental strictness with grades: serious	0.2081 (0.5400)	-0.2542 (0.5305)	-0.1922 (0.5621)	-0.3896 (1.4306)
Baseline cognitive ability	3.6813*** (0.1104)	4.9500*** (0.1103)	3.8556*** (0.1173)	12.4777*** (0.2951)
Attend preschool	0.2691 (0.2133)	0.4649** (0.2126)	-0.0114 (0.2263)	0.7887 (0.5693)
Female share (Class control)	1.9504 (1.8455)	2.0848 (1.9722)	3.6994** (1.7358)	7.4190* (3.9095)
Observations	17,609	17,596	17,593	17,556
Other class controls	✓	✓	✓	✓
School controls	✓	✓	✓	✓
County FE	✓	✓	✓	✓

Note: Other class controls include class size, head teacher's gender, age, and years of experience, local *Hukou* students' proportion, rural *Hukou* students' proportion, and class ranking. School controls include private school and school ranking. Standard errors are clustered at class level in brackets.

\* 10%, \*\* 5%, \*\*\* 1%.

Table 2.8: Robustness check: Additional controls

	(1)	(2)	(3)
Panel A: Chinese			
School FSS	-1.0782*** (0.3556)	-1.1266*** (0.3544)	-1.0925*** (0.3587)
School FOS	-1.9793* (1.0335)	-2.0074* (1.0284)	-2.0974** (1.0526)
Panel B: Mathematics			
School FSS	-1.2194*** (0.3661)	-1.2725*** (0.3649)	-1.2599*** (0.3690)
School FOS	-0.8215 (1.0637)	-0.9090 (1.0580)	-1.2222 (1.0823)
Panel C: English			
School FSS	-1.3629*** (0.3613)	-1.4093*** (0.3605)	-1.3377*** (0.3643)
School FOS	-2.4147** (1.0586)	-2.3926** (1.0549)	-2.6003** (1.0772)
Panel D: Total			
School FSS	-3.6113*** (0.9218)	-3.7557*** (0.9182)	-3.6363*** (0.9296)
School FOS	-5.2456* (2.7056)	-5.3622** (2.6909)	-5.9344** (2.7550)
Other controls			
Individual controls	✓	✓	✓
Class and school controls	✓	✓	✓
County FE	✓	✓	✓
Friends' academic performance		✓	
Other parents' strictness measurements			✓

Note: Class controls include class size, head teacher's gender, age, and years of experience, girls' proportion, local *Hukou* students' proportion, rural *Hukou* students' proportion, and class ranking. School controls include private school and school ranking. Standard errors are clustered at class level in brackets.

\* 10%, \*\* 5%, \*\*\* 1%.

Table 2.9: IV estimates of friends on grades by grade level

	Chinese (1)	Mathematics (2)	English (3)	Total (4)
Main results				
School FSS	-1.0782*** (0.3556)	-1.2194*** (0.3661)	-1.3629*** (0.3613)	-3.6113*** (0.9218)
School FOS	-1.9793* (1.0335)	-0.8215 (1.0637)	-2.4147** (1.0586)	-5.2456* (2.7056)
Panel A: 7th grade 2013–2014				
School FSS	-1.4051*** (0.5003)	-1.6849*** (0.5115)	-1.8462*** (0.5178)	-4.9435*** (1.2974)
School FOS	-4.4722** (1.8412)	-0.8602 (1.8898)	-5.5711*** (1.9266)	-10.8607** (4.8671)
Observations	9,318	9,314	9,316	9,298
Panel B: 7th grade 2014–2015				
School FSS	2.1406 (1.3252)	2.0985 (1.6703)	1.0564 (1.4309)	5.4404 (3.3909)
School FOS	-5.0320*** (1.7195)	2.7513 (2.1665)	-3.5014* (1.8469)	-8.0410* (4.3745)
Observations	8,702	8,704	8,694	8,693
Panel C: 9th grade 2013–2014				
School FSS	-0.5776 (0.5735)	-0.6023 (0.5849)	-0.4521 (0.5787)	-1.5435 (1.4772)
School FOS	-0.2232 (1.3729)	0.6422 (1.3867)	0.4234 (1.3859)	0.6450 (3.5270)
Observations	8,291	8,282	8,277	8,258
Class and school controls	✓	✓	✓	✓
County FE	✓	✓	✓	✓

Note: Class controls include class size, head teacher's gender, age, and years of experience, girls' proportion, local *Hukou* students' proportion, rural *Hukou* students' proportion, and class ranking. Among them, for 7th graders, the relationship between the girl's proportion in a class and outcomes are 3.6150, 0.2916, 1.6417 and 5.3974 for Chinese, Mathematics, English, and Total, respectively; for 9th graders, are 0.3686, 3.2289, 1.3763, and 4.8832, respectively. School controls include private school and school ranking. Standard errors are clustered at class level in brackets. \* 10%, \*\* 5%, \*\*\* 1%.

Table 2.10: IV estimates of friends on grades by gender

	Chinese (1)	Mathematics (2)	English (3)	Total (4)
Main results				
School FSS	-1.0782*** (0.3556)	-1.2194*** (0.3661)	-1.3629*** (0.3613)	-3.6113*** (0.9218)
School FOS	-1.9793* (1.0335)	-0.8215 (1.0637)	-2.4147** (1.0586)	-5.2456* (2.7056)
Panel A: Females				
School FSS	-0.8606** (0.4369)	-1.9118*** (0.4991)	-1.3908*** (0.4510)	-4.1185*** (1.1749)
School FOS	-2.3369** (1.1771)	-1.3217 (1.3431)	-2.7144** (1.2228)	-6.6234** (3.1847)
Observations	8,707	8,703	8,702	8,692
Panel B: Males				
School FSS	-0.9334 (0.5756)	-0.2798 (0.5543)	-0.7889 (0.5742)	-1.8571 (1.4485)
School FOS	-1.1992 (2.0050)	-0.0068 (1.9299)	-1.6545 (2.0197)	-3.0099 (5.1129)
Observations	8,902	8,893	8,891	8,864
Class and school controls	✓	✓	✓	✓
County FE	✓	✓	✓	✓

Note: Class controls include class size, head teacher's gender, age, and years of experience, girls' proportion, local *Hukou* students' proportion, rural *Hukou* students' proportion, and class ranking. Among them, for female students, the relationships between the girl's proportion in a class and outcomes are 2.3043, 0.9483, 1.4322, 4.8120 for Chinese, Mathematics, English, and Total, respectively; for male students, are 1.9493, 2.7640, 0.2899, and 4.1767, respectively. School controls include private school and school ranking. Standard errors are clustered at class level in brackets.

\* 10%, \*\* 5%, \*\*\* 1%.

Table 2.11: Descriptive statistics of how time is used

	N	Mean	St. Dev.	Min	Max
<b>Time allocation:</b>					
School assignments	16,472	16.4237	9.1297	0	51.0000
Extra assignments	15,015	2.9421	4.3559	0	19.8333
Cram schools	13,767	0.4529	1.2751	0	8.6667
Sports	15,459	4.2886	4.1226	0	19.8333
Reading (not textbooks)	16,260	5.9795	4.7364	0	23.8333
Watching TV	15,602	5.4000	4.8031	0	25.2333
Internet and video games	16,198	3.6361	4.4778	0	26.2500
Housework	15,792	5.2040	4.5413	0	24.8167
<b>Activities and behaviors:</b>					
Number of hobbies	18,415	1.6096	1.1279	0	7
Museums and zoos (friends)	17,908	1.9293	1.0242	1	5
Movies, games and shows (friends)	17,863	2.2887	1.2686	1	5
Join in class/school activities	18,338	2.7546	1.0126	1	4
Late for classes	18,414	1.2489	0.6136	1	4
Absence from class	18,408	1.0878	0.4211	1	4
Romantic relationship	18,306	1.2375	0.4909	1	3
Sleeping time	18,031	7.9817	1.2376	4	12.9333
<b>Class and school environment:</b>					
Nice classmates	18,350	3.2747	0.7969	1	4
Easy to get along with classmates	18,355	3.1748	0.8340	1	4
Good class atmosphere	18,330	3.1404	0.8717	1	4
Close to people in school	18,216	2.9406	0.9211	1	4
Bored of school	18,267	1.6668	0.8644	1	4
Desire to transfer	18,376	1.5058	0.8662	1	4

Table 2.12: Mechanisms

Panel A: Time allocation								
	SCH ASGMT (1)	Extra ASGMT (2)	Crams (3)	Sports (4)	Reading (5)	TV (6)	INET & Games (7)	Housework (8)
School FSS	-0.3463 (0.3659)	-0.3069 (0.1899)	0.0208 (0.0566)	-0.1675 (0.1786)	0.0966 (0.1970)	0.7370*** (0.2081)	0.3675* (0.1916)	-1.1379*** (0.2078)
School FOS	-3.1983*** (1.1309)	-0.0389 (0.5454)	-0.0215 (0.1656)	-1.3362** (0.5719)	1.0323* (0.5885)	0.6670 (0.6280)	1.2510** (0.5565)	-2.3730*** (0.6119)
Observations	15,761	14,337	13,107	14,782	15,553	14,920	15,491	15,122
Panel B: Activities and behaviors								
	Hobbies (9)	Mus & Zoo (10)	Shows (11)	CLS AV (12)	Late (13)	Absence (14)	RR (15)	Sleeping (16)
School FSS	0.0562 (0.0442)	0.1171*** (0.0394)	0.1816*** (0.0496)	0.0276 (0.0391)	-0.0390 (0.0243)	0.0273 (0.0168)	-0.0325 (0.0200)	-0.2415*** (0.0457)
School FOS	-0.1794 (0.1290)	0.5171*** (0.1212)	0.6210*** (0.1512)	0.2965*** (0.1125)	0.0503 (0.0705)	0.0120 (0.0485)	0.1648*** (0.0571)	-0.0020 (0.1352)
Observations	17,589	17,119	17,074	17,516	17,588	17,582	17,481	17,238
Panel C: Class and school environment								
	Classmates (17)	Easy to get to (18)	Atmosphere (19)	Close (20)	Bored (21)	Transfer (22)		
School FSS	0.0751** (0.0313)	0.0975*** (0.0330)	0.1835*** (0.0348)	0.1866*** (0.0363)	-0.1325*** (0.0344)	-0.1159*** (0.0343)		
School FOS	-0.0826 (0.0913)	0.0431 (0.0954)	-0.0917 (0.1007)	0.1180 (0.1029)	0.1500 (0.0987)	0.1608 (0.0991)		
Observations	17,528	17,532	17,511	17,400	17,446	17,551		

Note: Class controls include class size, head teacher's gender, age, and years of experience, girls' proportion, local *Hukou* students' proportion, rural *Hukou* students' proportion, and class ranking. School controls include private school and school ranking. Standard errors are clustered at class level in brackets.

\* 10%, \*\* 5%, \*\*\* 1%.

# Figures

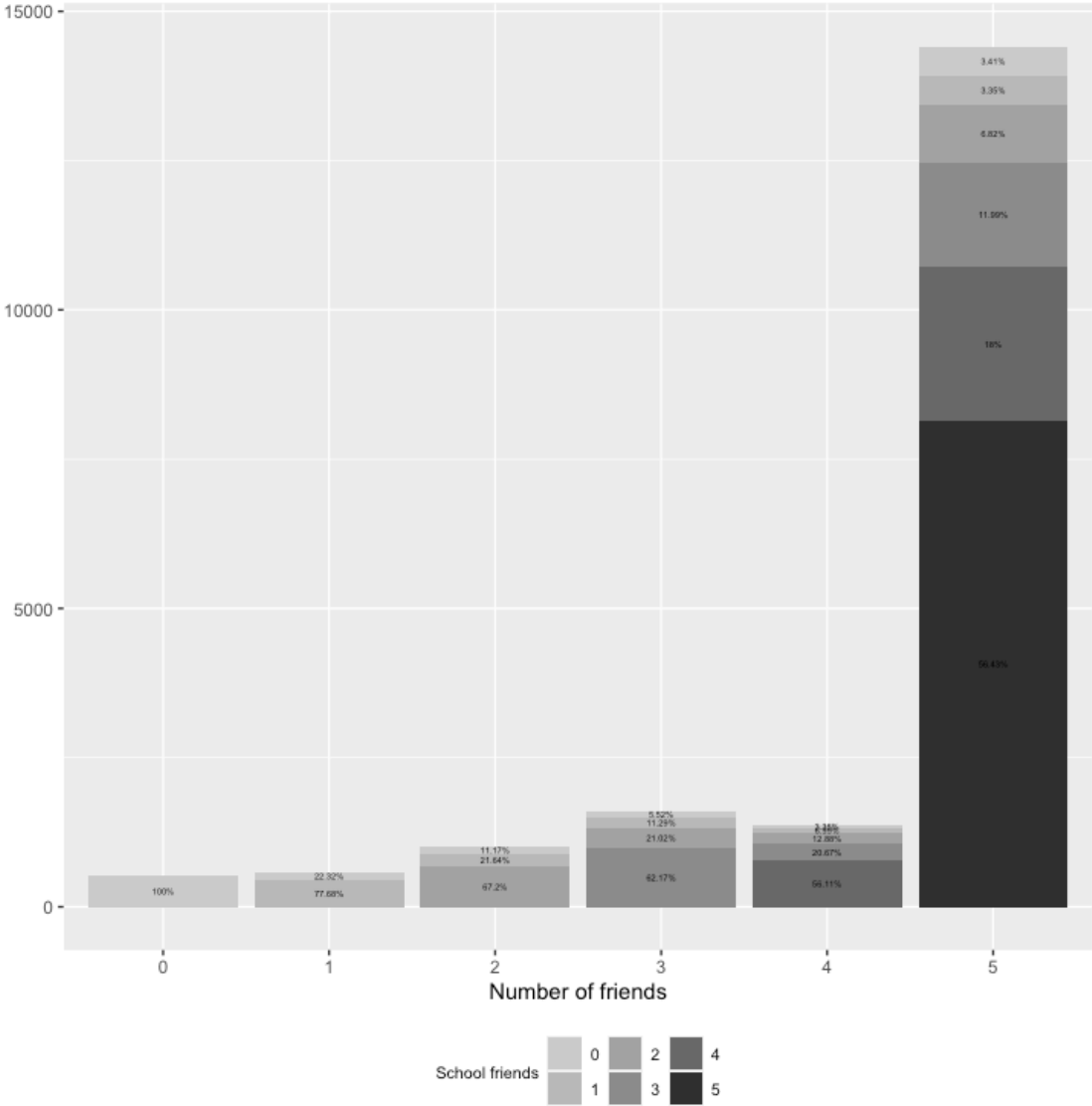


Figure 2.1: Number of friends in the schoolmate network

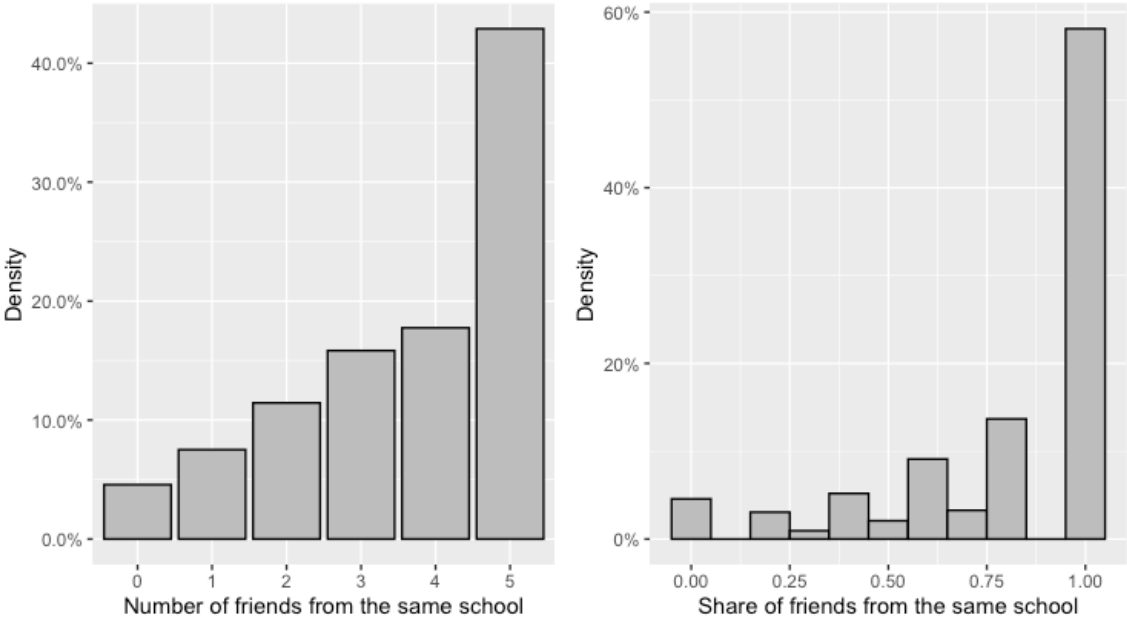


Figure 2.2: Distribution of friends in the schoolmate network

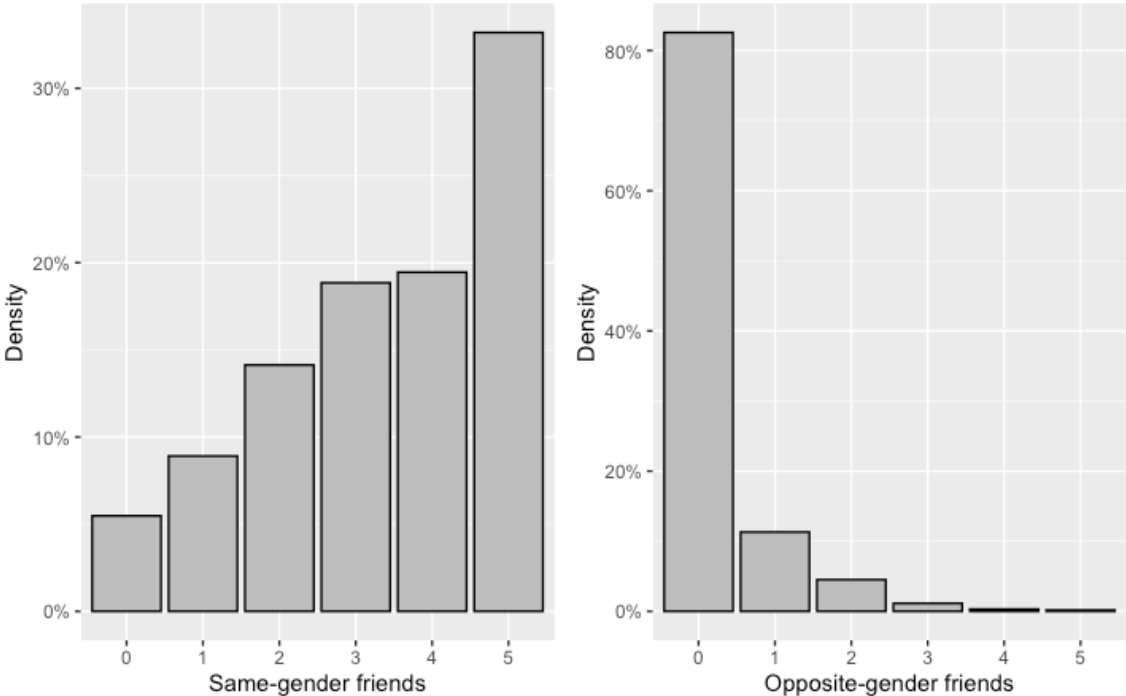


Figure 2.3: Distribution of friends in relative gender

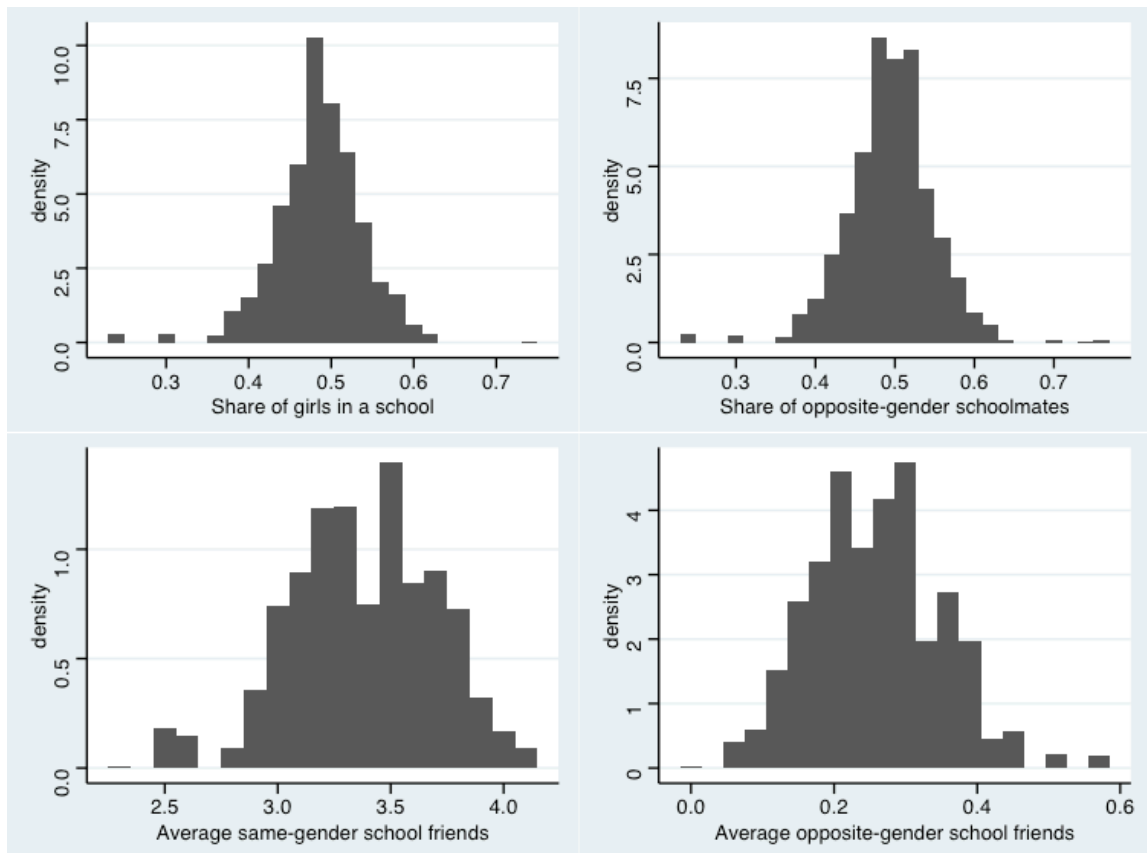


Figure 2.4: Distribution of instrumental variables

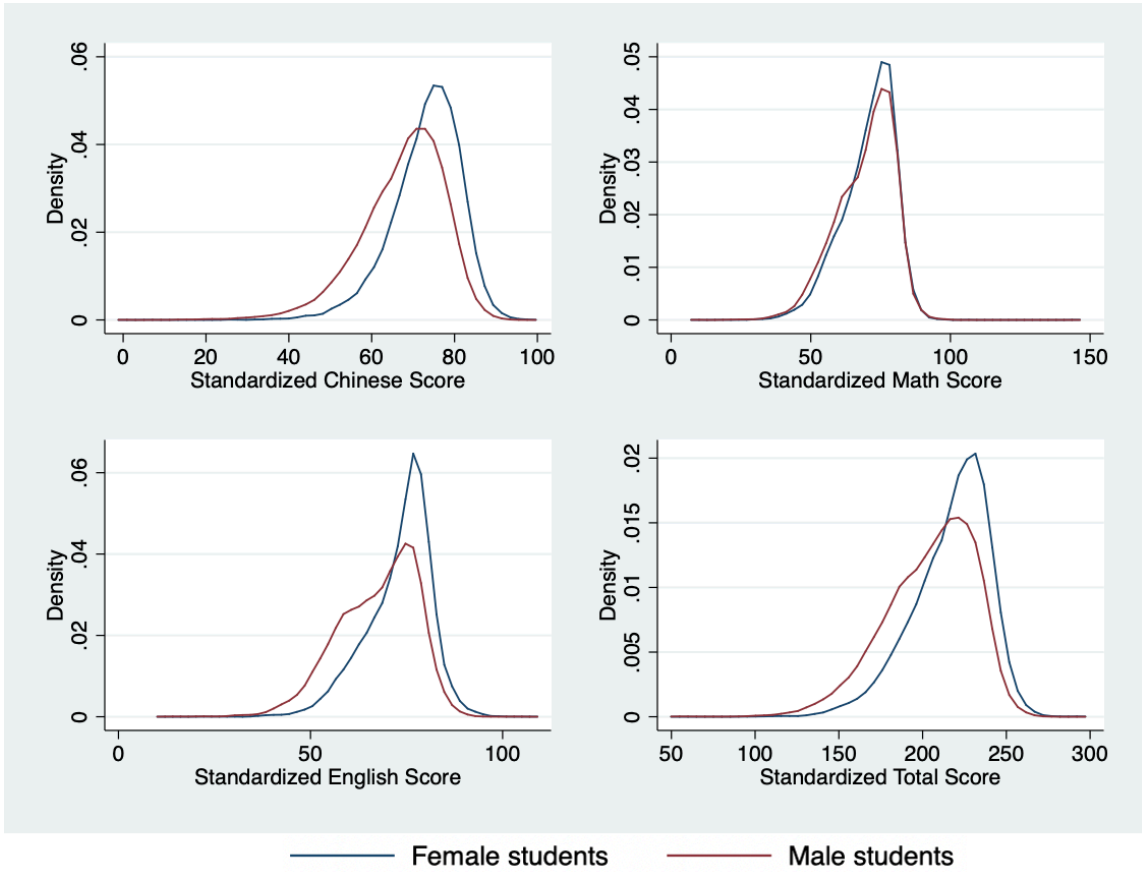


Figure 2.5: Distribution of standardized scores by gender

# Chapter 3

## Social Learning in Enrollment Decisions for National Rural Pension Scheme in China

### 3.1 Introduction

In terms of aging, China is undoubtedly the most important developing country in the world. China Statistical Yearbook, released by the National Bureau of Statistics of China, reports that the population of 65 years old and above was 166.58 million in 2018, accounting for 11.9% of the total population, while it was 88.21 million at the end of 2000, only accounting for 7.0% of the total population. The aging population has almost doubled in 8 years.<sup>1</sup> It is predicted that by 2050, the number of older people in China will reach 330 million, and have the world's largest elderly population.

Traditionally, elderly people in China live with their offspring following Confucian

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<sup>1</sup>It is the most updated data <http://www.stats.gov.cn/tjsj/ndsj/2019/indexeh.htm> on September 2021.

“filial piety.” The tradition of family-based care for the elderly is deeply rooted in rural areas (Giles et al., 2010). Due to China’s long-standing urban-rural dual-sector economic system, which will be discussed in Section 3.3, for most rural people, public pensions were either insufficient or non-existent. Rural households must rely on their own labor earnings or family support even as they reach their 60s and beyond due to a lack of pension support. As shown in the 2015 one percent population sample, in Figure 3.1, there are contrasting sources of support for the Chinese elderly in urban and rural areas. Family support and pensions are the two major primary sources for the elderly. The rural elderly most rely on family support (46.4%) and labor income (34.4%), while pensions support a sizable portion of the metropolitan elderly (53.1%). However, the traditional family model has been weakened due to the shrinkage of family size caused primarily by fertility decline since the one-child policy initiated in the early 1980s and younger generations’ movement to cities. The significant and rapid demographic transformation has led to a top-heavy population pyramid. Age dependency ratio,<sup>2</sup> the percentage of the working-age population in China was reported at 42.21% in 2020: for every 100 people of working age, around 42 seniors and children had to be supported. In 2020, the old-age dependency ratio, which is the proportion of elder dependents (those aged 64 and up) to the working-age population (those aged 15 to 64), is expected to be 3.74. With the decreased number of children, senior citizens in a family without children around in rural areas have brought about a series of social problems. Older people in rural China need pension income to reach the basic standard of living and reduce vulnerability to poverty. To

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<sup>2</sup>The interdependence between three age groups within a population is expressed by the age dependency ratio: ages 0-15, 16-64, and 65 and up.

solve this problem, the Chinese government introduced a National Rural Pension Scheme (NRPS) in 2009 as a response, aiming to cover rural residents fully. Instead of depending on children, the Chinese government encourages rural inhabitants to be active participants in the pension plan.

The NRPS was being implemented county by county. Although the NRPS had reached full coverage at the county level by the end of 2012, not all qualified residents chose to enroll immediately after introduction. Figure 3.2 shows that the population under NRPS coverage still increases after 2012. Policymakers need to comprehend the factors that influence pension program participation. The universal coverage of the rural pension plan is beneficial to the growing rural economy and the expansion of domestic demand. Numerous studies have been devoted to reviewing the empirical evidence on the factors influencing the demand for pensions. Large cross-group variances can also be explained by social interactions. Figure 3.3 shows that the participation rate of NRPS differs by province in China. Some studies show demand arises from characteristics of potential pensioners: lack of education (Fornero and Monticone, 2011), understanding of insurance (Duflo and Saez, 2003), household assets (Zhao et al., 2016; Duflo and Saez, 2003), and levels of economic development (Quan, 2012). Some studies show different supply deficiencies might reduce demand, such as less attractive contract design (Zhang, 2011).

The motivation for studying social interaction effects arises from utility interdependence. People's utility could be increased or decreased by the social neighborhood when engaging in a particular behavior. We will show some literature in Section 3.2. There are at least three reasons why peers are important in the NRPS. First, the

NRPS provides rural residents with their first access to a pension plan. Making financial decisions is frequently challenging due to the complexity of financial products. Even if people opt to participate, they may not have all of the necessary information. The application procedure, for example, could cost time and effort to navigate. Peers who have already enrolled in the pension plan may be an excellent source of information for future retirees. Second, NRPS is newly introduced. The quality of NRPS is challenging to know *ex-ante*. Combined with the fact that rural residents are not well-educated, elders' imperfect understanding of pension could be modeled by uncertainty. The demand for pensions is negatively associated with potential applicants' uncertainty about future earnings. Acquisition of information from people around might reduce the uncertainty, which induces a change in the slope of demand. Finally, social norms or perceptions about social norms may influence engagement. China's rural population is accustomed to living in small, close-knit communities. People can learn about correct social behavior by observing their co-villagers. According to the theory of conformity proposed by [Bernheim \(1994\)](#), individuals care about their social status, such as popularity. Therefore, they have the incentive to conform to their social contacts' behaviors, although their personal preferences are different.

[Manski \(1993\)](#) has pointed out that the challenge to empirically quantify the social effect is the identification problem. It comes from the difficulty of distinguishing between endogenous interaction, contextual effects, and correlated effects. Endogenous effects exist when the peers' outcomes have a direct causal effect on an individual's outcome, whereas contextual effects occur when the peers' exogenous features have

a direct causal effect. The propensity of an individual to participate in a pension plan changes with the participation of other residents, which is an endogenous influence. A contextual effect is that more people will engage in the program if a village's average income is higher. The classical linear-in-means model proposed by [Manski \(1993\)](#) is not able to disentangle endogenous effects and contextual effects. Correlated effects arise when people behave similarly to their peers because ties are more likely to form between people with similar unobserved characteristics. To overcome the identification problem, the available literature generally takes one of three techniques: instrumental variables, randomized experiment, and usage of a certain subsample. Speaking of correlated effects, it is ideal to allocate individuals randomly to groups. In the absence of such an experiment, for continuous variables, [Lin \(2010\)](#) uses a group fixed effect to differentiate the endogenous and correlated effects. To account for the associated effects, [Lee et al. \(2014\)](#) include a group random effects term as well as a fixed effect at a higher level.

Motivated by considerations that people want what their peers have, the goal of this work is to assess peer effects in NRPS enrollment decisions using the two-step method, which is frequently used in discrete games ([Bajari et al., 2010](#); [Liu et al., 2014](#)). The first step is to form a nonparametric estimate of the choice probability. We do this using varied specifications. Then, we estimate the peer variable given the estimates of the choice probabilities. In the second step, the endogenous peer effect is estimated by a linear least square regression. We combine the data from the China Health and Retirement Longitudinal Survey (CHARLS) (2013, 2015, 2018) and the corresponding China Statistical Yearbook at the county level.

Here is a summary of our findings. To begin, we discover statistically significant endogenous social interaction effects among members of the same community. When we don't adjust for simultaneity, we find that estimates for endogenous social interaction effects have a considerable positive bias. If simultaneity is ignored, for example, the marginal effect is overestimated by around 50%.

The remainder of the paper is structured as follows. Section 3.2 reviews the relevant literature. Section 3.3 describes the background information on the pension system in China. Section 3.4 describes the data sources we use in our analysis and the variables we employ in the paper. Section 3.5 explains estimation methods. Section 3.6 provides the empirical results, and robustness checks are conducted in Section 3.7. Finally, Section 3.8 concludes the paper.

## 3.2 Literature Review

According to a growing body of research, individuals are impacted by knowledge of their peers' decisions or the information offered by peers in program participation and financial decisions. Specifically, peers do have an important influence on the decision to participate in welfare programs. With instrumental variables in sub-groups (2002) and a randomized experiment (2003), Duflo and Saez study the peer effects on employees' decision to participate in a Tax Deferred Account (TDA) retirement plan with a large university. A random selection of employees from one department attended an information fair in the randomized trial. In departments where some people were treated, TDA enrollment was much greater than in departments

where no one was treated. In the absence of an experiment, average wages and tenure in the department were used as instruments for average participation. There was still some evidence that one's peer group's decisions influenced one's decision to join. [Sorensen \(2006\)](#) used data from the University of California to examine the social learning effects of coworkers' decisions on individuals' choices of health plans. The strength of the effect is determined by factors such as the size of the department and the employee's demographic distance from his or her coworkers. The size of social interaction impacts a worker's tendency to draw a disability pension (DP) from the disability entrance rate of similarly aged workers in the worker's area in Norway is investigated in [Rege et al., \(2012\)](#). The disability participation rate among a person's previously employed neighbors was measured using exposure to plant-downsizing events by [Rege et al. \(2012\)](#). A one-percentage-point rise in peers' participation rate increased the subsequent four-year admission rate by 0.4 percentage points, according to the findings. [Liu et al. \(2014\)](#) investigate the effect of social learning in household health insurance enrollment decisions and discover that a ten percent rise in a village's enrollment rate boosts an individual's likelihood of enrolling by five percent. [Beshears et al., \(2015\)](#) conduct a field experiment to investigate the impact of providing information on what a target population's peers are contributing to retirement savings decisions. It was discovered that, surprisingly, information regarding peers' high saving rates can cause low-saving individuals to reduce their savings even further when compared to a control group who did not get peer information. This impact was partly fueled by peer information discouraging people from trying new things. In the Philippines, [Hoffmann \(2017\)](#) investigates the

impact of peer impacts in communities on poor households' use of vital health care services. Individual health care consumption increases by 6.6 percentage points for every ten percent increase in program adoption in the peer group. In [Lieber and Skimmyhorn \(2018\)](#), the peer effects on financial decisions among newly drafted soldiers, including retirement savings and life insurance purchases, were studied using exogenous random assignment of new U.S. Army soldiers, and no effects were found.

Existing research also implies that social interactions play a crucial impact on other financial decisions. [Hong et al. \(2004\)](#) found that social households are more likely to invest in the market than non-social households. [Brown et al. \(2008\)](#) use stock ownership in the states where one's nonnative neighbors lived at the time they applied for their Social Security numbers to prove causal community effects in stock market involvement. An increase of ten percentage points in community stock ownership increases a person's likelihood of participating in the stock market by four percentage points. [Bursztyn et al. \(2014\)](#) separately identified the effects of social learning and social utility on investment decisions using a field experiment and found statistically and economically significant effects in both channels. [Cai et al. \(2015\)](#) look at the influence of social networks in the spread of weather insurance. Using a field experiment, it concluded that having one additional friend attending the intensive session increases own take-up by 6.7 percentage points. The monetary equivalence of the network effect equals 15% of the insurance premium. However, social learning has not been studied on take-up decisions in NRPS.

Regarding econometrics models, game theory has played a central role in studying network effects on social behaviors. The standard setting of the game is there are

many independent markets are observed and each with a small number of players. Each individual's behavior is a function of the characteristics or behavior of others. While [Manski \(1993\)](#) specifies how an individual is influenced by other members in the same group for continuous outcomes, [Brock and Durlauf \(2001\)](#) establish a discrete choice model with social interactions incorporating terms reflecting the desire of individuals to conform to the behavior of others. It can be viewed as a situation in which an individual's choice in a group is determined by his or her expectation of the average choice of the group to which he or she belongs. The anticipation is shaped by the features of the group. Given reasonable views, the subjective expectation for the group's average choice is the same for everyone in the group, and it agrees with the mathematical expectation. More recently, [Lee et al. \(2014\)](#) extend the model from homogeneous rational expectations to heterogeneous rational expectations. Every member in the network creates a rational belief based on both group and peer characteristics, resulting in a heterogeneous rational expectation.<sup>3</sup> For example, a person may have differing expectations about his or her male and female neighbors' involvement prospects. In contrast, such gender characteristics are not observable in the model in [Brock and Durlauf \(2001\)](#). [Lin \(2014\)](#) investigates the peer impacts on four delinquent activities among adolescents: consuming alcohol, having risky behaviors, missing classes, and physical aggression, using a binary choice network model with heterogeneous rational expectations. All four behaviors have both endogenous and contextual social impacts.

[Aguirregabiria and Mira \(2002\)](#) present a two-step strategy for estimating static

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<sup>3</sup>The reflection problem is avoided in the binary choice model with heterogeneous rational expectations.

games with incomplete information. The two-step method is also used by [Aguirregabiria and Mira \(2007\)](#), [Bajari et al. \(2007\)](#), and [Bajari et al. \(2010\)](#). In the first phase, we estimate the likelihood that one of the small number of viable choices is chosen, conditional on the necessary covariates, using traditional econometric methods. The economist estimates a single agent random utility model in the second phase, utilizing the first stage's equilibrium beliefs about others' behavior as controls. [Leung \(2015\)](#) identifies endogenous determinants, an agent chooses to link with other agents depending on the anticipated structure of the network, and exogenous determinants, an agent links to another agent for sharing similar attributes, in-network formation on a simultaneous game of incomplete information. The model is estimated using a two-step probit. To identify the social interaction repercussions of the smoking habit in couples, friends, siblings, and a parent and an adult child, [Li and Gilleskie \(2021\)](#) employ a two-player simultaneous move game with complete information. The econometric model addresses simultaneity, homophily, confounding, attrition, and multiplicity of equilibria. They find statistically significant endogenous social interaction effects in couples and friends. A sibling's or parent's smoking behaviors have no statistically significant consequences, while a non-smoking adult child's parent is less likely to smoke.

### 3.3 Pension System in China

While the pension systems of developed countries are relatively stable, the pension system in China continues to develop and change, largely to address the challenge of

the aging population. In 1997, the main foundation for China's pension system was established.<sup>4</sup>

The Chinese pension system consists of subsystems. Both employees and employers must contribute to the retirement system. Employers contribute a percentage of total earnings paid to their employees, while workers contribute based on their wages. Employer contributions go to the social pension, whereas employee contributions go to a personal account. After retirement, the balance of the personal account, including interest, is partitioned into 139 payments, which are paid out monthly over ten years. On top of the personal account benefits, the employee is eligible for general pension payments, which are paid by company contributions and are payable until death.<sup>5</sup> Any shortages must be covered by the government by law. General pension benefits are calculated using the number of years in the workforce, income level in the sector, and average life expectancy.<sup>6</sup> Before January 2015, civil officials and other government employees, such as teachers, had their own pension scheme. Employees were not required to contribute to their pensions and were entitled to a large government-subsidized pension when they retired. Following the implementation of a new pension plan in January 2015, such employees began contributing to

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<sup>4</sup>It is addressed in the document "Decision of State Council on the Establishment of a Unified Basic Pension System for Enterprise Workers".

<sup>5</sup>When workers reach the statutory retirement age, they are eligible for pension payments, but only if they have been members of the scheme for at least 15 years. Those who haven't contributed for 15 years have the option of deferring retirement until they have. They can choose to pay the remaining mandatory contributions, transfer their pension plan to a non-employed rural or urban resident plan, or receive a lump sum payment for the balance of their individual account, including interest.

<sup>6</sup>Companies were exempt from paying social security contributions in 2020, when the Covid-19 epidemic broke out. For up to six months, employers could stop contributing to pension funds, unemployment insurance, and work-injury insurance.

the pension fund.<sup>7</sup> Employees of public institutions and government workers have their basic pay and pension benefits increased to compensate for any financial losses incurred as a result of the new system.

In late 2009, the Chinese government established an innovative initiative, the National Rural Social Pension Scheme for rural residents, in response to the rapidly aging population and to improve the welfare of elderly people in rural areas.<sup>8</sup> To begin with, participation is entirely voluntary for all rural people aged 16 and over who are not students and are not already covered by a basic urban plan. They can join whether they are self-employed or employed, and whether they operate in a rural or urban setting. To vest and be eligible for pensions at the age of 60, participants must contribute for 15 years. Participants who are older than 45 when they join the program must contribute every year until they reach the age of 60, after which they must make a lump-sum payment to make up the difference in years.

The New Rural Pension System consists of a basic pension component, which is the direct payment of money, and a personal account component based on contributions from enrolled individuals. The contribution per year has five levels from 100 *yuan* to 500 *yuan* with an increment of 100 *yuan*. The basic component is almost the same as in a defined benefit plan, even though there are no restrictions on employment. Regardless of prior earnings or income, all registrants receive 55 *yuan* every month.<sup>9</sup> A defined contribution plan is an individual account. The government is in charge

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<sup>7</sup>It is addressed in the document "Decision of State Council on the Reform of the State Employee Pension System".

<sup>8</sup>*hukou* is not always consistent with residency. People who reside in urban areas may have a rural *hukou*, and vice versa.

<sup>9</sup>The benefits increased to 75 *yuan* in 2014.

of investment decisions and investment management for the plan. The government guarantees a return equal to that of a one-year time deposit. The participation of their adult children was a requirement for pensioners with adult children. However, since many adult children of the qualified seniors were working abroad and unable to participate, decreasing the take-up rate and delaying the program's deployment. The government removed this restriction to boost rural senior participation (Huang and Zhang, 2021). We still consider children's participation in our research and do not consider the pension benefits as "free money". We explore the heterogeneous effects of children in Section 3.6.2. It's an opportunity that happens once in a lifetime for the world's most populous country. Since its start, the New Rural Pension system has rapidly expanded, now embracing all 2,853 county-level administrative regions and 460 million rural inhabitants in 2012.

To separate itself apart from the previous "old" rural pension program, which launched in 1992, the NRPS refers to the "new" rural pension scheme. The finance and payment methods of the previous rural pension system and the new rural pension system are two major changes. For starters, rural residents were primarily responsible for the old pension system. Premiums were accumulated in a personal account and accrued at a low-interest rate, making it a self-saving model. After 1998, the old pension scheme stalled, owing in part to rampant mismanagement of the funds and the program's insignificance. According to China Agricultural Statistical Yearbooks, the enrolment rate in the previous rural pension system has plummeted to fewer than 3% in 2005. Individual payments, communal subsidies, and government subsidies are all used to fund the new rural pension scheme. The central government, in

particular, subsidizes local governments, and this subsidy is passed on to rural populations.<sup>10</sup> Second, the old rural pension system is mainly to establish the accounts of rural residents. The design of the new rural pension in the payment structure is two parts: one is the basic pension, and the other is the pension of the personal account. The state finances guarantee the basic pension. In other words, Chinese farmers will enjoy the national universal pension after the age of 60.

## 3.4 Data

### 3.4.1 CHARLS data

We draw data from the China Health and Retirement Longitudinal Survey (CHARLS), which is a national panel survey involving Chinese individuals aged 45 and above, born before July 1, 1966, and their spouses of any age in 450 communities in 150 counties spread throughout 28 provinces.<sup>11</sup> Villages in rural regions and communities in urban areas with at least one resident committee were used as primary sample units (PSUs), which is peer groups in our paper. All the counties and districts in China are covered except those in Tibet. It began in 2011 and has subsequently been re-interviewed every two years. Currently, national data for waves 2011, 2013, 2015,

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<sup>10</sup>It is another beneficial agricultural policy following the abolition of agricultural taxes (AAT) (2005–2006), direct agricultural subsidies, and new rural cooperative medical care.

<sup>11</sup>Multistage probability sampling was used to create the CHARLS samples. In the first stage, 150 county-level units were randomly selected from all county-level units excluding Tibet in China using a probability-proportional-to-size (PPS) selection technique. The sample was stratified by area, and within each area, by urban districts or rural counties, using gross domestic product per capita information (GDP).

and 2018 are available for study. CHARLS was designed in a similar way to the US Health and Retirement Study (HRS) as a multipurpose social science survey of China's senior citizens. Demographic information, income, assets, health, cognition, family structure and connections, health care usage and costs, housing, job status and history, expectations, biomarkers, and insurance are all gathered in the survey.

CHARLS is great as the records are close enough to the launch of the New Rural Pension System. It provides us with individual data on NRPS enrollment. We use waves 2013, 2015, and 2018 as the NRPS has already covered all counties. Whether or not to participate in the pension scheme is totally a personal choice. Individual identities are provided in order to relate the waves. We subset 14,277 individuals who are tracked in three waves. Since the NRSP is only applicable to residents who have rural *hukou*, we remove the respondents whose *hukou* is urban and leaving only the rural population of the crowd as our research object, resulting in 10,504 respondents.<sup>12</sup> Next, we dropping observations who had government/institutions/-firms pension or whose age was younger than 16. 470 respondents are excluded from the sample. Finally, we drop communities which have less than 5 observations and individuals whose NRPS information is missing.<sup>13</sup> In a peer group, the median number of people is 34 with a minimum of 5 and a maximum of 66. We construct a balanced panel data of 9,476 observations from 319 communities. Thus, our sample consists of 9,476 individuals  $\times$  3 waves, 28,428 observations.

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<sup>12</sup>We distinguish urban and rural population by *hukou*, which is the household registration management system in China. The government divides *hukou* into "agricultural *hukou*" and "non-agricultural *hukou*".

<sup>13</sup>We define peers as those who live in the same community.

Table 3.1 displays the individual and household characteristics of the rural residents, as well as county-level variables<sup>14</sup> in the full sample and separate waves. The average participation rate is 77.06%.<sup>15</sup> The average age is 61.31. The percentage of female is 55.47%. 86.11% of the residents are married. 65.52% of the respondents have at least one chronic disease. The educational level is identified according to a three-tier harmonized scale:<sup>16</sup> “1. Less than lower secondary education, 2. Upper secondary & vocational training, and 3. Tertiary education.” If a respondent declares an education level of “No Formal Education (Illiterate)”, “Did Not Finish Primary School but can Read”, “Sishu (Private Tutoring)”, “Elementary School” or “Middle School”, she is given a code of 1. If a respondent declares an education level of “High School” or “Vocational School”, she is given a code of 2. If a respondent declares an education level of “Two/three-year College”, “College Grad” or “Post-graduate degree”, she is given a code of 3. In our sample, 95.56% of the respondents never attended high school. 5.36% never attended college and the rest 0.09% attended college. A household, a single or a couple, on average, has 2.678 children and additional 1.7213 members living together with.<sup>17</sup> The average wage is 2,911.74 *yuan* per year. The average transfer income from children is 3,592.81 *yuan*. The average land value is 2,069.76 *yuan*. Log transformation will be applied to income variables due to the nature of right-skewed.<sup>18</sup>

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<sup>14</sup>County-level variables will be discussed in the following section.

<sup>15</sup>71.59% choose to participate in the NRPS program in wave 2013, 73.62% choose to participate in wave 2015, and 85.96% choose to participate in wave 2018.

<sup>16</sup>The US Health and Retirement Study uses this scale, which is a shortened version of the 1997 International Standard Classification of Education (ISCED-97) codes, to make results comparable across countries (HRS).

<sup>17</sup>The co-residency does not include children.

<sup>18</sup>We use  $\log(x + 1)$  transformation because income variables include zero values.

### 3.4.2 County (City) Social and Economic Statistical Yearbook

We collect county-level characteristics from the China County (City) Social and Economic Statistical Yearbook in 2013, 2015, and 2018, released by the National Bureau of Statistics of China's Department of Rural Surveys. All counties in China's 31 provinces are included.<sup>19</sup> Data on a wide range of socioeconomic indicators is collected through the reporting system, which is prepared by local government departments. We match county-level characteristics with the identifiers for provinces and counties in CHARLS.

The CHARLS data contains information of province, county, and community, from large to small, for each respondent. County in China is a subordinate level of city and could be geographically smaller than counties in the United States (Yao and Delgado, 2020). Usually each county has one "county center" (*xian cheng*) where people cluster and socialize. Rural villagers living nearby go to these centers for supplies. Therefore, it is reasonable to use county-level characteristics to capture common shocks. We also define peer groups based on counties later in Section 3.7.

## 3.5 Model

In order to motivate our empirical specification, we model NRPS enrollment decision with social interactions using the framework of the discrete-choice model. The

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<sup>19</sup>Hong Kong SAR, Macao SAR, and Taiwan are excluded from the Yearbook.

utility of the decision to enroll NRPS is determined by the individual's characteristics and the expected probability that his or her peers will do so. We treat the decision whether or not to engage in the NRPS as a simultaneous discrete game with incomplete information. This part closely follows [Bajari et al. \(2010\)](#).

Suppose we have  $n$  players and all players act at the same time. In each time period  $t$ , each player  $i$  has two options available to choose:  $a_{it} \in \{0, 1\}$ , where  $a_{it} = 0$  denotes the action "enroll" and  $a_{it} = 1$  denotes the action "not enroll". An individual  $i$  decides on a course of action in order to maximize her present period utility. We let  $a_t = (a_{1t}, \dots, a_{nt})$  denote the set of actions for all the players.  $i$ 's peers is denoted by  $-i$ . Therefore, the actions of player  $i$ 's peers at time period  $t$  are  $a_{-i} = (a_1, \dots, a_{i-1}, a_{i+1}, \dots, a_n)$ .  $S_{it}$  are state variables, which are observable by other players and the researchers, such as the demographic and socioeconomic information. In addition to  $S_{it}$ , each player  $i$  also has private stochastic preference shock  $\epsilon_{it}(a_{it})$  for each possible action  $a_i$ .  $\epsilon_i(a_i)$  is not observed by  $j \neq i$ , as well as the researchers.<sup>20</sup> The preference shocks are distributed i.i.d. across players and actions.<sup>21</sup> It means that, given the observable factors  $S$ , players' equilibrium are conditionally independent.<sup>22</sup>

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<sup>20</sup>Another interpretation of  $\epsilon_i(a_i)$  is optimization mistakes. People do not always know what is best for them when they are making decisions. The decisions may be cognitively comprehensive for them.

<sup>21</sup>It's worth noting that our model excludes unobserved heterogeneity.

<sup>22</sup>Because of the private information  $\epsilon_i$ , player  $i$ 's decision will be probabilistic from other players' view.

The payoff function for player  $i$  at time period  $t$  is:

$$U_{it}(a_{it}, a_{-it}, S_{it}, \epsilon_{it}; \theta) = \pi_{it}(a_{it}, a_{-it}, S_{it}; \theta) + \epsilon_{it}(a_{it}), \quad (3.1)$$

where  $\theta$  is the structural parameters of the game, which are unknown functions. The actions of other players  $a_{-i}$  are included in the player  $i$ 's utility, unlike in a typical discrete choice model.<sup>23</sup> However, other players private information  $\epsilon_{-it}$  are unobservable to player  $i$ . In the context of pension enrollment decision, for example an individual does not know his or her peers' trust in government, which will influence their decision to enroll or not.

According to Equation 3.1, the utility from participating in the NRPS in a linear parameterization is

$$\pi_{it}(a_{it} = 1, a_{-it}, S_{it}, \epsilon_{it}; \theta) = \beta S_{it} + \alpha \left( \frac{1}{N_{C_i} - 1} \sum_{j \in C_i} \mathbf{1}(a_{jt} = 1) \right), \quad (3.2)$$

where  $C_i$  denotes the group of individuals in the same community as  $i$ .  $\beta S_{it}$  captures the private utility. It depends on the characteristics of the individual, but independent of others' characteristics.  $\alpha \left( \frac{1}{N_{C_i} - 1} \sum_{j \in C_i} \mathbf{1}(a_j = 1) \right)$  captures the social effects utility. Each individual's decision is based on the decisions of his/her neighbours. Because decision-makers are solely interested in differences in choice-specific payoffs, the mean utility of action  $\theta$  is normalized to 0 by setting  $\beta = \alpha = 0$  for all state

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<sup>23</sup>In a normal discrete choice model, agents  $i$  are assumed to behave in isolation, with  $a_{-i}$  excluded from the utility function.

variables, actions and players:<sup>24</sup>

$$U_{it}(a_{it} = 0, a_{-it}, S_{it}, \epsilon_{it}; \theta) = 0 \quad (3.4)$$

In this Bayesian game, player  $i$ 's maps his or her private information  $\epsilon_{it}$  to his or her choice  $a_{it}$  at time period  $t$ . Following the Bayesian Nash equilibrium, player  $i$  maximizes his or her expected payoff over beliefs:

$$E_{\epsilon_{-i}}(a_{it}, s, \epsilon_{it}; \theta) = \beta S_{it} + \alpha \left( \frac{1}{N_{C_i} - 1} \sum_{j \in C_i} \sigma_{jt}(a_{jt} = 1 | S_{it}; \theta) \right). \quad (3.5)$$

We have already assumed  $\epsilon_{ik}$  to be i.i.d. across both actions and players. Suppose we generate  $\epsilon_{ik}$  from an extreme value distribution with the probability density function is  $f(\epsilon) = \exp(\epsilon) \exp[-\exp(\epsilon)]$ ,<sup>25</sup> players' equilibrium choices are conditionally independent given  $S$ . Given the assumption, Equation 3.5 can be rewritten in terms

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<sup>24</sup>Beliefs for player  $i$  at time period  $t$  can be expressed as probability functions defined over  $A_{-it}$ . For any set of beliefs  $\sigma_{-it}: A_{-it} \rightarrow [0, 1]$ , player  $i$ 's expected utility from choosing  $a_{it}$  is:

$$u_{it}(a_{it}, s, \epsilon_{it}; \theta) = \sum_{a_{-it} \in A_{-it}} \pi_{it}(a_{it}, a_{-it}, s; \theta) \sigma_{-it}(a_{-it} | s) + \epsilon_{it}(a_{it}), \quad (3.3)$$

where  $\sigma_{-it}(a_{-it} | s) = \prod_{j \neq i} \sigma_{jt}(a_{jt} | s)$  is the joint probability distribution of peers' actions.  $\sum_{a_{-it}} \pi_{it}(a_{it}, a_{-it}, s; \theta) \sigma_{-it}(a_{-it} | s)$  is the expected value of  $\sum_{a_{-it}} \pi_{it}(a_{it}, a_{-it}, s; \theta)$ .

<sup>25</sup>If  $\epsilon$  draws from the extreme value distribution, the difference between two randomly draw  $\epsilon$ s follows a logistic distribution. It is a common assumption in the discrete choice model literature, see Brock and Durlauf, 2001; Bajari et al., 2010.

of equilibrium choice probabilities.

$$\sigma_{it}^*(S; \theta) = \frac{\exp[\beta S_{it} + \alpha(\frac{1}{N_{C_i}-1} \sum_{j \in C_i} \sigma_{jt}(a_{jt} = 1|S_{it}; \theta))]}{1 + \exp[\beta S_{it} + \alpha(\frac{1}{N_{C_i}-1} \sum_{j \in C_i} \sigma_{jt}(a_{jt} = 1|S_{it}; \theta))]} \quad (3.6)$$

Therefore, Equation 3.6 is demonstrated in the standard binomial logit formula, except for the presence of the equilibrium choice probabilities of other players. The existence of a solution follows Brouwer's fixed point theorem for any finite  $S$  (McKelvey and Palfrey, 1995).

Some recent development of estimating such discrete games in two steps see Bajari et al., 2010; Liu et al., 2014; Yakovlev, 2018. We are able to have a consistent estimate  $\hat{\sigma}_i(a_i = 1|s)$  of  $\sigma_i(a_i = 1|s)$  by observing enrollment decisions in a wide number of groups. In the main results, the first-stage estimates uses a linear probability model. We will discuss a more flexible and robust semiparametric strategy proposed by Bajari et al. (2010) as a robustness check. The functional form of the model is provided before the model is fit to data in typical parametric regression models, and the goal is to estimate the model's parameters. In nonparametric regression, on the other hand, the goal is to estimate the regression function without explicitly stating its form. In the second step, we take as given the estimates  $\hat{\sigma}_i(a_i = 1|s)$  of the equilibrium choice probabilities. We then estimate the structural parameters of the payoff,  $\beta$  and  $\alpha$ , in a single agent random utility model, including as controls the equilibrium beliefs about the behavior of others from the first step. Given we have a binary response, we only need to simply estimate a logit model.

The main issue with identification is that both the first stage estimates  $\hat{\sigma}_i(a_i = 1|s)$

and the term  $\beta(s)$  are dependent on the state variable vector  $s$ . This means that in order to distinguish  $\beta$  and  $\alpha$  individually, we will face a collinearity problem. We solve the problem by imposing an exclusion restriction following [Liu et al. \(2014\)](#). In this study, for instance, multiple variables related to a household's income are included in  $s$ , i.e., wages and earnings, transfer wealth from children, and land value. Individual  $-i$ 's information will not immediately affect individual  $i$ 's utility. These are only introduced indirectly through co-villagers' behaviors, such as enrollment decisions. Therefore, if we exclude the income of other individuals from  $\beta(s)$ , we would no longer suffer from a collinearity problem. Similar reasoning holds for individuals  $-i$ 's age as for NRPS, residents who are 60 years old and above start receiving the benefits.

[Bajari et al. \(2010\)](#) demonstrates a nonparametric estimation procedure may lead to drastically different point estimates in small samples although its advantages of flexibility and robustness against misspecification. We apply a semiparametric estimation where the deterministic utility components  $\pi_{it}(a_{it}, a_{-it}, S_{it})$  are specified to be a linear function of a finite dimensional parameter vector  $\theta$ . We apply spline, the most common example of sieve regression, the most popular nonparametric technique in applied econometrics in the first step ([Hansen, 2014](#)). A  $k$ th order spline is a continuous piecewise polynomial function of degree  $k$  with continuous derivatives of orders  $1, \dots, k-1$  at its knot points. The most typical example is  $k = 3$ , which is the case of cubic splines. These are continuous piecewise cubic functions with continuous first and second derivatives. Splines require a rule to determine the location of the knots. A common choice is to set the knots to evenly partition the support of

regressors. An alternative is to set the knots to evenly partition the percentile of the distribution of regressors. We use the quantile rule for our main specification and use even partition rule for robustness checks.

Following the theoretical model, the probability for individual  $i$  to enroll in the pension program is given as follows:

$$\begin{aligned}
 p_{ict} &= \frac{\exp(\beta_0 + \alpha(\frac{1}{N_{C_i}-1} \sum_{j \in C_i} \mathbf{1}(a_j = 1)) + \beta_1 x_{ict} + \beta_2 z_{ct} + v_i + u_t + \varepsilon_{ict})}{1 + \exp(\beta_0 + \alpha(\frac{1}{N_{C_i}-1} \sum_{j \in C_i} \mathbf{1}(a_j = 1)) + \beta_1 x_{ict} + \beta_2 z_{ct} + v_i + u_t + \varepsilon_{ict})} \\
 &= \Psi(x_{ict}, z_{ct}, v_i, u_t; \theta)
 \end{aligned} \tag{3.7}$$

where  $p_{ict}$  indicates the probability of individual  $i$  in community  $c$  chose to enroll in period  $t$ . The vector  $x_{ict}$  contains individual and household characteristics. The vector  $z_{ct}$  contains county-level characteristics.  $v_i$  is the individual fixed effect, capturing a individual-specific common shock, and  $u_t$  is the time fixed effect, capturing a time-specific common shock. Standard errors are calculated using a bootstrap procedure. The parameter of interest is  $\alpha$ . Assuming  $\alpha$  is unbiased,  $1/(1 - \alpha)$  gives a value for the social multiplier.

In this paper, to estimate how an individual's enrollment decision is influenced by the enrollment decisions of others in the same community, we use a two-step approach. In the first step, we have access to data on three waves for each individual. For each wave, we observe the action, e.g., enroll in NRPS or not, and state variables for each respondent. We estimate each individual's enrollment probability  $p_{ict}$  on individual and household characteristics, as well as an individual fixed effect and a year fixed

effect. In comparison to a linear spline, the third-order spline allows for more flexible first-stage estimation. The term  $\frac{1}{N_c-1} \sum_{j \neq i} y_{jhct}$  is replaced by  $\frac{1}{N_c-1} \sum_{j \neq i} \hat{y}_{jct}$ , where the fitted value  $\hat{y}_{ict}$  are generated from the first-stage regression. In the second stage, we use Equation (3.7) to estimate the peer effects  $\alpha$ .

## 3.6 Empirical Results

### 3.6.1 Main Results

Unbiased estimate requires the peer engagement rate must be independent of the unobserved factors of engagement. However, we face at least two challenges to recover the true parameter. The first one is the reflection problem proposed by [Manski \(1993\)](#). While the peers' decisions affect the individual's decision, the individual's decision is also a predictor of the peers'. It is also called a simultaneity bias. Second, an individual's and peers' enrollment decisions may be affected by common unobservables shocks, which will cause an omitted variables bias. While integrating a large number of individual- and area-level covariates can help to reduce bias, there are still some factors that are endogenous with NRPS involvement that cannot be seen.<sup>26</sup>

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<sup>26</sup>Discussed by [Manski \(1993\)](#), another issue is that people often choose which social groups to join. If the selection is related to their enrollment decisions, the estimated coefficients will be biased. The peer groups we use in this paper are people who live in the same community. Residents in China's communities are sufficiently small that it is plausible to suppose they interact with one another. Therefore, the third challenge should be of less concern given the full coverage of NRPS at the county level.

With the exclusion condition discussed in Section 3.5, our first stage is to regress the NRPS enrollment  $y_{ict}$  on an indicator of age 60 or above, a third-order spline of wages and earnings, a third-order spline of transfer wealth from children, a third-order spline of land value, an individual fixed effect, and a wave fixed effect. The age variable is a key variable in determining an individual's decision to enroll in the pension plan or not as described in Section 3.3. The knots are placed at quantiles. We also use multiple alternative specifications in the first stage and will be used as robustness checks in Section 3.7.

The results of estimating Equation (3.7) using a conditional logit model are presented in Table 3.2. In the second step, we consider several specifications for enrollment decisions. In column (1), we do not include peer effects in the equation. In column (2), we use the actual enrollment to calculate the leave-me-out peers' average and include it as a regressor. The preferred result is in column (3), we generate the leave-me-out peers' average using the predicted enrollment rate from the first stage. The coefficients of peers' enrollment are positive and significant as expected. As for other coefficients, age has a concave effect. The effect of age changes when a resident gets older. The older a resident is, the probability he or she chooses to enroll in NRPS is higher, and the increment becomes smaller. More children are associated with a higher propensity to enroll in NRPS as children usually can be considered both physical and financial supporters for parents in rural areas.<sup>27</sup> The coefficients of household income (earned income and transfer income) and wealth (land value) are positive and significant, indicating that higher household income increases the

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<sup>27</sup>Gender, educational levels, and ethnicity are not estimated under the fixed effects specification as there is no variant between waves.

probability of participating in NRPS. It is consistent with the literature that people with higher household incomes are more likely to purchase health and life insurance (Lewis, 1989; Harmon and Nolan, 2001). The marginal effect is calculated by taking the derivative of Equation (3.7):

$$\frac{\partial p_{ict}}{\partial \text{Peers' enrollment}} = p(1 - p)\alpha, \quad (3.8)$$

where  $p$  is the leave-me-out peers' average/predicted peers' average. Given the average enrollment rate of 0.771 and the coefficient of 4.889, the marginal effect at the means equals to 0.863 in column (2). Similarly, the marginal effect at the means equals to 0.541 in column (3). Therefore, there is evidence that the coefficient of peers' enrollment is overestimated due to the unobserved shared shock. Even in the absence of endogenous peer effects, people who live in the same villages are almost certainly in the same position and may have similar behaviors or choices. The two-step technique rules out the possibility of a correlated effect as the marginal effect in column (3) is about three-fifths of the size of column (2) and is significant at the 1% level.<sup>28</sup> On average, 77.06% people choose to participate in NRPS. The average group size is 30, that is, each individual has 29 neighbors on average.<sup>29</sup> Among the 29 neighbors, 22 of them choose to enroll in NRPS. All else equal, if an individual moves from a community where no one joins NRPS to one community where all

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<sup>28</sup>We also estimate the second step using a linear probability model. Results are shown in Table B.2. The marginal effects are much easier to interpret with LPMs. We find the same pattern in Table B.2 and confirm the upward bias from the same environment and situation. The magnitudes are smaller than the marginal effects at the means using a conditional logistic model but still comparable.

<sup>29</sup>The smallest group size is 6 and the largest group size is 66. The distribution of group size is exhibit in Table B.1.

residents decide to join NRPS, this person's probability of joining will increase by 0.541.

[Zhao and Qu \(2021\)](#) study the same social learning effects using different data and methods. Data is from the 2013 China Household Finance Survey (CHFS), and method follows [Lee et al. \(2014\)](#). Their results show that when the peers' participation rate increases by 1, an individual's enrollment rate goes up by 16%. The endogenous peer effects in the New Cooperative Medical Scheme (NCMS) is studied by [Liu et al. \(2014\)](#). The effect is approximately 0.501. Our result is close to theirs.

To investigate the possible non-linearity of the social learning effect, we add a quadratic term of the peers' enrollment. The results are shown in [Table 3.3](#). We find that only the main effect, but not the quadratic part is significant. Therefore, the social effect presents a linear pattern.

We also investigate a piecewise linear regression with two breaks of 0.65 and 0.9, which correspond to the 25th and 75th percentiles of peer enrollment, respectively. [Table 3.3](#), column (3) shows that the social effect is stronger when the peers' enrollment rate is lower than 0.65. It is the early stage of information dissemination. Villagers get to know NRPS from words of mouth. It becomes weaker as the peers' enrollment rate reaches 0.65. In this stage, non-participants have an incentive to follow what most neighbors choose. Therefore, we could still see a significantly positive effect. Once the peers' enrollment rate is above 0.9, the social effect becomes insignificant. At this stage, most residents already have a full understanding of the new pension program. For the non-participants, there is a rare information barrier.

The insignificant result illustrates that their utilities would not be penalized for non-adherence to social norms. No matter their neighbors choose to join or not, they prefer not to join.

### 3.6.2 Heterogeneous Effects

#### 3.6.2.1 Peer effects within and between subgroups

If the peer effects are from social interactions, we would expect a more substantial effect within subgroups and a weaker or even no effect between subgroups, although in the same community. For example, people of the same sex are more likely to be friends. Talks between girls and boys are normally less than between girls and girls, boys and boys. To test whether people in the same village make the same choices because they face the same environment or because other people influenced their decisions, we follow the idea developed by [Duflo and Saez \(2002\)](#). We estimate the within and between sub-groups effects using Equation 3.9:

$$p_{ict}^k = \frac{\exp(\beta_0 + \alpha_1^k E(y|k) + \alpha_2^k E(y|\bar{k}) + \beta_1 x^k + \beta_2 z^k + u^k)}{1 + \exp(\beta_0 + \alpha_1^k E(y|k) + \alpha_2^k E(y|\bar{k}) + \beta_1 x^k + \beta_2 z^k + u^k)}, \quad (3.9)$$

where  $k$  is the sub-group within a community.  $E(y|k)$  denotes the within sub-groups effects and  $E(y|\bar{k})$  denotes the between sub-groups effects. We divide the villagers into two groups by age, gender, marital status, and educational level, respectively. Therefore,  $k = 0$  or  $1$ .  $\bar{k}$  is the complement of  $k$ .

The results based on the conditional logistic model are exhibited in Table 3.4. In

the first two columns, you'll see the results for the full sample. Individuals in group 1 have their results displayed in the middle two columns, while those in group 2 have their results displayed in the last two columns. Each panel's first row indicates the within sub-groups effects, while the second row depicts the between sub-groups effects. The simple average results are reported in columns (1), (3), and (5), whereas the two-step results are reported in columns (2), (4), and (6). Results based on the linear model are exhibited in Table B.4.

The impact of average enrollment is split by age 60 in panel A. Under both specifications, the participation of young residents is considerably influenced by the average participation of other young residents, but not by that of old inhabitants, as shown in columns (3) and (4). In a balanced relationship, the average participation of other elderly residents has a considerable impact on the participation of old inhabitants, but not on the participation of young people, as shown in columns (5) and (6).<sup>30</sup>

In Table 3.4, panel B, we repeat the exercise by dividing the sample by gender. We detect within-group effects only. Female residents' participation is considerably influenced by the female average, but not by the male average. Male residents' participation is considerably influenced by the male average, but not by the female average. Table 3.4's panel C divides the sample by marital status. Column (4) shows that the average of married and unmarried people has a considerable impact on married residents' participation. The participation of unmarried inhabitants is considerably affected by the unmarried average, but not by the married average,

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<sup>30</sup>We expect to find some cross-group peer effects. However, cross-group coefficients are very small and insignificant.

as seen in column (6). In Table 3.4, panel D, we divide the sample by whether or not they attended high school. Table 3.4, column (4) shows that the involvement of less educated residents is considerably influenced by the average of less educated people, but adversely affected by the average of more educated residents.<sup>31</sup> More educated residents' participation is favourably influenced by more educated peers, while participation of less educated residents is negatively influenced by less educated peers, as seen in column (6) of Table 3.4, although not significant.

### 3.6.2.2 Alternative Peers

We expect the social learning effect to come from the interaction among people rather than the same environment. To verify it, we define peers in different ways. In the main results, peers are defined as people in the same village. Now we have another two groups of peers: people in the same county but not in the same village, and people in the same province but not in the same county.<sup>32</sup> We have shown that the social effect exist within subgroups in Section 3.6.2. We present the results in Table 3.5. Column (1) is our baseline result. In column (2), we regress the

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<sup>31</sup>It could be explained that people's perspectives are divided by education (Campbell, 2006). Only a small portion of residents finish high school education and above in rural China. In our sample, there are 1,551 (5.46%) respondents finished high school education and above while 26,877 (94.54%) did not. The more educated, the more off-farm income, as well as the higher probability of being responsible for the grassroots self-government (Wang et al., 2018). Less educated people might doubt their motivations.

<sup>32</sup>For example, Suzhou in Jiangsu province is a county. It has five communities: Gusu district, Huqiu district, Wuzhong district, Xiangcheng district, and Wujiang district. For an individual from a community in Suzhou, Jiangsu, the first peer group is other people in the same community. As the community information is not made public, we only know the group of individuals from the same community. But we do not know which specific one it is. The second peer group is people from different communities in Suzhou, Jiangsu. The third peer group is people from other counties in Jiangsu.

individual's enrollment decision on peers in other communities of the same county. The result is significant at the significance level of 5%. In column (3), we regress the individual's enrollment decision on peers in other counties of the province. The result is insignificant. In column (4), we regress the individual's decision on all peers. Only the peers in the same community have a significant impact on an individual's enrollment decision. It provides evidence that the effect only occurs among people who are normally interacted with rather than the correlated effect.

### 3.6.2.3 Mechanisms

The theory of social learning explains that the peer effects capture information sharing. That is, the effect should be larger for individuals who receive relatively less information. The strength of social learning effects may be reduced by modern communication technologies such as the Internet and mobile phones. To address how technologies provide alternative channels for information sharing, we take into account interactions between peer enrollment and Internet density and between peer enrollment and mobile per capita in the specification, respectively. In column (1) of Table 3.6, the negative significant interaction term suggests the peer effect is weaker when they have more access to the Internet. In column (2), we also find a negative significant interaction term, implying that such social learning effect is weaker when cell phones become more popular.

Having more children could also be considered an alternative channel for information sharing. First, children are exposed to more information. For example, old

rural people are usually less-educated, even illiterate. Although they have access to newspapers or the Internet, they may not be able to read them. Another problem for rural residents in China is the dialect, limiting who they can talk to. It has been shown that over 400 million Chinese cannot speak Mandarin, the standard Chinese (Lai, 2009). Therefore, children provide a channel for parents to get new information. Second, children can help parents make decisions. Parents are more relying on children when they get old. Children can help them confirm the decision to join NRPS when they are unsure. It is highly likely that peer effects also occur among children. We see a negative interaction term in column (3) of Table 3.6. This part can also be treated as a piece of evidence for information dissemination, one of the mechanisms underlying the peer effects.

As we discussed in Section 3.3, at the early stage of rolling out, adult children of the qualified elderly are required to enroll and contribute to the program so that their parents are eligible to receive the money. Therefore, we can also explain such heterogeneous effects as the younger generation refuses to join the pension plan as they think they are paying for their parents. However, CHARLS data only include people age 45 and above and their spouses. We do not have children's enrollment decisions.

## 3.7 Robustness Checks

### 3.7.1 Alternative estimates in the first stage

We use a third-order spline for each income variable in the main specification to estimate the choice probabilities. Other nonparametric regression methods could also be used to estimate the first step. We report the results in Table B.5. Column (1) copies the main results using third-order splines in the first stage as a comparison. In columns (2), we change the knots selection method. We use an even partition rule instead of using the quantile rule. Next, besides the age and income variables, we also add splines of other individual characteristics, e.g., years of education, number of children, number of coresidence, and number of chronic diseases in the first stage. Results are shown in columns (3). Column (4) presents the results when we use a smoothing spline in the first stage. The detailed introduction of the methods is in Appendix B.1. We find that the second stage estimates of the social learning effects are similar. Therefore, our model is robust to alternative nonparametric or semiparametric first-stage estimates.

### 3.7.2 Exclusion restriction

As explained in Section 3.5, the validity of our exclusion condition that co-villagers' age and income have no direct impact on one's NRPS membership decision is dependent on the soundness of our exclusion condition. We evaluate the validity of the

exclusion conditions in multiple ways.<sup>33</sup> First, peers' income could be an indicator of the economic development in the area, which is a determinant of the local coverage rate. Thus, peers' income might be correlated with an individual's enrollment decision. We examine if the estimate is affected by including average income. Similarly, peers' ages may be tied to the community's age structure, which influences an individual's likelihood of enrolling in NRPS. We also see if the estimate is affected by include the natural growth rate, which is a proxy for the county's age structure. All of the specifications include the natural growth rate and GDP per capita at the county level, as collected from the County Social and Economic Statistical Yearbook. Table B.3, first two columns show that the estimated coefficients on these variables in the main specifications. Column (3) presents the results which exclude the county-level natural growth rate and GDP per capita. The results are similar to that in column (2). Therefore, it provides evidence that peers' age and income pass the exclusion restriction.<sup>34</sup>

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<sup>33</sup>Such an exclusion condition can be explained as an individual's utility does not depend on the peers' demographic information we use in the first step. These peers' demographic information are not included in the second step.

<sup>34</sup>Following the method in Yakovlev (2018), we also test the exogeneity of those peers' demographic information by employing the a linear-in-means specification using the peers' demographic information use instrumental variables. The linear-in-means specification is as follows:  $a_i = \beta_0 + \alpha(\frac{1}{N_{C_i}-1} \sum_{j \in C_i} \mathbf{1}(a_j = 1)) + \beta_1 x_{ict} + \beta_2 z_{ct} + v_i + u_t + \varepsilon_{ict}$ .  $\frac{1}{N_{C_i}-1} \sum_{j \in C_i} \mathbf{1}(a_j = 1)$  is instrumented by peers age and income variables. We could test the exogeneity of instruments using J-test. The null hypothesis is all instruments are exogenous. The J-test's p-value is 0.20.

### 3.8 Conclusion

It is critical for policymakers to comprehend the factors that influence welfare program participation. In economics, social interactions demonstrate individual interdependence when one person's activities influence the choices of another. A voluntary pension program for China's rural elderly was established in 2009. The initiative was widely publicized and swiftly extended. In 2012, the NRPS achieved full coverage at the county level. However, until today, individual participation rates have been well below full coverage. The size of social interaction effects in NRPS pension enrollment decisions is empirically investigated in this research. Endogenous social interaction effects imply that a policy intervention that has a direct impact on an individual's enrollment decision will also have an indirect impact on the enrollment decisions of the individual's friends and contacts, potentially spreading across the social network. The social multiplier effects are an important component in cost-effective studies of pension program promotion measures for policymakers. We define community as the reference group. To address the endogeneity, we use a two-step model proposed by [Bajari et al. \(2010\)](#). First, we estimate the individual's probability of participating in the pension program. Second, given the knowledge of equilibrium choice probabilities, we estimate the reduced-form equation that an individual's utility is a linear function of the actions of other players and his/her individual characteristics. Peers' individual characteristics are used as exclusion restrictions. Our results of social learning effects are comparable with previous literature on different welfare programs ([Liu et al., 2014](#)), and the same welfare program but different methods

and datasets ([Zhao and Qu, 2021](#)).

The choices of other persons are significant predictors in the model characterizing a given individual's choice in a discrete-choice model with endogenous interpersonal contacts. We find a positive social learning effect. Specifically, 1 percentage point increase in peers' enrollment causes a 0.541 percentage point increase in the probability of enrollment. From the view of information dissemination, we prove it by showing that the peer effects within the sub-groups are stronger than those between the sub-groups. Additionally, if we define peer groups in a broader way, the peer effects become smaller and insignificant. We also test the robustness of the results.

## Tables

Table 3.1: Summary statistics

	Full sample	Wave 2013	Wave 2015	Wave 2018
Enrollment status	0.771 (0.421)	0.716 (0.451)	0.736 (0.441)	0.860 (0.347)
<b>Individual characteristics</b>				
Age	61.315 (9.733)	59.001 (9.518)	60.973 (9.517)	63.972 (9.516)
Female	0.555 (0.497)			
Married	0.861 (0.346)	0.884 (0.320)	0.867 (0.340)	0.832 (0.374)
Han	0.917 (0.275)			
Education: no high school	0.945 (0.227)			
Education: no college	0.054 (0.225)			
Education: college	0.001 (0.031)			
Chronic disease	0.655 (0.475)	0.704 (0.456)	0.805 (0.396)	0.456 (0.498)
Number of children	2.678 (1.480)	2.294 (1.495)	2.842 (1.435)	2.897 (1.433)
Number of coresidence	1.721 (1.982)	3.604 (1.878)	0.566 (0.807)	0.994 (1.485)
Earnings	2,911.74 (9,360.73)	3,319.55 (9,816.50)	2,301.04 (7,629.05)	3,114.63 (10,379.86)
Transfer income	3,592.81 (9,264.20)	2,797.62 (8,233.41)	5,245.19 (10,040.27)	2,735.63 (9,208.71)
Land value	2,069.76 (24,384.90)	1,869.74 (32,121.55)	2,044.75 (12,375.48)	2,294.80 (24,473.61)
<b>County characteristics</b>				
GDP per capita	47,252.75 (36,985.52)	40,742.73 (31,285.58)	45,779.96 (34,852.50)	55,235.57 (42,453.57)

Population density	460.95 (286.32)	456.48 (282.41)	461.25 (286.06)	465.13 (290.39)
Natural increase rate	5.914 (6.129)	7.005 (5.069)	7.515 (5.585)	3.222 (6.694)
Social worker density	56.382 (22.888)	51.634 (20.271)	56.910 (23.343)	60.603 (23.984)
Community worker density	14.786 (62.824)	22.144 (91.327)	14.808 (51.680)	7.407 (26.859)
Physician density	21.262 (9.452)	19.244 (8.413)	20.655 (9.687)	23.888 (9.595)
Hospital bed density	43.170 (14.461)	40.269 (13.185)	45.356 (14.404)	43.884 (15.244)
Access to Internet	0.198 (0.144)	0.1404 (0.113)	0.172 (0.132)	0.283 (0.145)
Mobile per capita	0.940 (0.469)	0.894 (0.471)	0.908 (0.456)	1.033 (0.467)
Average salary	56,549.66 (16,013.52)	44,024.03 (8,143.18)	53,811.34 (12,146.80)	71,813.60 (12,572.86)

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Note: Standard deviations are reported in brackets.

Table 3.2: Conditional logistic estimates of peer effects in decision of NRPS

	No peer effects (1)	Simple average (2)	Two-step (3)
Peers' enrollment		4.889*** (0.178)	3.062*** (1.005)
Age	0.314 (0.359)	0.190 (0.403)	0.308 (0.359)
Age <sup>2</sup>	-0.005*** (0.000)	-0.005*** (0.001)	-0.005*** (0.000)
Married	-0.079 (0.139)	-0.116 (0.148)	-0.074 (0.139)
Chronic disease	0.009 (0.060)	0.009 (0.065)	0.006 (0.060)
Number of children	0.071*** (0.023)	0.073*** (0.026)	0.069*** (0.023)
Number of coresidence	-0.004 (0.017)	-0.013 (0.018)	-0.003 (0.017)
log(Earnings)	0.016** (0.008)	0.017** (0.009)	0.015* (0.008)
log(Transfer income)	0.019*** (0.007)	0.019*** (0.007)	0.017*** (0.007)
log(Land value)	0.027*** (0.007)	0.022*** (0.007)	0.021*** (0.007)
Year 2015	0.641 (0.702)	0.647 (0.787)	0.513 (0.704)
Year 2018	2.833 (1.769)	2.431 (1.982)	1.357 (1.836)
Observations	11,772	11,772	11,772
County characteristics	✓	✓	✓
Individual FE	✓	✓	✓

Note: County characteristics include GDP per capita, population density, natural increase rate, social worker density, community worker density, physician density, hospital bed density, access to Internet, mobile per capita, and average salary in the county. Standard errors are reported in brackets. Standard errors are calculated using a bootstrap procedure.

\* 10%, \*\* 5%, \*\*\* 1%.

Table 3.3: Nonlinear peer effects

	Quadratic polynomial (1)	Piecewise (2)
Peers' enrollment	2.607** (1.061)	
Peers' enrollment <sup>2</sup>	0.080 (0.060)	
Peers' enrollment: below 0.65		4.526** (1.811)
Peers' enrollment: 0.65 - 0.9		3.273** (1.651)
Peers' enrollment: above 0.9		0.887 (8.868)
Observations	11,772	11,772
Individual characteristics	✓	✓
County characteristics	✓	✓
Individual FE	✓	✓
Year FE	✓	✓

Note: Individual characteristics include age, marital status, chronic disease, number of children, number of coresidence, earnings, transfer income, and land value. County characteristics include GDP per capita, population density, natural increase rate, social worker density, community worker density, physician density, hospital bed density, access to Internet, mobile per capita, and average salary in the county. Standard errors are calculated using a bootstrap procedure in brackets.

\* 10%, \*\* 5%, \*\*\* 1%.

Table 3.4: Conditional logistic estimates of peer effects among sub-group

	Full sample		Group 1		Group 2	
	SA (1)	Two-step (2)	SA (3)	Two-step (4)	SA (5)	Two-step (6)
<i>(A) Group 1: young (below 60) and Group 2: old (60 and above)</i>						
Average enrollment in own-group	7.066*** (0.210)	4.290*** (0.750)	7.990*** (0.416)	4.873*** (1.359)	6.927*** (0.273)	4.884*** (1.168)
Average enrollment in cross-group	0.253 (0.159)	0.229 (0.519)	0.045 (0.258)	-0.219 (1.382)	0.053 (0.239)	0.468 (0.697)
<i>(B) Group 1: female and Group 2: male</i>						
Average enrollment in own-group	7.351*** (0.254)	3.671*** (0.917)	7.361*** (0.343)	4.739*** (1.297)	7.416*** (0.393)	2.608*** (1.343)
Average enrollment in cross-group	-0.045 (0.219)	-0.952 (0.876)	-0.073 (0.294)	-1.494 (1.121)	-0.026 (0.340)	-0.457 (1.466)
<i>(C) Group 1: married and Group 2: unmarried</i>						
Average enrollment in own-group	7.170*** (0.221)	3.698*** (0.767)	7.255*** (0.255)	5.491*** (1.230)	8.341*** (0.642)	2.943** (1.266)
Average enrollment in cross-group	0.169 (0.108)	2.614*** (0.331)	0.132 (0.112)	3.188*** (0.374)	-0.441 (0.644)	-0.895 (1.374)
<i>(D) Group 1: under high school and Group 2: high school and above</i>						
Average enrollment in own-group	7.317*** (0.276)	3.106*** (0.917)	7.100*** (0.282)	4.369*** (1.069)	2.570*** (0.880)	0.576 (0.895)
Average enrollment in cross-group	-0.058 (0.114)	-1.154*** (0.390)	-0.044 (0.114)	-1.291*** (0.396)	-0.380 (0.442)	-1.426 (1.080)

Note: Standard errors are calculated using a bootstrap procedure in brackets.

\* 10%, \*\* 5%, \*\*\* 1%.

Table 3.5: Alternative peers

	(1)	(2)	(3)	(4)
Peers in the same community	3.062*** (1.005)			2.204** (1.121)
Peers in other community of the county		2.096** (0.918)		1.528 (0.996)
Peers in other counties of the province			1.458 (1.763)	1.132 (1.791)
Age	0.308 (0.359)	0.190 (0.363)	0.205 (0.372)	0.075 (0.375)
Age <sup>2</sup>	-0.005*** (0.000)	-0.005*** (0.000)	-0.005*** (0.001)	-0.005*** (0.001)
Married	-0.074 (0.139)	-0.052 (0.140)	-0.069 (0.144)	-0.037 (0.145)
Chronic disease	0.006 (0.060)	-0.012 (0.061)	0.011 (0.063)	-0.006 (0.063)
Number of children	0.069*** (0.023)	0.074*** (0.024)	0.067*** (0.024)	0.069*** (0.025)
Number of coresidence	-0.003 (0.017)	-0.011 (0.017)	-0.003 (0.017)	-0.008 (0.017)
log(Earnings)	0.015* (0.008)	0.015* (0.008)	0.017** (0.008)	0.015* (0.008)
log(Transfer income)	0.017*** (0.007)	0.017** (0.007)	0.021*** (0.007)	0.019*** (0.007)
log(Land value)	0.021*** (0.007)	0.025*** (0.007)	0.028*** (0.007)	0.021*** (0.008)
Observations	11,772	11,544	10,962	10,962
Individual characteristics	✓	✓	✓	✓
County characteristics	✓	✓	✓	✓
Individual FE	✓	✓	✓	✓
Year FE	✓	✓	✓	✓

Note: Standard errors are calculated using a bootstrap procedure in brackets.

\* 10%, \*\* 5%, \*\*\* 1%.

Table 3.6: Peer effects by information dissemination

	(1)	(2)	(3)
Peers' enrollment	3.227*** (1.008)	2.903*** (1.015)	3.076 (1.008)
Peers' enrollment × access to Internet	-0.000** (0.000)		
Peers' enrollment × mobile per capita		-0.708** (0.297)	
Peers' enrollment × number of children			-0.005* (0.003)
Access to Internet	0.000* (0.000)		
Mobile per capita		0.055 (0.320)	
Number of children			0.083 (0.084)
Observations	11,772	11,772	11,772
Individual characteristics	✓	✓	✓
Other county characteristics	✓	✓	✓
Individual FE	✓	✓	✓
Year FE	✓	✓	✓

Note: Standard errors are calculated using a bootstrap procedure in brackets.  
 \* 10%, \*\* 5%, \*\*\* 1%.

# Figures

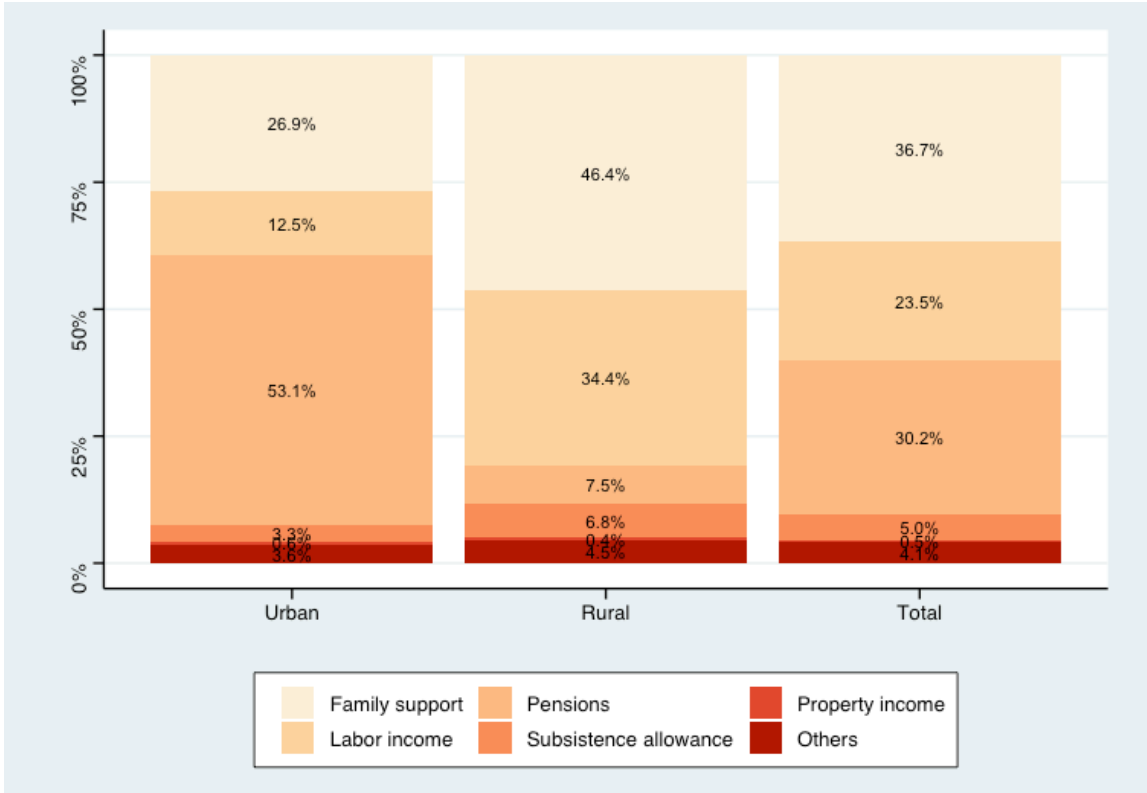


Figure 3.1: Primary source of support for the elderly

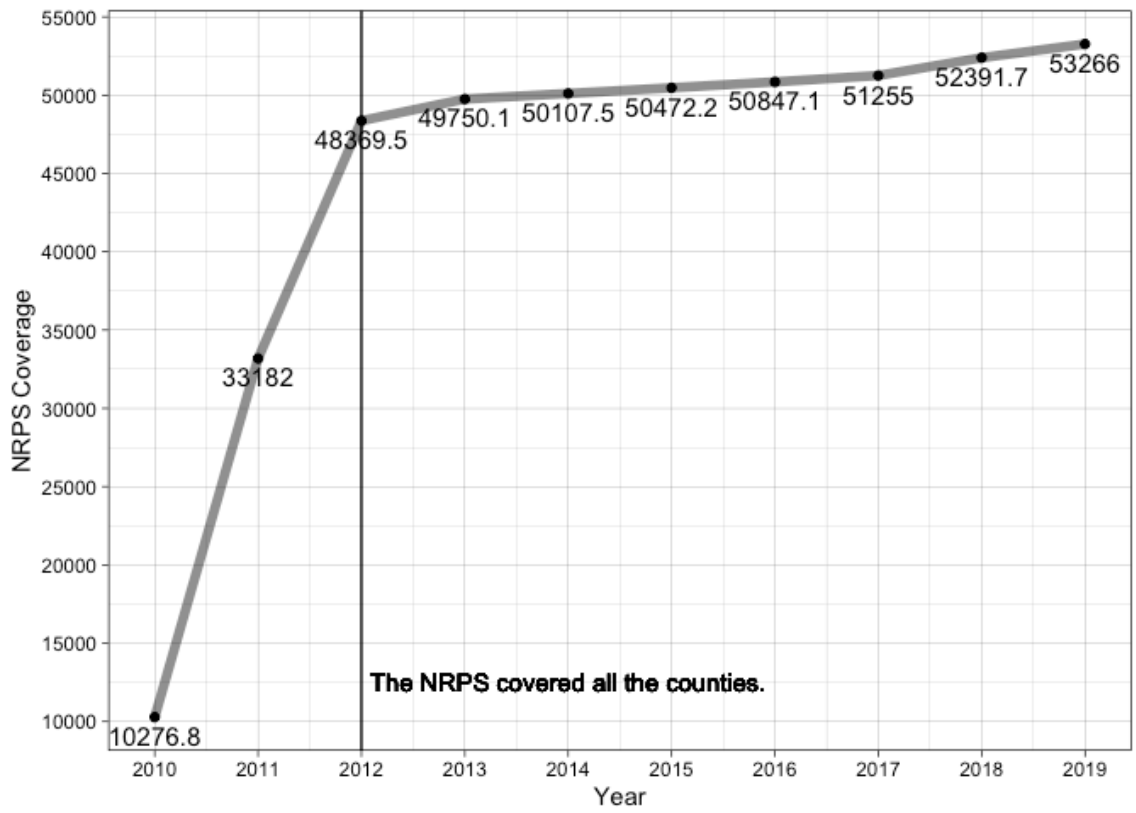


Figure 3.2: NRPS coverage by year (in 10,000)

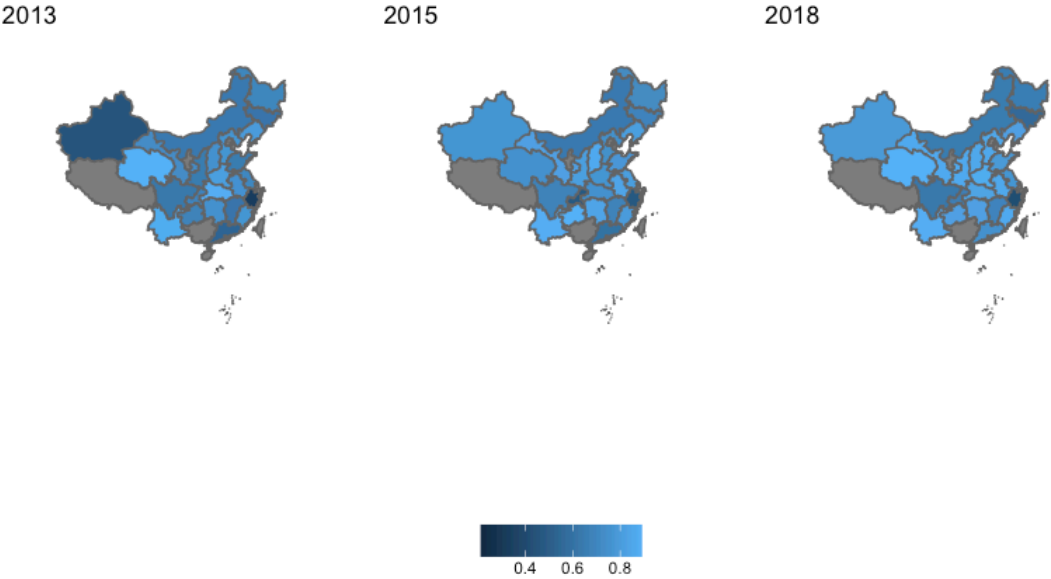


Figure 3.3: NRPS coverage by province

# Chapter 4

## Friendship and Mental Health

### 4.1 Introduction

It has been widely recognized among sociologists and economists that social capital has a great impact on economic outcomes. The term “social capital” was first introduced by [Bourdieu \(1977\)](#) and empirically developed by [Coleman \(1988\)](#). Social capital is defined differently by economists. In microeconomic studies, the definition of social capital is still under debate. Some think of social capital as a or a set of community-level characteristics ([Lindström, 2004](#)). Some define social capital as networks ([Bolin et al., 2003](#)). Researchers have witnessed the importance of friends. According to [Suanet and Antonucci \(2017\)](#), the importance of friends grows as the number of children in a family decreases and traditional communities such as churches deteriorate. [Furman and Rose \(2015\)](#) conclude that negative friendship contacts have an adverse influence on parent-child interactions, and this tendency grows stronger with age.

In this paper, we explore how social capital in the school network affects students’ mental health in two cohorts: the 7th and 9th graders. We have evidence from Chap-

ter 2 that they are influenced by friends differently in terms of age and the stage of friendship. First, the 7th grader is younger. [Birkeland et al. \(2014\)](#) state that as a teenager grows older, the role of friends becomes more important. Friendship gives adolescents a sense of belongings when they build up their identities. Adolescents begin to forge their bond of safety and trust with people outside of their families through making friends. Such a bond is more critical for older teenagers. Second, in the context of the One-child policy,<sup>1</sup> Chinese teenagers lack the opportunity to closely get along with the opposite sex of the same age. Middle students are going through physical and hormonal changes. Younger students are more likely to seek out a group of people of the same age and gender as friends. As they grow older, they gradually learn to interact with the opposite sex. The following explanations are unique in China. One the top of different ages, the 7th graders are less familiar with their schoolmates, even classmates, than the 9th graders. Typically, students graduate from elementary schools in China after finishing the 6th grade and entering middle school. Although public elementary schools and middle schools are enrolled based on *hukou* registration, students have the freedom to choose schools in a certain school district.<sup>2</sup> Additionally, the size of middle schools is larger than elementary schools in most cases. Even a student enters a middle school with some elementary school classmates; it only accounts for a small proportion of the middle school classmates. In this case, the friends of the 7th-grade students are likely to be just casual acquaintances given the limited time to have deep conversation. Figure 4.1 shows

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<sup>1</sup>Students in the data were born from 1996 to 2002 when the One-child policy was being implemented.

<sup>2</sup>To ensure the educational equality, most developed areas use a lottery system to determine the enrollment.

that the 7th grader tends to propose more friends. Still, the 9th grader has a more balanced friendship network implying these two cohorts stand for different stages of accumulating social capital.

Similar to Chapter 2, our IV estimates correct the bias in the OLS estimates. We find that popularity in the peer group with the same gender benefits students mental health measures across all five items. The magnitude is larger for the 7th graders. On the other hand, popularity in the peer group with the opposite gender has no impact on the 7th graders, but a negative impact on the 9th graders. To be consistent with other gender peer effects literature (Lavy and Sand, 2019; Gong et al., 2019), we include the female share in a class in all specifications. The girls' proportion either benefits students' mental health status or has no impact. Therefore, we conclude that friendship has a unique effect on top of classmates' gender composition.

The chapter is structured as follows: in Section 4.2, past economic studies on the impact of the number of friends are presented. Section 4.3 talks about the data and the empirical method. The empirical results of the paper are presented in Section 4.4. To evaluate the quality of our results, we use alternative specifications and alternative outcomes in Section 4.5. We also examine the heterogeneity of peer effects by gender and family relationship in Section 4.6. Section 4.7 concludes the paper.

## 4.2 Literature Review

Peers play an important part in the socialization process during adolescence, which is linked to social capital in a variety of social interaction theories (Glaeser et al., 2002; Becker and Murphy, 2009). While an understanding of the relationship between peers' outcomes and characteristics and an individual's outcome is widely explored, Haynie (2001) proposed the characteristics of adolescents' friendship networks, such as its density and adolescents' centrality and popularity, condition the delinquency-peer association, also play a role. Calvó-Armengol et al. (2009) also study the position in a network. They find that more connection a student has leads to better academic performance. Fryer Jr and Levitt (2010) focus on race differences. For white students, it is true that the most popular students have higher academic performance. But it is not true for minorities. For Hispanic, the best student in grades is the least popular student. For a black student, the average student in grades is the most popular student. Conti et al. (2013) study the labor market returns to early accumulation of social capital. They conclude that a 10 percent higher wage comes from greater number of friendship nominations from schoolmates from the 20th percentile to the 80th percentile. Lavy and Sand (2019) study the impact of the number of different types of friends on multiple non-cognitive behavioral outcomes. The identification uses a class random assignment within a school, together with a school fixed effect. In the classroom, having more reciprocal friends minimizes personal involvement in school violence and enhances school enjoyment, whereas having more followers improves social satisfaction in class. The inclusion of rejecters and a second circle of

reciprocal friends, on the other hand, has no effect. Friendships of any kind have no bearing on the amount of time spent on assignments. [Orr \(2021\)](#) also investigates the impact of a student's peers' gender composition on two separate skills. It looks at the answers to eight items in the Add Health data that evaluate self-worth and a sense of belonging. Increases in the percentage of female peers had little effect on female students' feelings of belonging or self-worth, whereas male students do.

There is a growing body of research on the impact of social capital on health outcomes. [Pescosolido's](#) studies of Network-Episode Model (NEM) can be traced back to [1991](#) and keep developing in the following years ([1992](#), [1996](#), [2006](#)). In the first phase of the model, it proposes the relationship between social network structure<sup>3</sup> and health outcomes. The author also provides empirical evidence using the model. [Pescosolido et al. \(1998\)](#) find a positive relationship between the size of social networks and low-income people's mental health in Puerto Rico. According to [Guralnick \(2006\)](#), social isolation has a negative impact on mental health during adolescence, especially for the group who are easily overlooked in social interactions, such as children with developmental delays. [Van der Horst and Coffé \(2012\)](#) demonstrate that the number of friends, frequency of contact, and heterogeneity of friends shape subjective well-being through the benefits they bring. [Ho \(2016\)](#) develops a two-step model to identify the effect of number of friends on general health, overweight, obesity, sad, depressed, and smoking. A bias correction method is used to deal with the incidental parameter bias from adding individual fixed effects. The number of friends has a positive relationship with physical and mental health; nevertheless, the

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<sup>3</sup>Social network structure includes density, size, and strength of tie.

number of friends has a negative relationship with smoking frequency. Using the same data as our paper, [Gong et al. \(2021\)](#) explore how the proportion of female students in class influences students' mental status and social acclimation in school using a subset of sample whose class assignment with a school is random. It appears that having more female classmates has little effect on adolescents' mental stress levels. However, there is a positive effect of having more females on students' social acclimation. [Xiong \(2021\)](#) uses a categorical measure of peer relationship and finds that students have worse relationships with classmates have worse mental health.

Friendship are also related to negative consequences. [Schaefer et al. \(2012\)](#) discover that after controlling for other friend selection procedures, smokers were more likely to be named as friends than those who never smoke, indicating that smoking increased the level of popularity. Adolescents were more prone to choose friends who smoked at the same level as they did. [Huang et al. \(2014\)](#) find similar patterns. Students who consumed more alcohol were more likely to send and receive friendship nominations, as well as make friends with other alcoholics.

### 4.3 Data and Empirical Strategy

The data and identification method we use in this chapter is the China Education Panel Survey (CEPS). This survey is conducted by the National Survey Research Center (NSRC) at Renmin University of China. It aims to provide the first large-scale nationwide survey on tracking Chinese middle school students to find out how family, school, and community affect the academic outcomes. In the baseline survey,

it collected information of 7th and 9th graders in the 2013-2014 academic year. In the 2014-2015 academic year, the follow-up covers the 7th graders. in the 2013-2014 academic year. We have already concluded that popularity plays different roles for students in different grades when exploring the heterogeneous effects by grade level. Therefore, we study the two cohorts separately. We also provide the results for the full sample.

A larger number of friends indicates that the person has a broader social network. Therefore, we use the number of same-gender friends and the number of opposite-gender friends as proxies for the popularity among the same gender and the opposite gender, respectively. Students were asked to report their best friends' names during the interview. However, such information was lost in the data collection phase. We fail to construct the social network as those papers using Add Health. (Ho, 2016). Thus we have no information about if students were reciprocally nominated as friends by friends. Although we are not able to identify a reciprocal friendship, a unilateral relationship, e.g., a student may nominate another student that she would ideally like to be friends with, even if the other student does not reciprocate this, is still meaningful for an individual (Gifford-Smith and Brownell, 2003). Table 4.2 summarizes how many friends a student has for the two cohorts. We find that students in Grade 7 have more same-gender friends but fewer opposite-gender friends than students in Grade 9. In Figure 4.1, we find that the smaller number of same-gender friends of students in Grade 9 comes from fewer nominations for the 5th friend. CEPS not only provides information related to students' academic performance, it also collects a variety of information on physical and mental health indicators. We

restrict friends in the same school in our study using students' answer to the question if each friend attended the same school as him/her.<sup>4</sup> If a friend's gender information is missing, we exclude him/her from our sample. On average, a 7th-grade student has 3.418 same-gender friends and 0.195 opposite-gender friends. A 9th-grade student has 3.148 same-gender friends and 0.317 opposite-gender friends.

The empirical model is derived from a health production function that describes the relationship between inputs and health output. In a cross-sectional setting, it can be written as follows:

$$\text{Health}_{ics} = \beta_0 + \beta_1 \text{FSS}_{ics} + \beta_2 \text{FOS}_{ics} + X'_{ics} \beta_3 + C'_{cs} \beta_4 + S'_s \beta_5 + \gamma_{\text{county}} + v_{ics}, \quad (4.1)$$

where  $\text{Health}_{ics}$  denotes the health outcomes of student  $i$  in class  $c$  and school  $s$ . They are measures of mental health status in the main results. The variables of interest are the number of same gender school friends  $\text{FSS}_{ics}$  and the number of opposite gender school friends  $\text{FOS}_{ics}$ , where  $\beta_1$  and  $\beta_2$  capture the associated effects.

The outcomes are based on the questionnaire items shown in Table 4.1. The measures are the frequency of feeling blue, depressed, unhappy, not enjoy life, and sad in the past 7 days. Answers are based on a five-point scale where 1 for never, 2 for seldom, 3 for sometimes, and 4 for often, and 5 for always. The lower the number, the better the psychological health. For easy interpretation, these indices are standardized with mean 0 and standard deviation 1. We also use the categorical outcomes in Section 4.5 for a robustness check.

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<sup>4</sup>Add Health identifies school friends by looking at if the friend's name is in the school roster.

The covariates are denoted by  $X'$ ,  $C'$ , and  $S'$ . The individual and family characteristics in the model  $X'$  include gender, local *hukou*, agricultural *hukou*, *Han*, the only child, standardized cognitive test, family socioeconomic status, and mother's and father's years of schooling. Three dichotomous variables related to the family environment are also included: an indicator for "whether a student has at least one alcoholic parent", an indicator for "whether a student's parents usually fight at home", an indicator for "whether a student's parents have a healthy relationship". Additionally, we include categorical variables that measuring the relationships with mother and father as covariates. They each have three levels: "not close", "moderate", and "very close". The summary statistics are shown in Table 4.4. There is no significant difference for most variables. We note that more 7th-grade students feel very close (75.9% with mother and 65.5% with father) to parents than 9th-grade students (69.6% with mother and 58.0% with father).

Class-level characteristics  $C'$  used in this paper include class size, the proportion of female peers in a class, the proportion of immigrants peers in a class, and the class rankings. We emphasize here that we include the proportion of female peers in a class in all the specifications. It allows us to study the size of social networks on the top of class gender composition that previous literature mainly works on when speaking of peer gender effects. In terms of school level characteristics  $S'$ , besides school type and school rankings, we also include if this school is a boarding school and the frequency of bad behavior at school.

Standard OLS estimates require  $E(FSS_{ics}\varepsilon_{ics}) = 0$  and  $E(FOS_{ics}\varepsilon_{ics}) = 0$  to yield unbiased results. These assumptions could be violated from the following aspects: First,

non-random formation of friendship. Making friends with whom is a personal decision based on personal preferences that are unobservable. For example, there may be unobserved determinants, e.g., quality-oriented education versus exam-oriented education, of non-cognitive outcomes that are correlated with the number of friends. Such unobservable effect might be correlated with both health outcomes and social capital. Second, an individual's friends is self-reported, which may result in measures becoming systematically skewed. Third, the possibility of reverse causality also bias the estimates. Individual in poor health may become more socially isolated. Therefore, we use the same set of instrumental variables in Chapter 2 to estimate the casual impact.

The first stage is estimated using the following equations:

$$\text{FSS}_{ics} = \xi_0 + \xi_1 Z_{ics} + X'_{ics} \xi_3 + C'_{cs} \xi_4 + S'_s \xi_5 + \xi_{\text{county}} + e_{ics}, \quad (4.2)$$

$$\text{FOS}_{ics} = \phi_0 + \phi_1 Z_{ics} + X'_{ics} \phi_3 + C'_{cs} \phi_4 + S'_s \phi_5 + \phi_{\text{county}} + \nu_{ics}, \quad (4.3)$$

where  $Z_{ics}$  denoting a vector of instruments for the numbers of friends in the school network for student  $i$  in class  $c$ , school  $s$ , including parents' strictness with friends making, the share of opposite gender schoolmates, the school-level average number of same-gender friends, and the school-level average number of opposite-gender friends. We will discuss the validity of the instrumental variables later.

The predicted FSS and FOS are then inserted into regression equation (4.1) to carry out a 2SLS estimation to identify how social capital affects students' health outcomes.

Therefore, Equation (4.1) is modified with FSS and FOS instrumented and robust standard errors clustered at the class level. It follows that:

$$\text{Health}_{ics} = \alpha_0 + \beta_1 \widehat{\text{FOS}}_{ics} + \beta_2 \widehat{\text{FFS}}_{ics} + X'_{ics} \beta_3 + C'_{cs} \beta_4 + S'_s \beta_5 + \gamma_{\text{county}} + v_{ics}. \quad (4.4)$$

To identify the validity, we need to show that these instruments are correlated with popularity among different genders but unlikely to be associated with the unobserved common shocks.

First, we point out that stricter parents tend to have a lower level of social capital, especially the number of opposite-gender friends. The interpretation is that when parents are strict with the child making friends with whom, parents will intervene in the procedure by setting constraints on friends' characteristics. For example, it is common in China for parents to limit their child's activities with the opposite gender to avoid developing romantic relationships too early.

We also employ the average level of social capital, same-gender friends, and opposite-gender friends as instrumental variables within the school. The idea is that the more schoolmates who make friends with each other, the more probable an individual is to make friends with schoolmates. In the same way, all adolescents in a given school have similar social interactions. Regardless of personal opinions and thoughts, an individual's choices and those of the school they attend must be linked. Our social capital measures the number of friends and distinguishes by gender. Therefore, we also incorporate the share of opposite-gender schoolmates as an instrumental variable. The possibility of making friends with an opposite-gender schoolmate de-

depends on the supply of such schoolmates. It is impossible to have an opposite-gender schoolmate if an individual attends a single-sex school.<sup>5</sup>

A number of tests were carried out in order to confirm the instruments' validity. A  $F$ -test is used to determine the overall significance of the instruments in the first-stage regression, as shown at the bottom of Table C.2. These values are large enough to suggest that the instruments are related to the endogenous variables. We should note that the estimates are slightly different from those in Chapter 2 as the covariates in the two models are different to some extent.

To validate the exclusion restrictions, we test if the instrumental variables have a predictive power on the outcomes after controlling for the number of friends. If the assumption holds, the instrumental variables should not have a significant relationship with the outcomes. To explain it in another way, if the parents' strictness with making friends has a substantial and significant effect on the health outcomes and it could not be mediated by the individual's social network, the exclusion restrictions are violated. Hill (2015) uses a similar IV, the gender composition of neighborhood children and shows that the composition of neighborhood children is closely related to the composition of schoolmates in United States, but parents do not choose school districts depending on the gender distribution of the local neighborhood. The idea is similar in China. Therefore, the gender of children in the school should not influence the location choice either.

We further test the validity of the instrumental variable with a placebo test: instead

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<sup>5</sup>Single-sex schools are rare in China. There is no single-sex school in our sample.

using the real gender composition in school friendship networks, we proxy gender with the birth month and create false gender information. We assume that schoolmates with an even birth month are of the opposite gender. The share of reassigned opposite-gender schoolmates, equivalent to the share of even birth month schoolmates, should not be correlated with the number of either same-gender friends or opposite-gender friends. Table C.3 reports the result from regressing the number of both types of friends on the share of even birth month schoolmates and shows that they are uncorrelated.

Another concern is the parenting style, severe or mild, depends on the child's character traits. For example, if a child is naughty by nature, the parents will be stricter in their discipline. On the other hand, whether parents are harsh or not is a question in the student questionnaire. Each student has a different definition of strictness. It is very likely that children who are more empathetic have a higher threshold for strictness than children who lack empathy. However, we believe that the richness of questions in the survey helps somehow mitigate the concern. We also conduct a falsification test by estimating the relationship between parental strictness with making friends together with the proportion of female students in school and their health consequences with county fixed effects only for students who do not have school friends. The intuition behind the test is if the assumption that the instrumental variables only influence the students' mental health through making friends is correct, then the relationship between instrumental variables and outcomes should not exist for those students. The findings in Table C.4 show that there is no significant correlation between them, as expected.

## 4.4 Results

We estimate the model by both OLS and IV strategies. As we discussed in Section 4.3, OLS estimates are biased can be interpreted as association only.

Table 4.6 reports OLS on mental health outcomes. Each column depicts the results of regressing an outcome on the numbers of different types of friends, as well as student-, class-, and school-level characteristics. In addition, each regression adjusts with county fixed effects. The top panel (Panel A) presents the results for the full sample. We find that the effects of same-gender friends are negative and significant, which provides evidence that having more same-gender friends is associated with less frequency of negative feelings. As for the effects of opposite-gender friends, the coefficients are all positive, which suggests that having more opposite-gender friends is associated with more frequency of negative feelings. Of the five outcomes, only “blue”, “depressed”, and “sad” are significant. Then we explore if the two cohorts are influenced differently. Panel B and C presents the results for 7th graders and 9th graders separately. When we partition our sample based on their grade levels into two, we find that the coefficients of same-gender friends are still negative and significant. The effect size for the 7th graders is larger than the 9th graders across all the items. However, the coefficient of opposite-gender friends on the frequency of feeling “unhappy” becomes negative, but insignificant for students in Grade 7. As all the coefficients are insignificant in Panel B, there is insufficient evidence to support the association between opposite-gender friends and negative feelings. On the contrary, the negative association still exists among students in Grade 9. We also

report the coefficients of female share in the classroom. We find that the coefficients are negative (better mental status), but only significant in “unhappy” and “sad” in the full sample and the Grade 7 cohort.<sup>6</sup>

IV estimates are shown in Table 4.7. The estimates of same-gender friends are still significantly negative in Panel A, B, and C. The magnitude of these estimates is larger compared to the OLS estimates. Specifically, on average, one more same-sex friend leads to a 0.052 standard deviation decrease in the frequency of “feeling blue”, a 0.067 standard deviation decrease in the frequency of “feeling depressed”, a 0.069 standard deviation decrease in the frequency of “feeling unhappy”, a 0.070 standard deviation decrease in the frequency of “feeling not enjoy life”, and a 0.059 standard deviation decrease in the frequency of “feeling sad”. As for the estimates opposite-gender friends using the full sample, the only significant exists in Panel A, column (2) after instrumenting. That is, one more opposite-sex friend leads to a 0.096 standard deviation increase in the frequency of feeling “depressed”.<sup>7</sup> Then we look at Panel B and C. There are three things that stand out. First, being more popular with the same gender benefits middle school students for both graders. The magnitude for the 7th grade is higher than that for the 9th grade across all the items, indicating that being popular generates more benefits for mental health when building up a friendship. According to the distinct stages of friendship we discussed in Section 4.1, students in the 7th grade may nominate people they meet frequently or have

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<sup>6</sup>Gong et al. (2019) also find insignificant effects of female classmate share on mental health using randomly assigned classrooms.

<sup>7</sup>Students have less than one opposite-gender friend on average, thus we can also interpret it as having at least one opposite-sex friend leads to a 0.096 standard deviation increase in feeling depressed.

common interests as friends. Students feel better when the network is larger, even they are not close friends, just casual friends. Second, for 7th graders, unlike in the full sample, being popular with the opposite gender does not have any significant impact on mental health. The estimate on the frequency of “feeling unhappy” in column (3) even becomes negative, although insignificant. Third, the estimates of number of opposite-gender school friends for 9th graders are significant in column (1), (2) and (3), implying that having one additional opposite-gender friend increases the frequency of “feeling blue” by 0.109 standard deviation, “feeling depressed” by 0.118 standard deviation, and “feeling unhappy” by 0.125 standard deviation. The coefficients of female share in the classroom are similar to the OLS results.

As previously stated, the impacts of social networks are investigated in addition to the classroom peer gender composition. [Getik and Meier \(2022\)](#) conclude that higher proportion of female classmates leads to a higher probability of having mental health issues. Specifically, if a class is changed from boys only to girls only, the probability of having mental health issues increases by 0.35 standard deviation among Swedish students. [Gong et al. \(2019\)](#) find insignificant influence of girls proportion on students’ mental health using CEPS data. Our results show that classroom female share is positively related to some outcomes, like “feeling unhappy” and “feeling sad”, but not correlated with other items, like “feeling blue”, “feeling depressed”, and “feeling not enjoy life”. As for the two different cohorts, the effects for the 7th graders have the same patterns as the full sample but the effects for the 9th graders are insignificant across all the items.

To partially explain why being popular with the opposite gender results in poor

mental health, we use the second wave to explore how social capital influences teenage romance. Given only the data for the cohort of the 7th graders is available in the second wave, we study the effects of friends in the 7th grade on their teenage romance-related behaviors during that year. Results are presented in Table C.5.<sup>8</sup> We find that having more same-sex friends decreases the probability of having romantic feelings, relationships, and holding hands with the opposite, but having more same-sex friends does the opposite. However, we do not find significant results in kissing and intimate physical contact.

## 4.5 Robustness Checks

### 4.5.1 IV ordered probit model

The outcomes we consider are responses from a Likert scale, therefore an ordered probit model could be considered without standardizing them. Table C.1 provides the summary information based on the five-point scale where 1 for never, 2 for seldom, 3 for sometimes, and 4 for often, and 5 for always. In the IV ordered probit model, we fit a nonlinear model instead of a linear one in the first stage.<sup>9</sup> Table

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<sup>8</sup>Original questions are: “Adolescents would have some romantic feelings for someone of opposite sex when they are growing up. Have you ever had such feelings for any of your schoolmates or friends of the opposite sex?”, “Have you ever been in a relationship?”, and “Have you ever done the following things with anyone of the opposite sex?”. Choices include “Holding hands”, “Kissing”, “Other more intimate physical contacts” and “None of the above”.

<sup>9</sup>OLS should be applied to both stages in the regular instrumental variable method. There are papers using an instrumental variables ordered probit model: [Brown et al., 2015](#); [Cullinan and Gillespie, 2016](#); [Saridakis et al., 2020](#). Other studies also use nonlinear specifications for both outcomes and endogenous variables ([Gershenson et al., 2018](#)). The `cmp` command was used to fit these models in Stata 13. This command works for models that are difficult to estimate

4.8 shows the results.<sup>10</sup> We could not interpret the coefficients as marginal effects directly. However, the signs and significance of the coefficients suggest that the two-stage estimates are robust to the specification in the first stage. The coefficients of class-level female share are also similar to the main results.

### 4.5.2 Friend gender or friend quality

Barry et al. (2009) display that adolescents with high friendship quality relationships are better at resolving conflicts in a positive manner. Therefore, we add friends' quality into the model and test if the effects of popularity are robust. We are also interested in if friend's quality also is also associated with our health outcomes. Friends' quality is measured by the mean academic performance of nominated friends. Students chose from "None of them", "One or two of them", or "Most of them" for how many nominated friends do well in academic performance.<sup>11</sup> This measure is useful as peer effects might be different for low, middle, or high ability students (Zimmerman, 2003). Table 4.9 shows that the effects of the numbers of same-gender and opposite-gender friends do not change a lot after introducing friends' quality to the model.<sup>12</sup> As for the estimates of friends quality, "One or two of them" do well

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using regular Stata commands, such as instrumental variables ordered probit models (Roodman (2011)). CMP is a limited information maximum likelihood (LIML) estimator where the first stage parameters are structural and the second stage parameters are reduced form.

<sup>10</sup>Ordered probit estimates are shown in Table C.6.

<sup>11</sup>"None of them" is assigned a value of 1. "One or two of them" is assigned a value of 2. "Most of them" is assigned a value of 3.

<sup>12</sup>We create extra instrumental variables for the interaction term, according to Wooldridge (2010). In our paper, we interact each of parents' strictness with friends making, the share of opposite gender schoolmates, the school-level average number of same-gender friends, and the school-level average number of opposite-gender friends with friends' quality to construct the extra interactions.

does not significantly change the effect comparing to the baseline “None of them”, but “Most of them” significantly improve the mental health from all aspects.

### 4.5.3 Alternative outcomes: risky behaviors

Risky behaviors, such as substance use, has been systematically associated with bad mental health (Wills et al., 2006; Belcher et al., 2014; Jones et al., 2015; Balsa et al., 2018).<sup>13</sup> Therefore, we approximate risky behaviors using the frequency of risky behaviors as a robustness check. We use the 9-grade cohort as the frequencies of risky behaviors questions “How often did you do the following things in the past year?” are only asked in the second wave conducted in the 2014-2015 academic year. There are 10 questions in total, covering “saying swearwords”, “quarreling with others”, “having a fight with others”, “bullying the weak”, “having a violent temper”, “being unable to concentrate on one thing”, “skipping classes”, “cheating in exams”, “smoking or drinking alcohol”, and “going to net bars”. The choices also use a five-point scale where 1 for never, 2 for seldom, 3 for sometimes, 4 for often, and 5 for always. Table 4.10 presents the results for saying swearwords, quarreling with others, having a violent temper, and cheating in exams. We do not find a significant influence on the rest outcomes. We find that having more same-sex friends decreases the frequency of quarreling with others and cheating in exams. Having more opposite-sex friends increases the frequency of these risky behaviors.

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<sup>13</sup>Economists have also studied the influence of social capital on individual substance use (Lundborg, 2006).

## 4.6 Heterogeneous Effects

### 4.6.1 Gender

In this subsection, we investigate whether male and female students are impacted differently by their friends. The results for the 7th grader are in Table 4.11. The effects of number of same-gender friends are still negative and significant, implying that having more same-gender friends is helpful for students' mental health. But the effects of number of opposite-gender are insignificant. We focus on the 9th graders for this purpose as its estimates of the number of opposite-gender friends are significant while those for the 7th graders are not. Table 4.12 exhibits the results for the 9th graders. The main results from Table 4.7 are replicated on the top panel for reference. Panel B shows the results for male students, while Panel C shows those for female students. We find that having one additional same-sex friend benefits both male and female students with the effects for female students being bigger. Being popular with the opposite gender, male students are more likely to be blue and unhappy, while female students are more likely to be depressed and sad. It is worth noting that the estimate of the number of opposite-gender friends not enjoying life for female students is negative, though not significant. It provides a hint that being popular with opposite-gender has effects of distinct direction according to gender. As for the female classroom share, it benefits girls' mental health in some aspects but not boys'. The coefficients of female share in the classroom are consistent with those in [Gong](#)

et al. (2019).<sup>14</sup>

### 4.6.2 Family relationship

According to Gauze et al. (1996), relationships with peers have a greater impact on adolescents from lower-functioning households, such as those with low adaptation and cohesion, than on those from higher-functioning households. It points out that when a kid's emotional needs in the family cannot be met, he or she will seek other substitutes, such as friendship, and become more reliant on them. In CEPS, students were asked to select from "not close", "moderate," and "very close." Since the percentages of students choosing "not close" are very small in both questions, we combine "not close" and "moderate." We divide students into two categories for each question. We find that the effect is larger when a child is not close to her mother in Table 4.13. Bad relationship with mother acts like an amplifier for both positive effects from same-gender friends and negative effects from opposite-gender friends. However, in Table 4.14, we find that being popular with the same gender benefits students who have a close relationship with their fathers more. Similar to the results in Table 4.13, the negative effects from opposite-gender friends are only significant for students who do not have close relationship with their either parents. We also conclude that a close relationship with parents is a buffer that prevents negative emotions from having opposite-gender friends.

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<sup>14</sup>According to the existing literature, the mechanisms under the peer effects for males and females are also distinct. Girls are more sensitive to their peers' gender composition (Hsieh and Lin, 2017). Boys care more about the size of social networks and the gender composition in a classroom can be treated as a constraint during the friendship formation (Gong et al., 2019; Getik and Meier, 2022).

## 4.7 Conclusion

Our results contribute to the literature that studies how social networks impact individuals' mental health, which has been proven to be a determinant for diverse economic outcomes both in the short term and long term, such as crimes ([for Mental Health, 2009](#); [Schucan Bird and Shemilt, 2019](#)), social welfare ([Jayakody et al., 2000](#); [von Eye and Anne Bogat, 2006](#)), and labor force ([Mitchell and Anderson, 1989](#); [Ettner et al., 1997](#); [Leroux et al., 2012](#)). While most studies use Add Health data as it provides unique information for students' social networks. We use CEPS to explore such effects in China, one of the most important developing countries. Rather than using the random assignment, we use the instrumental variables to overcome the endogeneity from the friendship formation. Specifically, we explore how the network size, an indicator of students' popularity, impacts students' mental health. We divide friends based on their gender: one is of the same gender of the student and the other one is the opposite gender of the student as previous literature has shown that gender plays an important role in the social network analysis ([Rose and Rudolph, 2006](#); [Pittman and Richmond, 2008](#); [Connolly and McIsaac, 2009](#)).

In general, we find that having more same-gender friends decreases the frequency of negative feelings. However, having more opposite-gender friends has a negative effect in some aspects. The effects also differ by cohorts. Concretely, for the 7th graders, we find that holding other things constant, one more same-gender friend relieves the frequency of "feeling blue" by a 0.066 standard deviation, the frequency of "feeling depressed" by a 0.084 standard deviation, the frequency of "feeling un-

happy” by a 0.078 standard deviation, the frequency of “feeling not enjoy life” by a 0.071 standard deviation, and the frequency of “feeling sad” by a 0.069 standard deviation. However, having an opposite-gender friend does not have a significant impact on mental health. For the 9th graders, we find that holding other things constant, one more same-gender friend relieves the frequency of “feeling blue” by a 0.046 standard deviation, the frequency of “feeling depressed” by a 0.058 standard deviation, the frequency of “feeling unhappy” by a 0.054 standard deviation, the frequency of “feeling not enjoy life” by a 0.063 standard deviation, and the frequency of “feeling sad” by a 0.054 standard deviation. Different from the students in Grade 7, having one additional opposite gender increases the frequency of “feeling blue” by a 0.109 standard deviation, the frequency of “feeling depressed” by a 0.118 standard deviation, and the frequency of “feeling unhappy” by a 0.125 standard deviation.

Our findings provide evidence to support same-gender friendships during this time period but not opposite-gender friendships. In the short term, having opposite-gender friends increases the probability of feeling depressed in a broader definition, regardless of gender. We suspect that, at this age, teens are not yet capable of handling opposite-sex peer relationships. Developing immature romantic relationships is harmful to students’ mental health. However, due to the data limitation, we are not able to investigate the long term effects. It is still possible that the early accumulation of social capital with the opposite gender could benefit the labor outcomes and marriage outcomes in the future.

## Tables

Table 4.1: Questionnaire items

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<i>Measures of health</i>	
Blue	Students are interviewed to see how much they agree “Do you feel blue in the last seven days?” by using a five-point scale.
Depressed	Students are interviewed to see how much they agree “Do you feel depressed in the last seven days?” by using a five-point scale.
Unhappy	Students are interviewed to see how much they agree “Do you feel unhappy in the last seven days?” by using a five-point scale.
Not enjoy life	Students are interviewed to see how much they agree “Do you feel not enjoying life in the last seven days?” by using a five-point scale.
Sad	Students are interviewed to see how much they agree “Do you feel sad in the last seven days?” by using a five-point scale.
<i>Individual characteristics</i>	
Gender	If the person is a man, the indicator will be one, otherwise it will be zero.
Local <i>hukou</i>	If the person has a local <i>hukou</i> , the indicator will be one, otherwise it will be zero.
Rural <i>hukou</i>	If the person has an agricultural <i>hukou</i> , the indicator will be one, otherwise it will be zero.
<i>Han</i>	If the person has an ethnicity of <i>Han</i> , the indicator will be one, otherwise it will be zero.
Only child	If the person is the only child in his/her family, the indicator will be one, otherwise it will be zero.
Cognitive ability	Standardized measure of cognitive assessment
Family SES	Indicator of “very poor”, “somewhat poor”, “moderate”, “somewhat rich”, and “very rich”
Mother’s years of schooling	The number of years of education the individual’s mother received based on the highest education level she has completed

Father's years of schooling	The number of years of education the individual's father received based on the highest education level she has completed
Alcoholic parent	If the person has at least one parent often gets drunk, the indicator will be one, otherwise it will be zero.
Parents fight at home	If the person's parents quarrel a lot, the indicator will be one, otherwise it will be zero.
Parents in good relationship	If the person's parents get along very well, the indicator will be one, otherwise it will be zero.
Relationship with mother	Indicator of "not close", "not too close nor too far", "very close"
Relationship with father	Indicator of "not close", "not too close nor too far", "very close"
<i>Class characteristics</i>	
Class size	The number of students in a class
% of girls	Proportion of girls in a class
% of immigrants	Proportion of students without Local <i>hukou</i> in a class
Class rankings	Indicator of "among the worst", "below average", "average", "above average", and "among the best"
<i>School characteristics</i>	
Private	If the school is private, the indicator will be one, otherwise it will be zero.
Boarding	If the school requires boarding, the indicator will be one, otherwise it will be zero.
School rankings	Indicator of "among the worst", "below average", "average", "above average", and "among the best"
Bad behavior	Measure the frequency: Indicator of "never", "seldom", and "usually"

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Table 4.2: Summary statistics of students' friends of different gender by cohort

	7th grader				9th grader			
	Mean (1)	St. Dev. (2)	Min (3)	Max (4)	Mean (5)	St. Dev. (6)	Min (7)	Max (8)
<b>Total</b>								
FSS	4.173	1.273	0	5	3.839	1.417	0	5
FOS	0.272	0.680	0	5	0.440	0.821	0	5
<b>In school</b>								
FSS	3.418	1.602	0	5	3.148	1.606	0	5
FOS	0.195	0.579	0	5	0.317	0.705	0	5
<b>In class</b>								
FSS	2.724	1.671	0	5	2.534	1.636	0	5
FOS	0.039	0.193	0	1	0.235	0.610	0	5
Number of students	10,199				9,177			
Number of classes	217				221			
Number of schools	110				112			

Table 4.3: Summary statistics of students' outcomes by cohort

	7th grader				9th grader			
	Mean (1)	St. Dev. (2)	Min (3)	Max (4)	Mean (5)	St. Dev. (6)	Min (7)	Max (8)
Feel blue	-0.083	0.982	-1.294	2.797	0.091	1.011	-1.294	2.797
Feel depressed	-0.095	0.970	-0.966	2.862	0.104	1.022	-0.966	2.862
Feel unhappy	-0.079	0.995	-1.291	2.610	0.087	0.998	-1.291	2.610
Not enjoy life	-0.060	0.978	-0.723	3.030	0.066	1.019	-0.723	3.030
Feel sad	-0.049	0.988	-1.045	2.852	0.054	1.010	-1.045	2.852
Number of students	10,199				9,177			
Number of classes	217				221			
Number of schools	110				112			

Table 4.4: Summary statistics of students' characteristics by cohort

	7th grader				9th grader			
	Mean (1)	St. Dev. (2)	Min (3)	Max (4)	Mean (5)	St. Dev. (6)	Min (7)	Max (8)
Gender	0.528	0.499	0	1	0.501	0.500	0	1
Local <i>hukou</i>	0.793	0.405	0	1	0.850	0.357	0	1
Agricultural <i>hukou</i>	0.538	0.499	0	1	0.559	0.496	0	1
<i>Han</i>	0.913	0.282	0	1	0.913	0.281	0	1
Only child	0.431	0.495	0	1	0.439	0.496	0	1
Standardized cognitive test	0.006	0.871	-2.029	2.333	0.003	0.851	-1.833	2.710
Family socioeconomic status								
Very poor	0.040	0.196	0	1	0.035	0.184	0	1
Poor	0.174	0.379	0	1	0.169	0.374	0	1
Moderate	0.727	0.445	0	1	0.735	0.442	0	1
Good	0.055	0.228	0	1	0.059	0.235	0	1
Very good	0.004	0.061	0	1	0.003	0.050	0	1
Mother's years of schooling	9.688	3.526	0	19	9.399	3.568	0	19
Father's years of schooling	10.419	3.152	0	19	10.205	3.128	0	19
Alcoholic parent	0.082	0.275	0	1	0.088	0.284	0	1
Parents fighting	0.097	0.296	0	1	0.104	0.305	0	1
Healthy relationship between parents	0.842	0.365	0	1	0.827	0.378	0	1
Relationship with mother								
Not close	0.026	0.158	0	1	0.024	0.154	0	1
Moderate	0.216	0.411	0	1	0.280	0.449	0	1
Very close	0.759	0.428	0	1	0.696	0.460	0	1
Relationship with father								
Not close	0.039	0.193	0	1	0.050	0.218	0	1
Moderate	0.306	0.461	0	1	0.370	0.483	0	1
Very close	0.655	0.475	0	1	0.580	0.494	0	1
Number of students	10,199				9,177			
Number of classes	217				221			
Number of schools	110				112			

Table 4.5: Summary statistics of class and school characteristics by cohort

	7th grader				9th grader			
	Mean (1)	St. Dev. (2)	Min (3)	Max (4)	Mean (5)	St. Dev. (6)	Min (7)	Max (8)
Class size	49.580	11.947	15	88	46.978	13.562	9	81
Head teacher's gender	0.339	0.473	0	1	0.397	0.489	0	1
Head teacher's age	36.064	6.888	21	60	38.538	6.577	19	60
Head teacher's experience	14.197	7.729	0	38	17.253	6.975	2	35
Class proportion of girl	0.472	0.075	0.160	0.750	0.499	0.084	0.111	0.739
Class proportion of local <i>hukou</i>	0.794	0.219	0.040	1	0.851	0.183	0	1
Class proportion of agricultural <i>hukou</i>	0.538	0.272	0	0.964	0.559	0.308	0	1
Class rankings								
Among the worst	0.039	0.192	0	1	0.026	0.161	0	1
Below average	0.152	0.359	0	1	0.115	0.319	0	1
Average	0.354	0.478	0	1	0.341	0.474	0	1
Above average	0.364	0.481	0	1	0.386	0.487	0	1
Among the best	0.092	0.289	0	1	0.131	0.337	0	1
Number of classes	217				221			
Private	0.074	0.262	0	1	0.073	0.261	0	1
Boarding school								
Yes	0.190	0.392	0	1	0.204	0.403	0	1
Partially	0.379	0.485	0	1	0.405	0.491	0	1
No	0.431	0.495	0	1	0.392	0.488	0	1
School rankings								
Among the worst	0.009	0.095	0	1	0.008	0.090	0	1
Below average	0.069	0.254	0	1	0.067	0.251	0	1
Average	0.115	0.319	0	1	0.114	0.318	0	1
Above average	0.590	0.492	0	1	0.576	0.494	0	1
Among the best	0.217	0.412	0	1	0.234	0.424	0	1
Bad behavior at school								
Never	0.394	0.489	0	1	0.394	0.489	0	1
Seldom	0.508	0.500	0	1	0.497	0.500	0	1
Usually	0.098	0.297	0	1	0.109	0.312	0	1
Number of schools	110				112			

Table 4.6: OLS estimates of friends on mental health outcomes

	Blue (1)	Depressed (2)	Unhappy (3)	Not enjoy life (4)	Sad (5)
Panel A: All					
School FSS	-0.047*** (0.005)	-0.059*** (0.005)	-0.055*** (0.005)	-0.055*** (0.005)	-0.058*** (0.005)
School FOS	0.028** (0.013)	0.026** (0.013)	0.014 (0.013)	0.010 (0.013)	0.031** (0.013)
Female share (Class control)	-0.059 (0.153)	-0.133 (0.140)	-0.277* (0.145)	-0.168 (0.148)	-0.340** (0.153)
Observations	18,101	18,056	18,079	18,040	18,075
Panel B: Grade 7					
School FSS	-0.051*** (0.007)	-0.065*** (0.007)	-0.060*** (0.007)	-0.058*** (0.007)	-0.066*** (0.007)
School FOS	0.010 (0.020)	0.019 (0.021)	-0.007 (0.020)	0.015 (0.022)	0.006 (0.021)
Female share (Class control)	-0.242 (0.207)	-0.227 (0.199)	-0.371* (0.197)	-0.263 (0.207)	-0.535** (0.227)
Observations	9,468	9,430	9,448	9,426	9,445
Panel C: Grade 9					
School FSS	-0.045*** (0.008)	-0.053*** (0.007)	-0.051*** (0.007)	-0.053*** (0.007)	-0.053*** (0.008)
School FOS	0.040** (0.016)	0.031* (0.016)	0.027* (0.016)	0.006 (0.017)	0.048*** (0.016)
Female share (Class control)	0.155 (0.186)	-0.091 (0.189)	-0.143 (0.193)	-0.094 (0.199)	-0.144 (0.202)
Observations	8,633	8,626	8,631	8,614	8,630
Individual controls	✓	✓	✓	✓	✓
Class controls	✓	✓	✓	✓	✓
School controls	✓	✓	✓	✓	✓
County FE	✓	✓	✓	✓	✓

Note: Standard errors are clustered at the class level in brackets. To simplify interpretation and comparison, the outcomes are all z-scored.

\* 10%, \*\* 5%, \*\*\* 1%.

Table 4.7: IV estimates of friends on mental health outcomes

	Blue (1)	Depressed (2)	Unhappy (3)	Not enjoy life (4)	Sad (5)
Panel A: All					
School FSS	-0.052*** (0.016)	-0.067*** (0.015)	-0.069*** (0.016)	-0.070*** (0.016)	-0.059*** (0.018)
School FOS	0.067 (0.047)	0.096** (0.047)	0.071 (0.050)	0.061 (0.052)	0.075 (0.050)
Female share (Class control)	-0.046 (0.150)	-0.127 (0.138)	-0.271* (0.143)	-0.170 (0.145)	-0.326** (0.149)
Observations	18,101	18,056	18,079	18,040	18,075
Panel B: Grade 7					
School FSS	-0.066*** (0.024)	-0.084*** (0.022)	-0.078*** (0.025)	-0.071*** (0.023)	-0.069*** (0.027)
School FOS	0.026 (0.079)	0.049 (0.082)	-0.015 (0.087)	0.025 (0.086)	0.031 (0.092)
Female share (Class control)	-0.236 (0.208)	-0.216 (0.206)	-0.377* (0.202)	-0.276 (0.209)	-0.531** (0.229)
Observations	9,468	9,430	9,448	9,426	9,445
Panel C: Grade 9					
School FSS	-0.046* (0.024)	-0.058*** (0.021)	-0.054** (0.023)	-0.063*** (0.023)	-0.054** (0.023)
School FOS	0.109* (0.061)	0.118* (0.066)	0.125* (0.068)	0.042 (0.067)	0.100 (0.062)
Female share (Class control)	0.159 (0.181)	-0.096 (0.180)	-0.139 (0.187)	-0.097 (0.195)	-0.139 (0.197)
Observations	8,633	8,626	8,631	8,614	8,630
Individual controls	✓	✓	✓	✓	✓
Class controls	✓	✓	✓	✓	✓
School controls	✓	✓	✓	✓	✓
County FE	✓	✓	✓	✓	✓

Note: Standard errors are clustered at the class level in brackets. To simplify interpretation and comparison, the outcomes are all z-scored.

\* 10%, \*\* 5%, \*\*\* 1%.

Table 4.8: Robustness checks: IV ordered probit estimates of friends on mental health outcomes

	Blue (1)	Depressed (2)	Unhappy (3)	Not enjoy life (4)	Sad (5)
Panel A: All					
School FSS	-0.059*** (0.018)	-0.071*** (0.018)	-0.073*** (0.019)	-0.076*** (0.019)	-0.063*** (0.021)
School FOS	0.071 (0.048)	0.101** (0.048)	0.074 (0.050)	0.065 (0.052)	0.079 (0.050)
Female share (Class control)	-0.053 (0.164)	-0.168 (0.151)	-0.314** (0.154)	-0.197 (0.169)	-0.386** (0.165)
Observations	18,101	18,056	18,079	18,040	18,075
Panel B: Grade 7					
School FSS	-0.073*** (0.026)	-0.087*** (0.025)	-0.082*** (0.026)	-0.085*** (0.024)	-0.076*** (0.029)
School FOS	0.031 (0.080)	0.057 (0.082)	-0.041 (0.088)	0.041 (0.086)	0.046 (0.093)
Female share (Class control)	-0.270 (0.232)	-0.257 (0.235)	-0.424* (0.222)	-0.335 (0.259)	-0.599** (0.259)
Observations	9,468	9,430	9,448	9,426	9,445
Panel C: Grade 9					
School FSS	-0.050* (0.026)	-0.059*** (0.022)	-0.058** (0.025)	-0.064*** (0.025)	-0.058*** (0.025)
School FOS	0.112* (0.064)	0.125* (0.069)	0.131* (0.072)	0.048 (0.070)	0.053 (0.064)
Female share (Class control)	0.184 (0.198)	-0.120 (0.190)	-0.164 (0.200)	-0.074 (0.220)	-0.184 (0.214)
Observations	8,633	8,626	8,631	8,614	8,630
Individual controls	✓	✓	✓	✓	✓
Class controls	✓	✓	✓	✓	✓
School controls	✓	✓	✓	✓	✓
County FE	✓	✓	✓	✓	✓

Note: Standard errors are clustered at the class level in brackets. Outcomes are in a five-point scale where 1 for never, 2 for seldom, 3 for sometimes, and 4 for often, and 5 for always.

\* 10%, \*\* 5%, \*\*\* 1%.

Table 4.9: Robustness checks: Estimates with friends quality

	Blue (1)	Depressed (2)	Unhappy (3)	Not enjoy life (4)	Sad (5)
School FSS	-0.047*** (0.018)	-0.065** (0.018)	-0.066*** (0.018)	-0.067*** (0.018)	-0.054** (0.021)
School FOS	0.075 (0.050)	0.102** (0.051)	0.075 (0.054)	0.069 (0.057)	0.079 (0.054)
Friends' quality: one or two of them	-0.040 (0.042)	-0.065 (0.042)	-0.093** (0.041)	-0.124*** (0.042)	-0.068 (0.042)
Friends' quality: most of them	-0.092** (0.044)	-0.121*** (0.044)	-0.161*** (0.043)	-0.173*** (0.044)	-0.097** (0.044)
Female share (Class control)	-0.046 (0.111)	-0.127 (0.112)	-0.271** (0.111)	-0.170 (0.112)	-0.326*** (0.111)
Observations	18,101	18,056	18,079	18,040	18,075
Individual controls	✓	✓	✓	✓	✓
Class controls	✓	✓	✓	✓	✓
School controls	✓	✓	✓	✓	✓
County FE	✓	✓	✓	✓	✓

Note: Standard errors are clustered at the class level in brackets. To simplify interpretation and comparison, the outcomes are all z-scored.

\* 10%, \*\* 5%, \*\*\* 1%.

Table 4.10: Estimates of friends on risky behaviors

	Swearwords (1)	Quarreling (2)	Bad temper (3)	Cheating (4)
School FSS	0.004 (0.056)	-0.100* (0.053)	-0.001 (0.046)	-0.125** (0.057)
School FOS	0.417** (0.201)	0.513*** (0.199)	0.334* (0.174)	0.416* (0.224)
Female share (Class control)	-0.2049 (0.193)	-0.081 (0.194)	-0.122 (0.189)	-0.245 (0.192)
Observations	8,907	8,901	8,899	8,887
Individual controls	✓	✓	✓	✓
Class controls	✓	✓	✓	✓
School controls	✓	✓	✓	✓
County FE	✓	✓	✓	✓

Note: Standard errors are clustered at the class level in brackets. Outcomes are in a five-point scale where 1 for never, 2 for seldom, 3 for sometimes, and 4 for often, and 5 for always.

\* 10%, \*\* 5%, \*\*\* 1%.

Table 4.11: Estimates of friends on mental health outcomes by gender (7th graders)

	Blue (1)	Depressed (2)	Unhappy (3)	Not enjoy life (4)	Sad (5)
Panel A: All					
School FSS	-0.066*** (0.024)	-0.084*** (0.022)	-0.078*** (0.025)	-0.071*** (0.023)	-0.069*** (0.027)
School FOS	0.026 (0.079)	0.049 (0.082)	-0.015 (0.087)	0.025 (0.086)	0.031 (0.093)
Female share (Class control)	-0.236 (0.208)	-0.216 (0.206)	-0.377* (0.202)	-0.276 (0.209)	-0.531** (0.229)
Observations	9,468	9,430	9,448	9,426	9,445
Panel B: Male					
School FSS	-0.057** (0.026)	-0.081*** (0.024)	-0.080*** (0.028)	-0.069*** (0.025)	-0.064*** (0.029)
School FOS	0.052 (0.089)	0.016 (0.089)	-0.003 (0.093)	0.018 (0.094)	0.051 (0.113)
Female share (Class control)	-0.302 (0.223)	-0.241 (0.222)	-0.562 (0.217)	-0.253 (0.223)	-0.583 (0.220)
Observations	4,683	4,670	4,671	4,663	4,678
Panel C: Female					
School FSS	-0.073*** (0.027)	-0.090*** (0.026)	-0.075*** (0.029)	-0.079*** (0.026)	-0.076*** (0.030)
School FOS	-0.018 (0.082)	0.075 (0.086)	-0.021 (0.088)	0.040 (0.089)	-0.010 (0.098)
Female share (Class control)	0.004 (0.255)	0.047 (0.255)	-0.142 (0.254)	-0.169 (0.248)	-0.336 (0.258)
Observations	4,309	4,294	4,305	4,293	4,301
Individual controls	✓	✓	✓	✓	✓
Class controls	✓	✓	✓	✓	✓
School controls	✓	✓	✓	✓	✓
County FE	✓	✓	✓	✓	✓

Note: Standard errors are clustered at the class level in brackets. To simplify interpretation and comparison, the outcomes are all z-scored.

\* 10%, \*\* 5%, \*\*\* 1%.

Table 4.12: Estimates of friends on mental health outcomes by gender (9th graders)

	Blue (1)	Depressed (2)	Unhappy (3)	Not enjoy life (4)	Sad (5)
Panel A: All					
School FSS	-0.046* (0.024)	-0.058*** (0.021)	-0.054** (0.023)	-0.063*** (0.023)	-0.054** (0.023)
School FOS	0.109* (0.061)	0.118* (0.066)	0.125* (0.068)	0.042 (0.067)	0.100 (0.062)
Female share (Class control)	0.159 (0.181)	-0.096 (0.180)	-0.139 (0.187)	-0.097 (0.195)	-0.139 (0.197)
Observations	8,633	8,626	8,631	8,614	8,630
Panel B: Male					
School FSS	-0.039 (0.025)	-0.045* (0.023)	-0.046* (0.025)	-0.051** (0.025)	-0.047* (0.025)
School FOS	0.113* (0.064)	0.081 (0.069)	0.131* (0.072)	0.050 (0.072)	0.083 (0.066)
Female share (Class control)	0.135 (0.181)	-0.140 (0.182)	-0.150 (0.184)	-0.163 (0.200)	-0.152 (0.195)
Observations	4,683	4,670	4,671	4,663	4,678
Panel C: Female					
School FSS	-0.054*** (0.026)	-0.068*** (0.024)	-0.064*** (0.026)	-0.72*** (0.026)	-0.069*** (0.027)
School FOS	0.101 (0.062)	0.126* (0.068)	0.101 (0.071)	-0.017 (0.71)	0.124** (0.063)
Female share (Class control)	-0.211 (0.209)	-0.202 (0.205)	-0.346* (0.203)	-0.234 (0.210)	-0.537** (0.225)
Observations	4,309	4,294	4,305	4,293	4,301
Individual controls	✓	✓	✓	✓	✓
Class controls	✓	✓	✓	✓	✓
School controls	✓	✓	✓	✓	✓
County FE	✓	✓	✓	✓	✓

Note: Standard errors are clustered at the class level in brackets. To simplify interpretation and comparison, the outcomes are all z-scored.

\* 10%, \*\* 5%, \*\*\* 1%.

Table 4.13: Estimates of friends on mental health outcomes by relationship with mother (9th graders)

	Blue (1)	Depressed (2)	Unhappy (3)	Not enjoy life (4)	Sad (5)
Panel A: All					
School FSS	-0.046* (0.024)	-0.058*** (0.021)	-0.054** (0.023)	-0.063*** (0.023)	-0.054** (0.023)
School FOS	0.109* (0.061)	0.118* (0.066)	0.125* (0.068)	0.042 (0.067)	0.100 (0.062)
Female share (Class control)	0.159 (0.181)	-0.096 (0.180)	-0.139 (0.187)	-0.097 (0.195)	-0.139 (0.197)
Observations	9,468	9,430	9,448	9,426	9,445
Panel B: Not close					
School FSS	-0.064* (0.033)	-0.066** (0.033)	-0.068** (0.033)	-0.079** (0.034)	-0.105*** (0.033)
School FOS	0.130 (0.089)	0.140 (0.090)	0.165* (0.089)	0.064 (0.091)	0.123 (0.095)
Female share (Class control)	-0.069 (0.122)	-0.152 (0.125)	-0.341*** (0.121)	-0.168 (0.131)	-0.407*** (0.124)
Observations	2,468	2,467	2,470	2,463	2,469
Panel C: Close					
School FSS	-0.037 (0.028)	-0.040 (0.028)	-0.043 (0.028)	-0.039 (0.028)	-0.041 (0.029)
School FOS	0.084 (0.085)	0.044 (0.091)	0.062 (0.091)	0.011 (0.091)	0.061 (0.098)
Female share (Class control)	-0.205 (0.193)	-0.081 (0.194)	-0.122 (0.189)	-0.245 (0.192)	-0.280 (0.198)
Observations	5,836	5,831	5,831	5,819	5,831
Individual controls	✓	✓	✓	✓	✓
Class controls	✓	✓	✓	✓	✓
School controls	✓	✓	✓	✓	✓
County FE	✓	✓	✓	✓	✓

Note: Standard errors are clustered at the class level in brackets. To simplify interpretation and comparison, the outcomes are all z-scored.

\* 10%, \*\* 5%, \*\*\* 1%.

Table 4.14: Estimates of friends on mental health outcomes by relationship with father (9th graders)

	Blue (1)	Depressed (2)	Unhappy (3)	Not enjoy life (4)	Sad (5)
Panel A: All					
School FSS	-0.046* (0.024)	-0.058*** (0.021)	-0.054** (0.023)	-0.063*** (0.023)	-0.054** (0.023)
School FOS	0.109* (0.061)	0.118* (0.066)	0.125* (0.068)	0.042 (0.067)	0.100 (0.062)
Female share (Class control)	0.159 (0.181)	-0.096 (0.180)	-0.139 (0.187)	-0.097 (0.195)	-0.139 (0.197)
Observations	9,468	9,430	9,448	9,426	9,445
Panel B: Not close					
School FSS	-0.031 (0.033)	-0.040 (0.033)	-0.042 (0.033)	-0.050 (0.035)	-0.040 (0.033)
School FOS	0.160** (0.074)	0.164** (0.075)	0.186** (0.074)	0.093 (0.076)	0.137** (0.075)
Female share (Class control)	-0.324 (0.204)	-0.245 (0.211)	-0.494** (0.203)	-0.318 (0.225)	-0.628*** (0.207)
Observations	3,450	3,450	3,452	3,443	3,450
Panel C: Close					
School FSS	-0.089*** (0.027)	-0.087*** (0.027)	-0.094*** (0.027)	-0.075*** (0.027)	-0.085*** (0.027)
School FOS	0.015 (0.070)	-0.007 (0.070)	-0.002 (0.070)	-0.036 (0.069)	0.011 (0.070)
Female share (Class control)	0.185 (0.169)	-0.122 (0.170)	-0.177 (0.167)	-0.029 (0.177)	-0.185 (0.170)
Observations	4,854	4,848	4,849	4,839	4,850
Individual controls	✓	✓	✓	✓	✓
Class controls	✓	✓	✓	✓	✓
School controls	✓	✓	✓	✓	✓
County FE	✓	✓	✓	✓	✓

Note: Standard errors are clustered at the class level in brackets. To simplify interpretation and comparison, the outcomes are all z-scored.

\* 10%, \*\* 5%, \*\*\* 1%.

## Figures

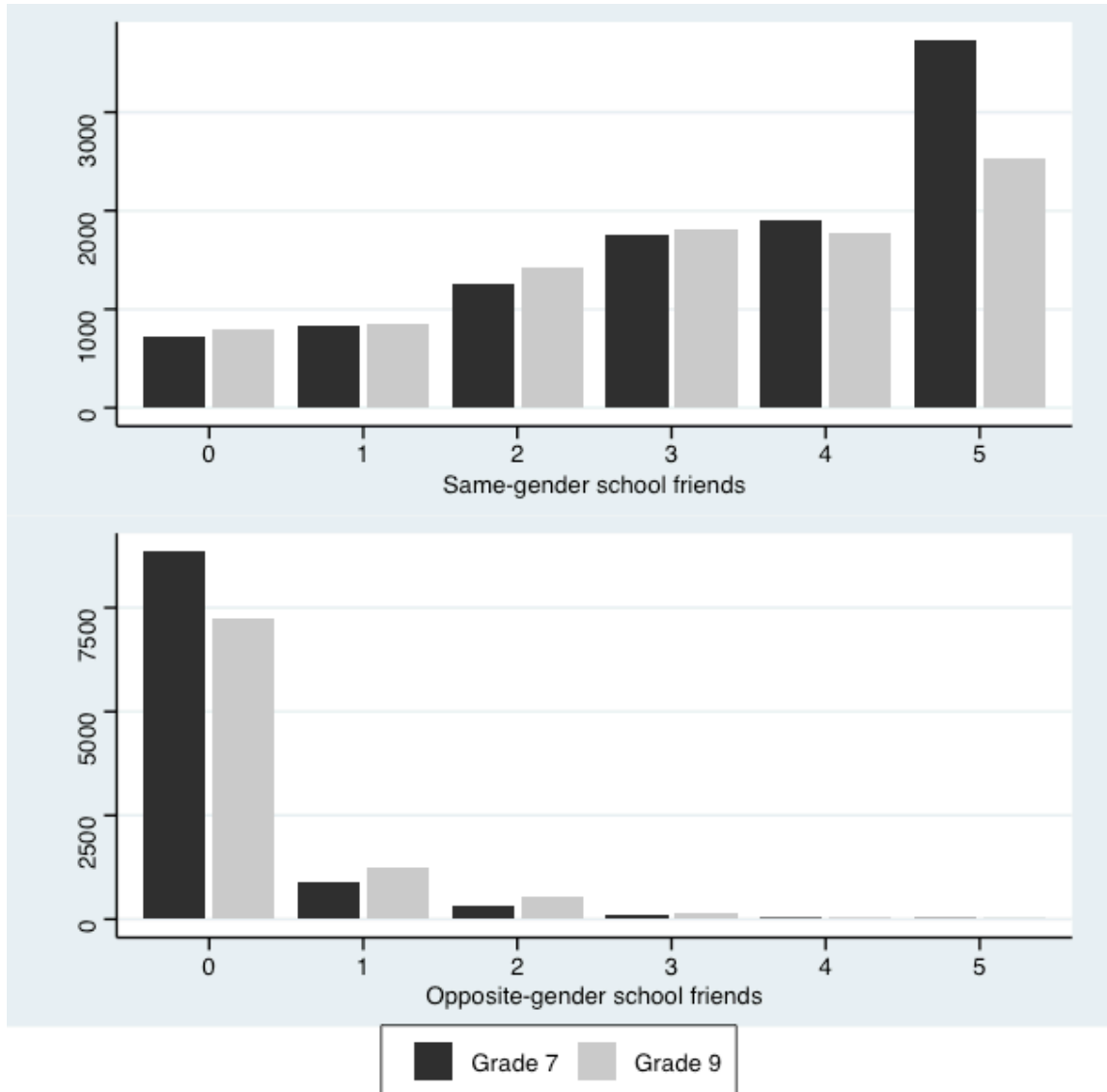


Figure 4.1: School friends gender composition by grade level

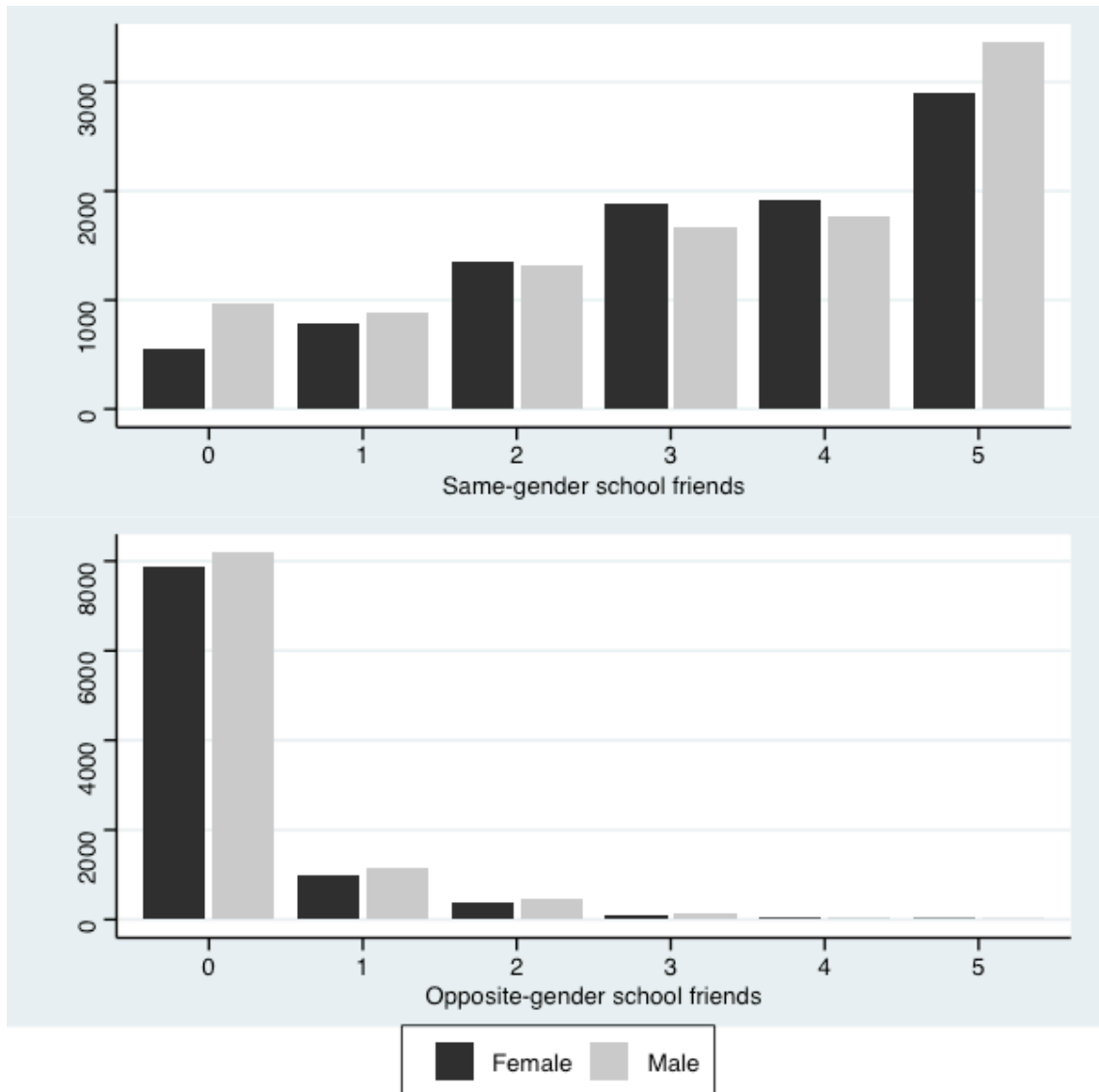


Figure 4.2: School friends gender composition by gender

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# Appendices

# Appendix A

## Appendix to Chapter 2

Table A.1: Correlations between measures of parents' strictness

	Grades	Behaviors	Attendances	Go home	Friends	Clothing	Internet	TV
Grades	1							
Behaviors	0.456	1						
Attendances	0.298	0.381	1					
Go home	0.260	0.307	0.450	1				
Friends	<b>0.226</b>	0.284	0.253	0.378	1			
Clothing	0.216	0.264	0.260	0.300	0.403	1		
Internet	0.291	0.258	0.217	0.234	0.223	0.277	1	
TV	0.301	0.245	0.203	0.228	0.234	0.281	0.538	1

Table A.2: Descriptive statistics of schools with random assignment

	N	Mean	St. Dev.	Min	Max
School FSS	12,286	3.3599	1.5357	0	5
School FOS	12,286	0.2744	0.6640	0	5
<b>Outcomes:</b>					
Chinese	12,276	70.2524	9.7087	6.1645	98.4746
Mathematics	12,271	70.1664	9.8341	17.5113	145.1149
English	12,273	70.2163	9.8379	18.0814	107.8161
Total	12,251	210.6701	25.5583	68.6015	293.9303
<b>Covariates:</b>					
Grade 9	12,286	0.4607	0.4985	0	1
Male	12,286	0.5090	0.4999	0	1
Han	12,255	0.8873	0.3162	0	1
Rural Hukou	12,286	0.4974	0.5000	0	1
Local Hukou	12,286	0.8056	0.3957	0	1
Only child in the family	12,286	0.4581	0.4983	0	1
Family SES: poor	12,252	0.0316	0.1749	0	1
Family SES: somewhat poor	12,252	0.1513	0.3584	0	1
Family SES: moderate	12,252	0.7529	0.4313	0	1
Family SES: somewhat rich	12,252	0.0611	0.2396	0	1
Family SES: rich	12,252	0.0030	0.0549	0	1
Parental education	12,262	11.0025	3.1878	0	19
Parental strictness with grades: no	12,271	0.0301	0.1708	0	1
Parental strictness with grades: moderate	12,271	0.4643	0.4987	0	1
Parental strictness with grades: serious	12,271	0.5057	0.5000	0	1
Baseline cognitive ability	12,286	0.0426	0.8792	-2.0290	2.7099
Attended preschool	12,203	0.8109	0.3916	0	1
<b>Covariates (class-level):</b>					
Class size	12,286	47.6837	13.7730	9	88
Male (Head teacher)	12,286	0.3637	0.4811	0	1
Age (Head teacher)	12,170	37.3448	7.0234	19	60
Teaching experience (Head teacher)	11,958	15.6320	7.6383	1	38
% of girls	12,286	0.4830	0.0832	0.1111	0.7500
% of local Hukou	12,286	0.8034	0.2088	0.0400	1
% of rural Hukou	12,286	0.4990	0.2925	0	1

Table A.2: Descriptive statistics of schools with random assignment (cont'd)

Class rankings: among the worst	12,286	0.0406	0.1974	0	1
Class rankings: below average	12,286	0.1561	0.3630	0	1
Class rankings: average	12,286	0.3240	0.4680	0	1
Class rankings: above average	12,286	0.3684	0.4824	0	1
Class rankings: among the best	12,286	0.1109	0.3140	0	1
<b>Covariates (school-level):</b>					
Private school	12,286	0.0739	0.2616	0	1
School rankings: below average <sup>1</sup>	12,286	0.0575	0.2327	0	1
School rankings: average	12,286	0.1192	0.3241	0	1
School rankings: above average	12,286	0.5555	0.4969	0	1
School rankings: among the best	12,286	0.2678	0.4428	0	1
<b>Instruments:</b>					
School-level average school FSS	12,286	3.3508	0.3173	2.3125	4.0920
School-level average school FOS	12,286	0.2737	0.0862	0	0.5625
% of opposite gender schoolmates	12,286	0.4933	0.0585	0.2455	0.7545
Parents' strictness with friends: no	12,286	0.1772	0.3818	0	1
Parents' strictness with friends: moderate	12,286	0.5029	0.5000	0	1
Parents' strictness with friends: serious	12,286	0.3199	0.4664	0	1

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<sup>1</sup>Schools with the worst rankings are dropped in the sample.

Table A.3: First-stage estimation (academic outcomes)

	Number of FSS (1)	Number of FOS (2)
School-level average school FSS	1.0156*** (0.0707)	0.0143 (0.0330)
School-level average school FOS	-0.0244 (0.2387)	1.0353*** (0.1036)
% of opposite gender schoolmates	-0.8211*** (0.2264)	0.4181*** (0.0983)
Parents' strictness with friends: moderate	0.0588* (0.0331)	0.0034 (0.0135)
Parents' strictness with friends: serious	0.0297 (0.0354)	-0.0379*** (0.0147)
Parental education	-0.0038 (0.0055)	0.0041* (0.0022)
Parental strictness with grades: moderate	0.1890** (0.0755)	-0.0547* (0.0317)
Parental strictness with grades: serious	0.2843*** (0.0761)	-0.0539* (0.0318)
Baseline cognitive ability	0.0299* (0.0164)	0.0188*** (0.0069)
Attend preschool	0.0675** (0.0298)	-0.0032 (0.0137)
Observations	17,624	17,624
F statistic	57.984 (0.000)	36.909 (0.000)

Note: Class controls include class size, head teacher's gender, age, and years of experience, girls' proportion, local *Hukou* students' proportion, rural *Hukou* students' proportion, and class ranking. School controls include private school and school ranking. Standard errors are clustered at class level in brackets.

\* 10%, \*\* 5%, \*\*\* 1%.

Table A.4: Falsification tests (academic outcomes)

	Chinese (1)	Mathematics (2)	English (3)	Total (4)
Parental strictness with friends: moderate	2.6344 (1.6908)	0.7204 (1.4630)	1.1991 (1.2575)	4.8979 (4.0305)
Parental strictness with friends: serious	1.1870 (1.7417)	0.1505 (1.6073)	0.6570 (1.4178)	2.2237 (4.2442)
Class % of girls	16.0249 (11.1014)	12.4665 (9.4784)	11.2655 (9.4806)	40.1467 (28.3174)
Class % of local Hukou	18.6462** (9.2043)	15.7995** (7.4209)	4.8539 (6.8217)	37.8488* (21.0985)
Class % of rural Hukou	-2.1263 (8.6464)	2.0605 (7.7702)	-6.0331 (6.5093)	-5.8029 (21.3662)
School % of girls	-16.0479 (22.5676)	-8.3235 (16.7072)	3.9445 (16.1319)	-21.7842 (49.9822)
School % of local Hukou	-18.2737 (11.8499)	-16.2551* (9.7755)	-6.8816 (8.5499)	-38.6757 (27.5748)
School % of rural Hukou	1.9142 (9.5865)	-0.5291 (8.8919)	6.4681 (7.0518)	8.3285 (23.6205)
Observations	459	462	463	458
$R^2$	0.0864	0.0915	0.0984	0.0951
Individual controls:	no	no	no	no
Class and school controls	no	no	no	no
County FE	✓	✓	✓	✓

Note: Other class controls include class size, head teacher's gender, age, and years of experience, and class ranking. School controls include private school and school ranking. Standard errors are clustered at class level in brackets.

\* 10%, \*\* 5%, \*\*\* 1%.

Table A.5: IV estimates of friends on grades (7th grade)

	Chinese (1)	Mathematics (2)	English (3)	Total (4)
School FSS	-1.4051*** (0.5003)	-1.6849*** (0.5115)	-1.8462*** (0.5178)	-4.9435*** (1.2974)
School FOS	-4.4722** (1.8412)	-0.8602 (1.8898)	-5.5711*** (1.9266)	-10.8607** (4.8671)
Male	-5.9245*** (0.1951)	-1.2599*** (0.1993)	-5.8277*** (0.2026)	-12.9464*** (0.5087)
Han	-0.6534 (0.4724)	-0.7267 (0.4831)	-0.6858 (0.4902)	-2.0747* (1.2298)
Rural hukou	0.1362 (0.2380)	0.4513* (0.2432)	-0.2091 (0.2465)	0.3445 (0.6186)
Local hukou	-1.6061*** (0.3102)	-1.2240*** (0.3165)	-0.8828*** (0.3214)	-3.6519*** (0.8052)
Only child in the family	0.5432** (0.2359)	0.6005** (0.2411)	0.8151*** (0.2446)	1.9283*** (0.6130)
Family SES: somewhat poor	1.5966*** (0.5332)	1.0960** (0.5454)	1.0305* (0.5513)	3.6173*** (1.3920)
Family SES: moderate	1.1200** (0.5098)	1.1275** (0.5214)	1.2618** (0.5263)	3.3926** (1.3297)
Family SES: somewhat rich	0.7624 (0.6466)	-0.0224 (0.6605)	0.3092 (0.6685)	0.9085 (1.6820)
Family SES: rich	-5.9175*** (1.6161)	-5.1001*** (1.6279)	-2.7805 (1.6969)	-12.9518*** (4.2532)
Parental education	0.1961*** (0.0418)	0.2177*** (0.0428)	0.2131*** (0.0434)	0.6314*** (0.1089)
Parental strictness with grades: moderate	1.7014*** (0.6377)	0.3213 (0.6459)	0.3999 (0.6552)	2.0461 (1.6586)
Parental strictness with grades: serious	1.9362*** (0.6476)	0.4317 (0.6549)	1.1523* (0.6644)	3.1020* (1.6828)
Baseline cognitive ability	3.6894*** (0.1243)	4.7707*** (0.1270)	3.7786*** (0.1290)	12.2149*** (0.3235)
Attend preschool	0.8289*** (0.2564)	0.8538*** (0.2620)	0.3688 (0.2656)	2.1234*** (0.6659)
Observations	9,318	9,314	9,316	9,298
Class and school controls	✓	✓	✓	✓
County FE	✓	✓	✓	✓

Note: Class controls include class size, head teacher's gender, age, and years of experience, girls' proportion, local *Hukou* students' proportion, rural *Hukou* students' proportion, and class ranking. School controls include private school and school ranking. Standard errors are clustered at class level in brackets. \* 10%, \*\* 5%, \*\*\* 1%.

Table A.6: IV estimates of friends on grades in the following year (7th grade)

	Chinese (1)	Mathematics (2)	English (3)	Total (4)
School FSS	2.1406 (1.3252)	2.0985 (1.6703)	1.0564 (1.4309)	5.4404 (3.3909)
School FOS	-5.0320*** (1.7195)	2.7513 (2.1665)	-3.5014* (1.8469)	-8.0410* (4.3745)
Male	-14.7681*** (0.5406)	-4.2071*** (0.6820)	-16.3118*** (0.5812)	-35.2194*** (1.3767)
Han	0.8989 (1.2832)	-1.3913 (1.6164)	-0.1528 (1.3775)	-0.6633 (3.2646)
Rural hukou	-0.7259 (0.6483)	1.8292** (0.8179)	0.1826 (0.6968)	1.2301 (1.6500)
Local hukou	-2.1303** (0.8507)	0.2378 (1.0732)	-0.7057 (0.9132)	-2.8038 (2.1624)
Only child in the family	0.4910 (0.6439)	0.6842 (0.8119)	1.7810** (0.6923)	2.8724* (1.6392)
Family SES: somewhat poor	2.8778** (1.4603)	1.6197 (1.8415)	2.7585* (1.5686)	7.3159** (3.7142)
Family SES: moderate	1.3151 (1.4000)	2.1727 (1.7652)	3.5235** (1.5038)	7.0087** (3.5607)
Family SES: somewhat rich	-0.9191 (1.7854)	0.0233 (2.2516)	1.5540 (1.9177)	0.6531 (4.5408)
Family SES: rich	-5.8442 (4.5193)	-6.4157 (5.6994)	-8.7816* (4.8541)	-21.0553* (11.4939)
Parental education	0.3665*** (0.1156)	0.7559*** (0.1458)	0.7516*** (0.1243)	1.8531*** (0.2942)
Parental strictness with grades: moderate	2.2829 (1.7735)	1.7376 (2.2363)	1.0854 (1.9053)	5.2228 (4.5112)
Parental strictness with grades: serious	2.4926 (1.7912)	2.9965 (2.2582)	2.8327 (1.9247)	8.4054* (4.5573)
Baseline cognitive ability	7.9813*** (0.3381)	13.2384*** (0.4265)	10.8354*** (0.3633)	32.0885*** (0.8603)
Attend preschool	2.0467*** (0.7044)	2.9736*** (0.8879)	2.6801*** (0.7575)	7.7603*** (1.7935)
Observations	8,702	8,704	8,692	8,693
Class and school controls	✓	✓	✓	✓
County FE	✓	✓	✓	✓

Note: Class controls include class size, head teacher's gender, age, and years of experience, girls' proportion, local *Hukou* students' proportion, rural *Hukou* students' proportion, and class ranking. School controls include private school and school ranking. Standard errors are clustered at class level in brackets.

\* 10%, \*\* 5%, \*\*\* 1%.

Table A.7: IV estimates of friends on grades (9th grade)

	Chinese (1)	Mathematics (2)	English (3)	Total (4)
School FSS	-0.5776 (0.5735)	-0.6023 (0.5849)	-0.4521 (0.5787)	-1.5435 (1.4772)
School FOS	-0.2232 (1.3729)	0.6422 (1.3867)	0.4234 (1.3859)	0.6450 (3.5270)
Male	-5.7223*** (0.2132)	-1.0358*** (0.2161)	-5.5880*** (0.2145)	-12.3257*** (0.5492)
Han	0.0892 (0.5237)	0.1812 (0.5309)	-0.4802 (0.5275)	-0.2012 (1.3507)
Rural hukou	0.5295** (0.2606)	0.6173** (0.2639)	0.1996 (0.2622)	1.3592** (0.6710)
Local hukou	-1.5689*** (0.3439)	-0.9557*** (0.3481)	-0.6638* (0.3463)	-3.1489*** (0.8856)
Only child in the family	-0.0977 (0.2638)	0.1771 (0.2667)	0.1714 (0.2652)	0.2458 (0.6802)
Family SES: somewhat poor	0.4926 (0.5850)	0.1622 (0.5916)	-0.4774 (0.5905)	0.0431 (1.5116)
Family SES: moderate	0.5114 (0.5568)	0.0980 (0.5630)	-0.5319 (0.5620)	-0.0386 (1.4385)
Family SES: somewhat rich	0.5618 (0.6847)	-0.0192 (0.6925)	-0.6713 (0.6904)	-0.2424 (1.7668)
Family SES: rich	-8.3278*** (2.1183)	-5.8601*** (2.1436)	-5.1635** (2.1291)	-19.5905*** (5.4438)
Parental education	0.3220*** (0.0428)	0.2962*** (0.0434)	0.3884*** (0.0431)	1.0076*** (0.1103)
Parental strictness with grades: moderate	-1.0497* (0.5565)	-0.7945 (0.5634)	-1.0191* (0.5595)	-2.7854* (1.4306)
Parental strictness with grades: serious	-0.0925 (0.5736)	0.0173 (0.5810)	-0.0744 (0.5768)	-0.1020 (1.4749)
Baseline cognitive ability	4.0707*** (0.1381)	5.5777*** (0.1399)	4.4396*** (0.1388)	14.0748*** (0.3552)
Attend preschool	0.1229 (0.2475)	0.3337 (0.2508)	0.0830 (0.2491)	0.5810 (0.6374)
Observations	8,291	8,282	8,277	8,258
Class and school controls	✓	✓	✓	✓
County FE	✓	✓	✓	✓

Note: Class controls include class size, head teacher's gender, age, and years of experience, girls' proportion, local *Hukou* students' proportion, rural *Hukou* students' proportion, and class ranking. School controls include private school and school ranking. Standard errors are clustered at class level in brackets.

\* 10%, \*\* 5%, \*\*\* 1%.

Table A.8: IV estimates of friends on grades (female)

	Chinese (1)	Mathematics (2)	English (3)	Total (4)
School FSS	-0.8606** (0.4369)	-1.9118*** (0.4991)	-1.3908*** (0.4510)	-4.1185*** (1.1749)
School FOS	-2.3369** (1.1771)	-1.3217 (1.3431)	-2.7144** (1.2228)	-6.6234** (3.1847)
Grade 9	-0.2247 (0.2453)	0.3093 (0.2795)	-0.2875 (0.2533)	-0.2018 (0.6596)
Han	-0.3932 (0.4269)	-0.0294 (0.4852)	-0.8974** (0.4412)	-1.4358 (1.1473)
Rural hukou	0.4066* (0.2219)	0.4145 (0.2524)	0.1484 (0.2290)	0.9294 (0.5958)
Local hukou	-1.2739*** (0.2791)	-0.9629*** (0.3173)	-0.5290* (0.2882)	-2.6836*** (0.7496)
Only child in the family	0.0350 (0.2239)	0.2568 (0.2545)	0.4317* (0.2310)	0.7075 (0.6011)
Family SES: somewhat poor	1.1730** (0.4872)	0.9475* (0.5540)	0.5212 (0.5025)	2.6339** (1.3066)
Family SES: moderate	0.5632 (0.4647)	0.5606 (0.5283)	0.2547 (0.4793)	1.3761 (1.2462)
Family SES: somewhat rich	0.7934 (0.5951)	0.2392 (0.6765)	0.2683 (0.6137)	1.2833 (1.5959)
Family SES: rich	-11.7389*** (1.8389)	-9.1603*** (2.0906)	-9.1391*** (1.8967)	-30.0973*** (4.9323)
Parental education	0.2546*** (0.0371)	0.2903*** (0.0422)	0.2978*** (0.0383)	0.8492*** (0.0996)
Parental strictness with grades: moderate	-0.8080 (0.5463)	-2.0757*** (0.6210)	-1.3290** (0.5631)	-4.3725*** (1.4650)
Parental strictness with grades: serious	-0.4411 (0.5644)	-1.8814*** (0.6416)	-0.7450 (0.5816)	-3.2121** (1.5128)
Baseline cognitive ability	3.5852*** (0.1160)	4.8350*** (0.1319)	3.5872*** (0.1197)	11.9912*** (0.3115)
Attend preschool	0.8030*** (0.2250)	0.9718*** (0.2558)	0.4387* (0.2320)	2.2537*** (0.6036)
Observations	8,707	8,703	7,702	8,692
Class and school controls	✓	✓	✓	✓
County FE	✓	✓	✓	✓

Note: Class controls include class size, head teacher's gender, age, and years of experience, girls' proportion, local *Hukou* students' proportion, rural *Hukou* students' proportion, and class ranking. School controls include private school and school ranking. Standard errors are clustered at class level in brackets.

\* 10%, \*\* 5%, \*\*\* 1%.

Table A.9: IV estimates of friends on grades (male)

	Chinese (1)	Mathematics (2)	English (3)	Total (4)
School FSS	-0.9334 (0.5756)	-0.2798 (0.5543)	-0.7889 (0.5742)	-1.8571 (1.4485)
School FOS	-1.1992 (2.0050)	-0.0068 (1.9299)	-1.6545 (2.0197)	-3.0099 (5.1129)
Grade 9	-0.3964 (0.3835)	-0.3113 (0.3710)	-0.5798 (0.3851)	-1.3812 (0.9781)
Han	-0.2290 (0.5463)	-0.6200 (0.5268)	-0.2628 (0.5475)	-1.0038 (1.3839)
Rural hukou	0.2108 (0.2660)	0.5211** (0.2559)	-0.2218 (0.2665)	0.5215 (0.6733)
Local hukou	-1.7393*** (0.3635)	-1.1680*** (0.3488)	-0.8701** (0.3640)	-3.7437*** (0.9167)
Only child in the family	0.5695** (0.2596)	0.6126** (0.2493)	0.8074*** (0.2597)	1.9563*** (0.6557)
Family SES: somewhat poor	1.0296* (0.6010)	0.4940 (0.5774)	0.2166 (0.6022)	1.5279 (1.5328)
Family SES: moderate	1.0834* (0.5715)	0.7407 (0.5492)	0.6086 (0.5729)	2.2242 (1.4585)
Family SES: somewhat rich	0.6744 (0.7006)	-0.2017 (0.6730)	-0.3242 (0.7018)	-0.0747 (1.7777)
Family SES: rich	-4.2598** (1.7578)	-3.3918** (1.6642)	-0.6908 (1.7856)	-7.5158* (4.5019)
Parental education	0.2614*** (0.0458)	0.2096*** (0.0442)	0.2932*** (0.0461)	0.7632*** (0.1165)
Parental strictness with grades: moderate	1.2571** (0.6395)	1.2399** (0.6105)	0.6244 (0.6360)	3.0842* (1.6147)
Parental strictness with grades: serious	2.0699*** (0.6473)	1.9181*** (0.6170)	1.7392*** (0.6428)	5.6173*** (1.6338)
Baseline cognitive ability	3.9896*** (0.1386)	5.1652*** (0.1335)	4.3606*** (0.1388)	13.5021*** (0.3505)
Attend preschool	0.2921 (0.2665)	0.4316* (0.2565)	0.1933 (0.2670)	0.9980 (0.6749)
Observations	8,902	8,893	8,891	8,864
Class and school controls	✓	✓	✓	✓
County FE	✓	✓	✓	✓

Note: Class controls include class size, head teacher's gender, age, and years of experience, girls' proportion, local *Hukou* students' proportion, rural *Hukou* students' proportion, and class ranking. School controls include private school and school ranking. Standard errors are clustered at class level in brackets.

\* 10%, \*\* 5%, \*\*\* 1%.

Table A.10: Effect of friends on time allocation

	SCH ASGMT (1)	Extra ASGMT (2)	Crams (3)	Sports (4)	Reading (5)	TV (6)	INET & Games (7)	Housework (8)
School FSS	-0.3463 (0.3659)	-0.3069 (0.1899)	0.0208 (0.0566)	-0.1675 (0.1786)	0.0966 (0.1970)	0.7370*** (0.2081)	0.3675* (0.1916)	-1.1379*** (0.2078)
School FOS	-3.1983*** (1.1309)	-0.0389 (0.5454)	-0.0215 (0.1656)	-1.3362** (0.5719)	1.0323* (0.5885)	0.6670 (0.6280)	1.2510** (0.5565)	-2.3730*** (0.6119)
Grade 9	2.5599*** (0.2213)	0.5266*** (0.1083)	-0.0128 (0.0322)	-0.0303 (0.1066)	-1.1246*** (0.1181)	-0.5819*** (0.1222)	0.2623** (0.1130)	-0.5578*** (0.1224)
Male	-1.6902*** (0.1483)	-0.3997*** (0.0767)	-0.0801*** (0.0221)	0.4559*** (0.0725)	-0.9940*** (0.0796)	0.2271*** (0.0845)	0.9542*** (0.0757)	-0.6659*** (0.0833)
Han	-0.0937 (0.3595)	-0.2236 (0.1893)	0.0452 (0.0569)	-0.0658 (0.1779)	0.1948 (0.1974)	-0.0083 (0.2030)	-0.0596 (0.1874)	-0.3416* (0.2025)
Rural hukou	0.4588** (0.1789)	-0.0679 (0.0915)	-0.0232 (0.0268)	0.1603* (0.0887)	0.1974** (0.0971)	0.0120 (0.1016)	-0.0906 (0.0931)	0.4119*** (0.0999)
Local hukou	-0.2577 (0.2358)	0.0333 (0.1196)	0.0707* (0.0364)	-0.2254* (0.1177)	-0.2732** (0.1275)	-0.2123 (0.1330)	0.1498 (0.1237)	-0.4043*** (0.1313)
Only child in the family	0.3682** (0.1754)	-0.0050 (0.0917)	0.0966*** (0.0271)	-0.1531* (0.0892)	-0.2040** (0.0969)	-0.1094 (0.1002)	-0.0880 (0.0923)	-0.3776*** (0.0983)
Baseline cognitive ability	-0.0548 (0.0936)	-0.0890* (0.0475)	0.0381*** (0.0141)	0.1322*** (0.0466)	0.2157*** (0.0503)	-0.3749*** (0.0522)	-0.1818*** (0.0481)	-0.4155*** (0.0518)
Attend preschool	0.1274 (0.1823)	0.1143 (0.0928)	0.0215 (0.0268)	0.0899 (0.0896)	0.1271 (0.0982)	-0.1224 (0.1037)	0.1593* (0.0940)	-0.2776*** (0.1019)
Observations	15,761	14,337	13,107	14,782	15,553	14,920	15,491	15,122
Parents and family control	✓	✓	✓	✓	✓	✓	✓	✓
Class and school controls	✓	✓	✓	✓	✓	✓	✓	✓
County FE	✓	✓	✓	✓	✓	✓	✓	✓

Note: Class controls include class size, head teacher's gender, age, and years of experience, girls' proportion, local *Hukou* students' proportion, rural *Hukou* students' proportion, and class ranking. School controls include private school and school ranking. Standard errors are clustered at class level in brackets.

\* 10%, \*\* 5%, \*\*\* 1%.

Table A.11: Effect of friends on activities and behaviors

	Hobbies (1)	Mus & Zoo (2)	Shows (3)	CLS AV (4)	Late (5)	Absence (6)	RR (7)	Sleeping (8)
School FSS	0.0562 (0.0442)	0.1171*** (0.0394)	0.1816*** (0.0496)	0.0276 (0.0391)	-0.0390 (0.0243)	0.0273 (0.0168)	-0.0325 (0.0200)	-0.2415*** (0.0457)
School FOS	-0.1794 (0.1290)	0.5171*** (0.1212)	0.6210*** (0.1512)	0.2965*** (0.1125)	0.0503 (0.0705)	0.0120 (0.0485)	0.1648*** (0.0571)	-0.0020 (0.1352)
Grade 9	-0.1537*** (0.0256)	-0.0889*** (0.0238)	0.0714** (0.0296)	-0.0926*** (0.0225)	0.0789*** (0.0141)	0.0135 (0.0097)	0.1033*** (0.0114)	-0.7211*** (0.0267)
Male	-0.1918*** (0.0177)	0.0147 (0.0161)	0.0399** (0.0203)	-0.0858*** (0.0155)	0.0451*** (0.0097)	0.0247*** (0.0067)	0.0512*** (0.0079)	0.1372*** (0.0183)
Han	-0.1005** (0.0431)	0.1072*** (0.0389)	0.0902* (0.0486)	0.0068 (0.0380)	0.0379 (0.0237)	0.0093 (0.0163)	-0.0557*** (0.0192)	0.0607 (0.0447)
Rural hukou	-0.0772*** (0.0216)	-0.0270 (0.0194)	-0.0921*** (0.0243)	-0.0352* (0.0190)	-0.0244** (0.0118)	-0.0065 (0.0081)	-0.0001 (0.0096)	0.0146 (0.0224)
Local hukou	-0.0837*** (0.0283)	-0.0616** (0.0255)	0.0478 (0.0319)	-0.0654*** (0.0249)	-0.0050 (0.0155)	0.0131 (0.0107)	-0.0146 (0.0126)	-0.0430 (0.0293)
Only child in the family	-0.0309 (0.0213)	0.0480** (0.0192)	0.0317 (0.0241)	-0.0207 (0.0188)	-0.0222* (0.0117)	-0.0153* (0.0081)	-0.0061 (0.0095)	-0.0324 (0.0221)
Baseline cognitive ability	0.0339*** (0.0112)	0.0475*** (0.0101)	0.0495*** (0.0127)	0.0629*** (0.0099)	-0.0388*** (0.0062)	-0.0325*** (0.0042)	-0.0205*** (0.0050)	-0.0429*** (0.0116)
Attend preschool	0.0611*** (0.0218)	0.0875*** (0.0196)	0.0840*** (0.0246)	0.0686*** (0.0192)	0.0043 (0.0120)	-0.0158* (0.0082)	-0.0054 (0.0097)	-0.0378* (0.0227)
Observations	17,589	17,119	17,074	17,516	17,588	17,582	17,481	17,238
Parents and family control	✓	✓	✓	✓	✓	✓	✓	✓
Class and school controls	✓	✓	✓	✓	✓	✓	✓	✓
County FE	✓	✓	✓	✓	✓	✓	✓	✓

Note: Class controls include class size, head teacher's gender, age, and years of experience, girls' proportion, local *Hukou* students' proportion, rural *Hukou* students' proportion, and class ranking. School controls include private school and school ranking. Standard errors are clustered at class level in brackets.  
\* 10%, \*\* 5%, \*\*\* 1%.

Table A.12: Effect of friends on class and school environment

	Nice classmates (1)	Easy to get along with (2)	Class atmosphere (3)	Feel close (4)	Bored of school (5)	Desire to transfer (6)
School FSS	0.0751** (0.0313)	0.0975*** (0.0330)	0.1835*** (0.0348)	0.1866*** (0.0363)	-0.1325*** (0.0344)	-0.1159*** (0.0343)
School FOS	-0.0826 (0.0913)	0.0431 (0.0954)	-0.0917 (0.1007)	0.1180 (0.1029)	0.1500 (0.0987)	0.1608 (0.0991)
Grade 9	0.0254 (0.0182)	0.0372* (0.0192)	0.0275 (0.0202)	-0.0236 (0.0208)	0.0991*** (0.0198)	0.0595*** (0.0199)
Male	-0.0961*** (0.0126)	-0.0639*** (0.0132)	-0.1101*** (0.0139)	-0.0963*** (0.0144)	0.0580*** (0.0138)	-0.0135 (0.0137)
Han	0.0041 (0.0307)	0.0699** (0.0321)	0.0719** (0.0338)	0.0247 (0.0353)	-0.0299 (0.0336)	-0.0374 (0.0334)
Rural hukou	-0.0298* (0.0153)	-0.0448*** (0.0160)	-0.0089 (0.0169)	0.0013 (0.0176)	-0.0388** (0.0168)	-0.0293* (0.0167)
Local hukou	-0.0287 (0.0201)	-0.0669*** (0.0210)	-0.0255 (0.0221)	-0.0233 (0.0231)	-0.0048 (0.0220)	-0.0115 (0.0219)
Only child in the family	-0.0163 (0.0152)	0.0021 (0.0159)	0.0101 (0.0168)	0.0297* (0.0174)	-0.0106 (0.0166)	-0.0217 (0.0165)
Baseline cognitive ability	0.0829*** (0.0080)	0.0544*** (0.0084)	0.0522*** (0.0088)	0.0700*** (0.0092)	-0.0674*** (0.0087)	-0.0521*** (0.0087)
Attend preschool	0.0351** (0.0155)	0.0421*** (0.0162)	0.0124 (0.0171)	0.0280 (0.0179)	-0.0177 (0.0170)	0.0122 (0.0169)
Observations	17,528	17,532	17,511	17,400	17,446	17,551
Parents and family control	✓	✓	✓	✓	✓	✓
Class and school controls	✓	✓	✓	✓	✓	✓
County FE	✓	✓	✓	✓	✓	✓

Note: Class controls include class size, head teacher's gender, age, and years of experience, girls' proportion, local *Hukou* students' proportion, rural *Hukou* students' proportion, and class ranking. School controls include private school and school ranking. Standard errors are clustered at class level in brackets.

\* 10%, \*\* 5%, \*\*\* 1%.

# Appendix B

## Appendix to Chapter 3

### B.1 Sieves

Traditional econometric models are parametric where parameters are well specified and in finite-dimensional spaces. In contrast, in a nonparametric model, all parameters are distribution free and in infinite-dimensional spaces. A semi-nonparametric model is in the middle: a model with both finite- and infinite-dimensional parameters.

It is computationally hard to estimate the parameters in a semi-nonparametric model given the finite sample and infinite-dimensional spaces. To solve the problem, the method of sieves simplifies the parameter spaces into a finite-dimensional one by using deterministic approximations to the unknown function developed by mathematician and computer scientist. One of the linear approximations is splines, which is used in the first stage of our estimation. [Bajari et al. \(2010\)](#) also mention that other nonparametric methods, such as kernel, can be used.

The idea of splines is to replace the regressor of interest, let's say  $X$ , with the transformations of  $X$ . Different from using polynomial terms of  $X$ , splines use different polynomials in regions defined by knots. For instance, with three knots  $k_1, k_2, k_3$ , and a cubic polynomial (a polynomial of degree 3), we have:

$$y_i = \begin{cases} \beta_{01} + \beta_{11}x_i + \beta_{21}x_i^2 + \beta_{31}x_i^3 + \varepsilon_i & \text{if } x < d_1, \\ \beta_{02} + \beta_{12}x_i + \beta_{22}x_i^2 + \beta_{32}x_i^3 + \varepsilon_i & \text{if } d_1 \leq x < d_2, \\ \beta_{03} + \beta_{13}x_i + \beta_{23}x_i^2 + \beta_{33}x_i^3 + \varepsilon_i & \text{if } d_2 \leq x < d_3, \\ \beta_{04} + \beta_{14}x_i + \beta_{24}x_i^2 + \beta_{34}x_i^3 + \varepsilon_i & \text{if } d_3 \leq x < d_4. \end{cases} \quad (\text{B.1})$$

As we discussed above, we need to select knots for the cubic splines. Smoothing spline is created to avoid the knot selection problem by using a maximal set of knots. The

loss function is the penalized residual sum of squares:

$$\text{RSS}(f, \lambda) = \sum_{i=1}^N (y_i - f(x_i))^2 + \lambda \int [f''(t)]^2 dt, \quad (\text{B.2})$$

where  $\lambda$  is a fixed smoothing parameter. When  $\lambda$  equals to 0, there is no constraint on  $f$ . When  $\lambda$  equals to  $\infty$ ,  $f$  is linear.

Table B.1: Distribution of the number of peers

No. of peers	Peer group-level frequency				Individual-level frequency			
	Freq.	Cum. Freq.	Pct	Cum.Pct	Freq.	Cum. Freq.	Pct	Cum.Pct
5	1	1	0.31	0.31	5	5	0.05	0.05
6	6	7	1.88	2.19	36	41	0.38	0.43
7	2	9	0.62	2.82	14	55	0.15	0.58
8	3	12	0.94	3.76	24	55	0.25	0.83
9	5	17	1.57	5.33	45	124	0.47	1.31
10	4	21	1.25	6.58	40	164	0.42	1.73
11	3	24	0.94	7.52	33	197	0.35	2.08
12	2	26	0.63	8.15	24	221	0.25	2.33
13	5	31	1.57	9.72	65	286	0.69	3.03
14	7	38	2.19	11.91	98	384	1.03	4.05
15	1	39	0.31	12.23	15	399	0.16	4.21
16	9	48	2.82	15.05	144	543	1.52	5.73
17	5	53	1.57	16.61	85	628	0.90	6.63
18	5	58	1.57	18.18	90	718	0.95	7.58
19	5	63	1.57	19.75	95	813	1.00	8.58
20	8	71	2.51	22.26	160	973	1.69	10.27
21	10	81	3.13	25.39	210	1183	2.22	12.48
22	10	91	3.13	28.53	220	1403	2.32	14.81
23	3	94	0.94	29.47	69	1472	0.73	15.53
24	8	102	2.51	31.97	192	1664	2.03	17.56
25	4	106	1.25	33.23	100	1764	1.06	18.62
26	6	112	1.88	35.11	156	1920	1.65	20.26
27	7	119	2.19	37.30	189	2109	1.99	22.26
28	13	132	4.08	41.38	364	2473	3.84	26.10
29	9	141	2.82	44.20	261	2734	2.75	28.85
30 and more	178	310	55.80	100.00	9215	9476	71.15	100

Note: Peers are defined as co-villagers who live in the same community. 74 peer groups (347 individuals) that contain less than 5 peers are excluded.

Table B.2: Linear estimates of peer effects in decision of NRPS

	No peer effects (1)	Simple average (2)	Two-step (3)
Peers' enrollment		0.765*** (0.019)	0.378*** (0.049)
Age	0.079*** (0.008)	0.048*** (0.007)	0.035*** (0.010)
Age squared	-0.000*** (0.000)	0.003*** (0.000)	-0.000*** (0.000)
Married	-0.016 (0.018)	-0.019 (0.018)	-0.015 (0.018)
Chronic disease	-0.005 (0.007)	-0.003 (0.007)	0.004 (0.007)
Number of children	0.004 (0.003)	0.008*** (0.003)	0.008** (0.003)
Number of coresidence	0.007*** (0.002)	0.001 (0.002)	-0.001 (0.002)
log(Earnings)	0.002* (0.001)	0.002* (0.001)	0.001 (0.001)
log(Transfer income)	0.001*** (0.001)	0.001* (0.001)	0.002*** (0.001)
log(Land value)	0.004*** (0.001)	0.003*** (0.001)	0.003*** (0.001)
Observations	28,230	28,230	28,230
County characteristics	✓	✓	✓
Individual FE	✓	✓	✓
Year FE	✓	✓	✓

Note: County characteristics include GDP per capita, population density, natural increase rate, social worker density, community worker density, physician density, hospital bed density, access to Internet, mobile per capita, and average salary in the county. Standard errors are reported in brackets.

\* 10%, \*\* 5%, \*\*\* 1%.

Table B.3: Conditional logistic estimates on exclusion restrictions

	SA (1)	Two-step (2)      (3)	
Peers' enrollment	4.889*** (0.178)	3.062*** (1.005)	3.118*** (1.005)
log(GDP per capita)	0.363 (0.247)	0.485** (0.241)	
Natural growth rate	-0.004 (0.006)	-0.002 (0.006)	
Observations	11,772	11,772	11,772
Individual characteristics	✓	✓	✓
Individual FE	✓	✓	✓
Year FE	✓	✓	✓

Note: Standard errors are calculated using a bootstrap procedure in brackets.

\* 10%, \*\* 5%, \*\*\* 1%.

Table B.4: Linear estimates of peer effects among sub-group

	Full sample		Group 1		Group 2	
	SA (1)	Two-step (2)	SA (3)	Two-step (4)	SA (5)	Two-step (6)
<i>(A) Group 1: young (below 60) and Group 2: old (60 and above)</i>						
Average enrollment in own-group	0.907*** (0.105)	0.858*** (0.075)	0.971*** (0.208)	0.894*** (0.168)	0.893*** (0.136)	0.576*** (0.117)
Average enrollment in cross-group	0.127 (0.080)	0.082 (0.052)	0.045 (0.129)	-0.022 (0.153)	0.253*** (0.091)	0.168** (0.070)
<i>(B) Group 1: female and Group 2: male</i>						
Average enrollment in own-group	0.753*** (0.127)	0.683*** (0.083)	0.836*** (0.171)	0.718*** (0.104)	0.742*** (0.197)	0.633*** (0.125)
Average enrollment in cross-group	-0.045 (0.110)	-0.095 (0.080)	-0.007 (0.147)	-0.015 (0.092)	-0.262 (0.170)	-0.157 (0.113)
<i>(C) Group 1: married and Group 2: unmarried</i>						
Average enrollment in own-group	0.717*** (0.111)	0.579*** (0.077)	0.726*** (0.128)	0.649*** (0.123)	0.683*** (0.064)	0.548*** (0.126)
Average enrollment in cross-group	0.017 (0.054)	0.057* (0.033)	0.030 (0.056)	0.119*** (0.037)	-0.044 (0.053)	-0.222 (0.148)
<i>(D) Group 1: under high school and Group 2: high school and above</i>						
Average enrollment in own-group	0.732*** (0.138)	0.642*** (0.106)	0.872*** (0.174)	0.757*** (0.138)	0.610*** (0.142)	0.494*** (0.106)
Average enrollment in cross-group	-0.058 (0.087)	-0.094 (0.056)	-0.060 (0.126)	0.038 (0.095)	-0.008 (0.137)	-0.237* (0.121)

Note: Standard errors are reported in brackets.

\* 10%, \*\* 5%, \*\*\* 1%.

Table B.5: Conditional logistic estimates of peer effects based on alternative first stage estimates

	(1)	(2)	(3)	(4)
Peers' enrollment	3.062*** (1.005)	4.147*** (0.734)	3.671*** (1.205)	3.713*** (1.092)
Age	0.308 (0.359)	0.083 (0.363)	0.063 (0.365)	0.0426 (0.365)
Age <sup>2</sup>	-0.005*** (0.000)	-0.005*** (0.000)	-0.003*** (0.001)	-0.004*** (0.001)
Married	-0.074 (0.139)	-0.076 (0.140)	-0.088 (0.141)	-0.089 (0.141)
Chronic disease	0.006 (0.060)	0.006 (0.061)	0.005 (0.061)	0.006 (0.061)
Number of children	0.069*** (0.023)	0.067*** (0.023)	0.064** (0.026)	0.062** (0.026)
Number of coresidence	-0.003 (0.017)	-0.002 (0.017)	-0.007 (0.017)	-0.005 (0.017)
log(Earnings)	0.015* (0.008)	0.016** (0.008)	0.017** (0.008)	0.015* (0.008)
log(Transfer income)	0.017*** (0.007)	0.017*** (0.007)	0.017** (0.008)	0.017** (0.008)
log(Land value)	0.021*** (0.007)	0.019*** (0.007)	0.024*** (0.008)	0.021** (0.009)
Observations	11,772	11,772	11,772	11,772
Individual characteristics	✓	✓	✓	✓
County characteristics	✓	✓	✓	✓
Individual FE	✓	✓	✓	✓
Year FE	✓	✓	✓	✓

Note: Standard errors are calculated using a bootstrap procedure in brackets.  
\* 10%, \*\* 5%, \*\*\* 1%.

# Appendix C

## Appendix to Chapter 4

Table C.1: Summary statistics of ordinal outcomes

	7th grader				9th grader			
	Mean (1)	St. Dev. (2)	Min (3)	Max (4)	Mean (5)	St. Dev. (6)	Min (7)	Max (8)
Feel blue								
Never	0.273	0.445	0	1	0.223	0.416	0	1
Seldom	0.358	0.480	0	1	0.319	0.466	0	1
Sometimes	0.304	0.460	0	1	0.369	0.483	0	1
Often	0.040	0.197	0	1	0.057	0.231	0	1
Always	0.024	0.15	0	1	0.032	0.175	0	1
Feel depressed								
Never	0.443	0.497	0	1	0.354	0.478	0	1
Seldom	0.297	0.457	0	1	0.306	0.461	0	1
Sometimes	0.189	0.392	0	1	0.240	0.427	0	1
Often	0.046	0.209	0	1	0.067	0.251	0	1
Always	0.024	0.154	0	1	0.032	0.177	0	1
Feel unhappy								
Never	0.268	0.443	0	1	0.204	0.403	0	1
Seldom	0.349	0.477	0	1	0.340	0.474	0	1
Sometimes	0.286	0.452	0	1	0.338	0.473	0	1
Often	0.064	0.245	0	1	0.079	0.270	0	1
Always	0.032	0.176	0	1	0.040	0.196	0	1
Not enjoy life								
Never	0.595	0.491	0	1	0.519	0.500	0	1
Seldom	0.209	0.407	0	1	0.244	0.429	0	1
Sometimes	0.122	0.327	0	1	0.152	0.359	0	1
Often	0.041	0.199	0	1	0.046	0.211	0	1
Always	0.032	0.177	0	1	0.039	0.193	0	1

Feel sad								
Never	0.372	0.483	0	1	0.322	0.467	0	1
Seldom	0.336	0.472	0	1	0.349	0.477	0	1
Sometimes	0.217	0.412	0	1	0.242	0.428	0	1
Often	0.046	0.210	0	1	0.050	0.218	0	1
Always	0.028	0.166	0	1	0.036	0.187	0	1
Number of students	10,199				9,177			
Number of classes	217				221			
Number of schools	110				112			

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Table C.2: First-stage estimation (health outcomes)

	Same-sex friends (1)	Opposite-sex friends (2)
School-level average school FSS	0.975*** (0.045)	0.003 (0.018)
School-level average school FOS	0.044 (0.134)	1.014*** (0.055)
% of opposite gender schoolmates	-0.697*** (0.182)	0.388*** (0.075)
Parents' strictness with friends: moderate	-0.069** (0.032)	-0.006 (0.013)
Parents' strictness with friends: serious	-0.064* (0.034)	-0.034** (0.014)
Grade 9	0.030 (0.032)	0.001 (0.013)
Male	-0.092*** (0.024)	0.049*** (0.010)
Standardized cognitive test	0.067*** (0.015)	0.023*** (0.006)
Attend preschool	0.074** (0.031)	-0.010 (0.013)
Observations	17,569	17,569
Class controls	✓	✓
School controls	✓	✓
County FE	✓	✓
F statistic	50.640 (0.000)	39.085 (0.000)

Note: Standard errors are clustered at class level in brackets.

\* 10%, \*\* 5%, \*\*\* 1%.

Table C.3: Placebo test: Effect of share even birth month schoolmates

	Same-sex friends (1)	Opposite-sex friends (2)
School-level average school FSS	0.959*** (0.096)	0.007 (0.042)
School-level average school FOS	0.052 (0.303)	0.974*** (0.133)
% of even birth month schoolmates	-0.297 (0.529)	0.087 (0.233)
Parents' strictness with friends: moderate	0.053* (0.031)	0.031 (0.024)
Parents' strictness with friends: serious	0.082 (0.059)	0.069*** (0.026)
Observations	15,933	15,933
Individual controls	✓	✓
Class controls	✓	✓
School controls	✓	✓
County FE	✓	✓

Standard errors are clustered at class level in brackets.

\* 10%, \*\* 5%, \*\*\* 1%.

Table C.4: Falsification tests (health outcomes)

	Blue (1)	Depressed (2)	Unhappy (3)	Not enjoy life (4)	Sad (5)
Parental strictness with friends: moderate	-0.127 (0.080)	-0.102 (0.081)	-0.103 (0.082)	-0.097 (0.084)	-0.805 (0.082)
Parental strictness with friends: serious	0.053 (0.086)	0.025 (0.086)	-0.049 (0.087)	-0.043 (0.090)	0.028 (0.087)
School % of girls	0.903 (0.812)	0.044 (0.813)	0.980 (0.825)	0.989 (0.854)	0.610 (0.825)
Observations	17,569	17,569	17,569	17,569	17,569
Individual controls	no	no	no	no	no
Class controls	no	no	no	no	no
School controls	no	no	no	no	no
County FE	✓	✓	✓	✓	✓

Note: Other class controls include class size, head teacher's gender, age, and years of experience, and class ranking. School controls include private school and school ranking. Standard errors are clustered at class level in brackets.

\* 10%, \*\* 5%, \*\*\* 1%.

Table C.5: Estimates of friends on teenage romance

	Feelings (1)	Relationship (2)	Hand holding (3)	No physical contacts (4)
School FSS	-0.087*** (0.027)	-0.025 (0.015)	-0.078*** (0.018)	0.082*** (0.018)
School FOS	0.264*** (0.096)	0.109* (0.059)	0.071 (0.070)	-0.064 (0.070)
Observations	8,395	8,398	8,364	8,364
Individual controls	✓	✓	✓	✓
Class controls	✓	✓	✓	✓
School controls	✓	✓	✓	✓
County FE	✓	✓	✓	✓

Note: Standard errors are clustered at the class level in brackets.

\* 10%, \*\* 5%, \*\*\* 1%.

Table C.6: Ordered probit estimates of friends on mental health outcomes

	Blue (1)	Depressed (2)	Unhappy (3)	Not enjoy life (4)	Sad (5)
Panel A: All					
School FSS	-0.053*** (0.005)	-0.064*** (0.005)	-0.060*** (0.005)	-0.062 *** (0.006)	-0.063*** (0.005)
School FOS	0.026** (0.013)	0.025* (0.013)	0.010 (0.013)	0.005 (0.014)	0.028** (0.013)
Observations	18,101	18,056	18,079	18,040	18,075
Panel B: Grade 7					
School FSS	-0.059*** (0.007)	-0.073*** (0.008)	-0.066*** (0.007)	-0.070*** (0.008)	-0.073*** (0.008)
School FOS	0.001 (0.020)	0.013 (0.021)	-0.017 (0.020)	0.006 (0.022)	0.004 (0.020)
Observations	9,468	9,430	9,448	9,426	9,445
Panel C: Grade 9					
School FSS	-0.050*** (0.008)	-0.056*** (0.008)	-0.056*** (0.008)	-0.056*** (0.008)	-0.057*** (0.008)
School FOS	0.043** (0.017)	0.033* (0.017)	0.029* (0.017)	0.007 (0.017)	0.044** (0.017)
Observations	8,633	8,626	8,631	8,614	8,630
Individual controls	✓	✓	✓	✓	✓
Class controls	✓	✓	✓	✓	✓
School controls	✓	✓	✓	✓	✓
County FE	✓	✓	✓	✓	✓

Note: Standard errors are clustered at the class level in brackets. Outcomes are in a five-point scale where 1 for never, 2 for seldom, 3 for sometimes, and 4 for often, and 5 for always.

\* 10%, \*\* 5%, \*\*\* 1%.