8-2017

Education and Nutrition Problems in Rural China

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EDUCATION AND NUTRITION PROBLEMS IN RURAL CHINA

by

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A dissertation submitted to the Graduate College
in partial fulfillment of the requirements
for the degree of Doctor of Philosophy
Economics
Western Michigan University
August 2017

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Western Michigan University, 2017

The increasing inequality between rural and urban China has raised many concerns for Chinese scholars. A large gap exists not only in income but in health and education. The rural-urban disparities in health and education may contribute to greater income inequality in the future, thus leading to a vicious cycle. This study explores the factors that contribute to the increasing inequality in health and education between rural and urban China.

Using a randomized controlled trial in Shaanxi province, the first chapter studies the effectiveness of a supplemental meal program in improving students' development outcomes. This study also compares the impact of the supplemental meal program on students' health and educational outcomes with other nutritional interventions: the parent training program and the vitamin supplement program. Using a fixed effects model, I find that the supplement breakfast program is effective in improving students' health outcomes, but not their educational performances. Compared with other intervention methods, it has similar impacts to a vitamin supplement program. All three nutritional interventions are ineffective in improving students' educational performances. The parent training program has no impact on any student development outcome.

The second chapter uses the China Family Panel Survey (CFPS), a nationally representative survey to investigate net impact of parental migration on left children's health and nutrition outcomes. My measurements of children's health outcomes are height-for-age z-score (HAZ), weight-for-age z-score (WAZ) and self-perceived health rating. The results show that absence of both parents has a significant negative impact on children's health outcomes in terms of HAZ and self-rated health status. These findings suggest that left-behind children are worse off in terms of physical development and self-perceived health status when compared to their peers who live with their parents. Furthermore, there is a gender disparity in the effect of parental absence on children's health outcomes. The adverse impact is more prominent for boys than girls, indicating that boys are in a more disadvantaged position than girls under the trend of increasing internal migration in China.

The third chapter uses CFPS to study the social economic determinants of shadow education and its impact on student's academic performance. Moreover, it uses a logistic regression model to study what social-economic factors determine the participation of shadow education. Findings reveal that children's nutrition conditions, family income, mother's education, parent's expectation, whether living in a rural or urban area and whether attending a key school all have a positive impact on the shadow education participation. As for the effectiveness of shadow education in improving children's academic performance, the results are mixed. I find no significant impact of shadow education on children's standardized test scores, when using the private tutoring participation dummy variable in the regression alone. After including the time and money spent on shadow education to control for variation in shadow education's quantity and quality, I find that shadow education has a significant positive impact on children's math test scores but not word test scores.

ACKNOWLEDGMENTS

I would like to begin by acknowledging the influence of Professor Shi Yaojiang. His enthusiasm for helping rural children in northwestern China has inspired me to investigate nutrition and education problems in rural China.

Secondly, I would like to thank the members of my doctoral committee, Dr. Christine Moser, Dr. Wei-chiao Huang, and Dr. Paul Clements, for giving me valuable comments and constructive advices. I would particularly like to thank Dr. Moser for guiding me through the whole process of writing the dissertation. This dissertation could not have been finished without her help. I am really grateful for she taking the time to meet with me and review my work.

Lastly, I would like to thank my parents for supporting me and believing in me even when I was in doubt of myself. I would also like to thank my wonderful friends who encouraged me and accompanied me during the past five years.

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CHAPTER I

INTRODUCTION

This study is based on a problem that China is currently facing: the increasing inequality between rural and urban areas. China has experienced rapid economic growth during the past decades. Accompanying the rise in the Chinese economy is a rise in the rural-urban gap. There are big disparities between rural residents and urban residents in all aspects, including living standard, income, health, education, and access to public services. In this dissertation, I mainly concentrate on the inequality of nutrition and education between rural and urban children.

Nutrition and education are two critical dimensions in measuring people's welfare. While there is a great deal of writing on China's rural-urban income gap, very few studies look into the inequality of nutrition and education between rural and urban areas in China.

In investigating nutrition and education gaps between rural and urban China, this study particularly focuses on children because the inequality of nutrition and education between rural and urban children is likely to cause disparity in their future income, which may lead to more profound social inequality. Thus it is important to understand what policies or programs might promote more equal health and educational outcomes for children in rural areas. It is also crucial to identify factors that would increase nutrition and education inequality so that policy makers and the public would be aware of such consequences.

In this dissertation, my first chapter uses a randomized controlled trial in Shaanxi Province to study the effectiveness of a supplemental meal program in improving students' health and education outcomes. I also compare the effectiveness of different nutrition intervention methods, hoping to provide more information and evidence for future social program aims in helping rural children.

The second chapter studies the left-behind children phenomenon in China and focuses more on children's health outcomes and I use national representative longitudinal data to investigate the impact of parental migration on children's health outcomes. The results help identify vulnerable groups of children under the increasing trend of internal migration from rural to urban area.

My third chapter investigates the use of shadow education and how it influences education inequality in China.

This dissertation aims to provide more statistics and information to help the public understand nutrition and education inequality in China. More importantly, it provides empirical evidence to help policy makers or organizations to design programs that will more efficiently help rural children.

CHAPTER II

ARE SUPPLEMENTAL MEAL PROGAMS EFFECTIVE IN PROMOTING STUDENTS' HEALTH AND EDUCATIONAL OUTCOMES? EVIDENCE FROM A RANDOMIZED CONTROLLED TRIAL IN SHAANXI PROVINCE

2.1 Introduction

China has experienced rapid economic growth during the past decades because of the economic reforms adopted in 1978. While the economic reforms have led to large reductions in poverty, they have also created a large gap between urban and rural China in both health and educational outcomes. For example, in 2005 over 80% of urban students graduated from high schools while the high school graduation rate for rural students was less than 40% (Wang et al. 2011). In terms of health, 38 % and 15% of rural children had moderate and severe stunting, as compared with 10% and 3% of urban children, respectively (Shen et al., 1996). The gap between rural and urban areas will not only create social instability but also contribute to more profound income and social inequalities in the future. Therefore, it is important to understand what policies or programs might promote more equal health and educational outcomes for school-aged children in rural areas. In this paper, I examine the effectiveness of a one-year long supplemental meal project's impact on students' health and educational outcomes.

In recent years, China's government has made great efforts to improve health and educational services in rural areas by launching programs such as The China Rural Health Project (The World Bank, 2014), the New Rural Cooperative Medical Scheme and the One Egg per Day Program. However, many of these projects are limited to certain regions and few of them specifically target school-aged children. Experience from a range of countries suggests that supplemental meal programs leads to both better health outcomes and academic performance (Bhattacharya et al., 2006; Gundersen et al., 2012; Meyers et al., 1989), and it is therefore important to examine whether this kind of project will also be effective when applied to China's unique context.

In this paper, I use hemoglobin levels and height for age z-scores as the main health measures. Height for age z-score is a commonly used indicator to measure the cumulative growth of children. Recent studies have found that height for age z-score is correlated with educational and economic performance later in life (Dewey and Begum, 2011; Hoddinott et al., 2008; Kingdon, G., 2010). Therefore, a nutrition program's impact on height for age z-score can be correlated with long-run impacts.

Focusing on the hemoglobin level (measured by the concentration of protein molecules in red blood cells that carry oxygen in blood, g/L) is based on the fact that anemia is a prevalent public health problem that has long existed in China, and it has many adverse health and learning consequences. There are many studies investigating the impact of iron-deficiency anemia on children's cognition and behavior. Studies from the U.S, India, Indonesia, Thailand and Chile all confirm the fact that there is an educational disadvantage associated with iron-deficiency anemia (Halterman et al., 2001; Pollitt et al., 1989 Soemantri et al., 1985; More et al., 2013; Walter et al., 2003). In addition to the impact of anemia on children's cognition and physical development, there is also evidence showing that a unit decrease in hemoglobin level will lead to increased risk (by 1.28%) of mild or moderate mental retardation (Hurtado et al., 1999). All of these studies agree that anemia has a negative impact on students' mental and physical development.

However, these studies fail to draw a causal relationship between these two due to uncontrolled socioeconomic backgrounds (Grantham-McGregor et al., 2001).

Few studies have investigated anemia in China (Chen et al., 2005; Ma et al., 2014; Piao et al., 2005). The existing literature on anemia mostly focuses on measuring the prevalence of anemia. In 2002, the anemia rate in China's population was estimated to be 20.1% which can be classified as a moderate public health problem based on the standard listed by the World Health Organization (WHO, 2001; Piao et al., 2005). The prevalence for subgroup populations can reach 40% to 60% in rural China (Chen et al., 2005). A study of anemia prevalence among children 3-11 years old shows that the anemia rates in rural areas were significantly higher than those in big cities. The result suggests that more attention needs to be given to students in rural areas (Ma et al., 2014).

Studies investigating the impact of nutrition interventions on children's developmental outcomes primarily focus on justifying the benefit of early childhood nutrition investment (Rivera et al., 2004; Hoddinott et al., 2008). A study from Guatemala found that nutrition intervention before age three was correlated with higher adult hourly wage (Hoddinott et al., 2008). Another randomized controlled trial from Mexico shows that PROGRESA, a development program with a nutritional intervention, is associated with better growth and lower rates of anemia in low-income, rural infants and children in Mexico (Rivera et al., 2004). In this paper, I will not only investigate the impact of a certain nutrition intervention on students' health and educational outcomes but also discuss the differences between different nutrition interventions.

A nutrition intervention program conducted by Northwest Socioeconomic Development Research Center (NSDRC) in China has provided the opportunity to examine anemia and the impacts of a supplemental meal program on students' health and education outcomes in rural China. It was a randomized controlled trial conducted from 2009-2010. I find the supplemental breakfast program led to a significant improvement in students' height, weight and height for age z-score. I also find some evidence that students' hemoglobin levels also increase due to the intervention. However, the program does not seem to have a significant influence on students' math test scores.

2.2 Study Design

This paper uses data from a nutrition intervention program that was conducted by the Northwest Socioeconomic Development Research Center (NSDRC) in China. This nutrition project aimed to promote rural students' health status in the Shaanxi province, located in Northwest China.

The participant students of this nutrition program come from 10 different counties in the Shaanxi province. Shaanxi province has an average yearly income level of 14371.5 yuan (2300 dollars) and ranked 22 (out of 32) among all provinces. It's a typical province in Northwestern China with mining and energy as its supporting industries. The population of Shaanxi province is 37.5 million, 52.7% of whom are rural residents (National Bureau of Statistics of China, 2014). To choose the sample, the research center first obtained a list of all 80 counties which have a high rural population percentage (greater than average 52.7%) and then randomly chose 10 out of the 80 counties. To choose the sample schools, NSDRC conducted a canvas survey by visiting each sample county's bureau of education. In each bureau a list of all elementary schools that fit two criteria was obtained. First, schools had to have more than 200 students. Second, there had to be at least 50 students living in dormitories and eating most of their meals at school. A total of 80 schools fit these criteria. From the list, 40 schools were randomly chosen with 1185 fourth grade students in total.

This nutrition project was designed as a randomized controlled trial. It involved two waves of data collection and one-year long intervention. Each survey wave consisted of four forms: student, household, school and teacher. These four parts provide comprehensive information about students' individual, household and school characteristics. The student form is filled in by students under the instruction of the trained research team members. The research team members not only explained to students how to fill in the form in detail but also checked for completeness and correctness to reduce missing data. This part collected students' general information including their age, gender, boarding status and their diet habits. The household form was handed out to each student in the class after the completion of the student form. Students were asked to take the household form home and have their parents or legal guardians complete it. In each school, one teacher was appointed to collect the household surveys. The household forms included basic information about students' family information, such as their family composition, parents' occupation, education, migration status and ownership of selected assets (such as car, cell phone, refrigerator). Teacher and school forms were completed by interviewing each school's principal and teachers.

In addition to the survey, each student in the sample was also required to take a physical examination including height and weight measurement and a blood test. A standardized math test was also given to the students before and after the intervention to measure their educational performance.

In 2009, the research center conducted the baseline survey among fourth grade students in 80 primary schools in the Shaanxi province. After the baseline survey, 30 schools were randomly placed in the control group and 12 schools were randomly assigned to receive the supplemental meal program. 15 schools were randomly chosen to receive a parent training program while another 15 schools were allocated to receive vitamin supplement programs. There was no overlap between intervention groups. In 2010, after the one-year supplemental meal program, an evaluation survey along with physical examinations and standardized tests were given to both control groups and treatment groups.

As mentioned above, there were three different interventions in this program: a parent training program, a vitamin supplement program and a supplemental meal program. For students who received the parent training program, their parents were required to participate in a training program where information about anemia, adverse effects of anemia and how to balance students' diet to combat anemia were provided to students' parents in detail. Students' daily nutrition intake was not altered. In the vitamin supplement program, each student was given a multivitamin with mineral supplements each day during the class break by their teacher. Detailed explanation on the supplemental meal program will be given in a later part.

There are other studies using the same data from this nutrition intervention project, but they focus on the analysis of the parent training program and nutrition supplement intervention (Shi et al., 2012; Shi et al., 2013; Chang et al, 2013). The first paper measures the overall impact of the parent training program on students' nutrition status, particularly hemoglobin level. The results suggest that parental training gives basic knowledge about anemia to parents, but this increased knowledge did not lead to sharp changes in behavior overall (Shi et al, 2012). A second paper investigates the parent training program's impact on students' hemoglobin level when students have parents staying at home versus staying away for work. Results show that the absence of parents has a negative impact on the effectiveness of intervention (Chang et al, 2013). The third paper focuses on analyzing the impact of the multivitamin supplements intervention on students. Those results suggest that the multivitamin supplements intervention has a significant positive impact on both student hemoglobin levels and standardized math test scores. (Shi et al, 2013).

This paper mainly focuses on the supplemental meal program. The design of the supplemental meal program is aimed at altering part of the students' diet to satisfy children's daily nutritional needs. The research team provided students with a specialized food called "vita meal" at breakfast every weekday as the intervention protocol. Breakfast was chosen as a targeted meal based on the fact that it is more feasible to control students' breakfast than lunch. Because 51% of the students (from the baseline survey) usually go back home and have their lunch during the mid-day break, it is impossible to require all students stay in school during the mid-day break and have a specialized lunch. Vita meal is a highly nutritious porridge; it not only provides students with the right amount of proteins, carbohydrates, iron and vitamins but it is also in the form of porridge which most of local students are used to eating.

Before the implementation of the breakfast program, the research team revisited the 12 supplemental meal program schools to make arrangements with each school's principal and teachers. The research center and intervention schools made detailed contracts about the intervention program. The contracts stated that principals and fourth year grade teachers were responsible for monitoring the school's cafeteria to make sure they cooked vita meal and served it as breakfast every weekday to every student. The research center was responsible for providing vita meal and all other equipment that were needed for cooking and serving. The research team personally trained chefs in the school cafe on how to cook and prepare vita meal for students. In addition, each school was also given several posters with detailed information about the vita meal and instruction on how to cook it. After the arrangement, intervention schools started to provide vita meal as breakfast to fourth grade students during a 20-minute long class break. This intervention lasted from October 2009 to June 2010 (except for winter break which lasted for one month). During the intervention period, the research team used several methods to monitor each school. They randomly called students' parents in intervention schools to get feedback on the vita meal breakfast. They also revisited selected intervention schools' cafe to check if they followed the instructions. At the end of the intervention, principals and fourth grade teachers got 100 yuan as a reward (equivalent to a two-day salary). Ethical approval for the study was granted by Stanford University's Institutional Review Board.

2.3 Data

The data used in this paper comes from two survey waves. The baseline survey covers 3067 fourth grade students from 80 schools. Only 1185 students from 42 schools were randomly assigned to the control group and supplemental meal program group. Another 869 students were chosen to participate in the other two intervention programs. The rest of the students were not selected to participate in the study. At the time of the evaluation survey, 42 students were lost due to absence and transfer. Thus, my final data set consists of 1143 students, 371 students are from the supplemental meal program group and 772 students are from the control group.

The hemoglobin level of each student was obtained from a blood test. Since anemia is defined by low hemoglobin levels, students' anemia status can be determined by comparing students' hemoglobin level with the anemia cut-off proposed by WHO. WHO recommends a hemoglobin level cut-off of 115g/L for children aged 5-11 years and 120 g/L for children aged 12-14 years (WHO, 2001). In this paper, I use the anemia cut-off of 115 g/L for children aged 11 years and under and the cut-off of 120 g/L for children aged 12 years and over.

Height for age z-score (HAZ) is used to measure students' physical development. The z-score is powerful in showing child development compared to a reference group of the same age and gender. I use the growth reference data for 5-19 year olds (WHO, 2007), which is the internationally accepted growth reference data, in constructing the HAZ variable. In addition to HAZ, I use height and weight directly as measurements of students' physical development to investigate the net impact of the supplemental meal program on students' growth.

In addition to HAZ, I also use weight and height because they are a more direct and intuitive way to measure children's physical development outcome for the general public. Height is also believed to be an indicator of lifetime health status. Many studies have found that height is associated with future wage and career success (Schultz, 2002; Judge & Cable, 2004).

A standardized math test was also included to evaluate students' school performance. The test consisted of 29 questions and students were required to finish it within 30 minutes. The scores of this standardized test can be used as a consistent measurement of students' school performance across different schools. I admit the limitation of using only test scores to measure students school performances due to the limitation of data.

To demonstrate that students in the control group serve as a valid counterfactual for the treatment group, table 2.1 provides a comparison of variable means between the control group and the treatment group. T tests have also been performed to determine whether students in the treatment group were statistically identical to students in the control group in terms of the main interest variable and a set of control variables. The table shows that students in the treatment and the control groups were balanced across the main variables: hemoglobin levels (row 1), HAZ (row 2), height (row 3) and weight (row 4). Except for boarding status, one can see that there are no statistically significant differences between the control and the treatment group in students' characteristics, including: age, anemia rate, gender percentage, parents' education level and parent's residence.

In this paper, I use a set of variables in measuring students' health and educational outcomes, including: hemoglobin level, HAZ, height, weight and standardized test scores. Table 2 provides the summary statistics of these outcome variables over control and intervention groups before and after intervention. A one-way ANOVA analysis is also performed to determine whether the difference between the evaluation survey and baseline survey is significantly different across groups and the results are shown in the last column.

From the descriptive statistics, we see that the treatment and control groups both experienced an increase in hemoglobin level over the one-year period, but the increase for the supplemental meal program group is statistically significantly higher than for the control group. This suggests that the treatment is effective in improving hemoglobin levels. In terms of students' physical development, both groups see an increase in height for age z-score over the one-year period. The increase is significantly larger for the supplemental meal program group, suggesting that the supplemental meal program has a positive impact on student physical development. For test scores, students in both groups performed better in the evaluation survey wave. Here, the control group gained more than the treatment group. But the difference was not significantly different, suggesting that the treatment does not have a significant impact on improving students' math scores.

A histogram is a more direct way to see the change of the students across time. As one can observe from figure 2.1, the whole distribution of hemoglobin levels shifts to the right after the intervention for both groups. However, from this histogram, one cannot conclude that intervention is effective in improving students' hemoglobin levels because this increase may solely be due to age effects.

From figure 2.2, one can observe that both the control group and the treatment group show changes after the one-year intervention. What needs to be noted is that this shift is especially visible in the lower tail of treatment group HAZ distribution. This suggests that those students who initially have comparatively bad physical development in the treatment group have greater improvement in their height for age z-score index.

Figure 2.3 shows the change of standardized test score for control and supplemental meal program groups. The right shifting trends for both graphs are obvious and the control group even seems to shift more than the treatment group.

Figures 2.4 and 2.5 show the changes in distribution of height and weight for both groups. Both figures suggest that students in the treatment group and in the control group both experience an increase in their height and weight. However, whether the magnitude of the increase in height and weight is different from the treatment group to the control group cannot be concluded.

2.4 Estimation

The main purpose of this paper is to examine the impact of the year long supplemental meal program's impact on student health and education outcomes. More specifically, I am interested in examining whether the program increased students' hemoglobin level, HAZ-score, height, weight and standardized math test scores. From the statistical analysis in the previous section, I found preliminary evidence that there is an average effect of the supplemental meal program on students' hemoglobin levels and physical development. I construct the baseline and evaluation information into panel data and use a fixed effects model to examine this question more rigorously. The advantage of the fixed effects model is that I can control for all other time-invariant unobservable student, family and school characteristics' impact on students' development outcomes. I regress the difference of the outcome variables (hemoglobin level, HAZ-score, height, weight and standardized math test score) on the corresponding changes in student characteristics that might have an impact on students' health status and education performance.

In addition to controlling for the unobservable characteristics, I also control for the possibility of intra-school correlation by clustering standard errors at the school level. Because the randomization of this program is at the school level and not the student level, students in the same school may encounter common shocks which may bias the regression results. To control for this, I use a robust standard error which accounts for the possible clustering. Tables 2.3 and 2.4 report estimation results for the impact of the supplemental meal program on students' educational and health outcomes.

The first two columns of table 2.3 present the results for the impact of the supplemental breakfast on student hemoglobin levels. Column (1) presents the results of the fixed effect model. The result shows that the treatment and time dummy are both significant in explaining students' increase in their hemoglobin level. The coefficient of time dummy suggests that over the course of the year, student hemoglobin levels increased by 2.6g/L, which is consistent with normal development trends. The treatment dummy has a coefficient of 2.1g/L, indicating that the increase in student hemoglobin levels is 2.1 g/L (80%) larger for the treatment group compared to the control group. This confirms the preliminary result that the supplemental meal program is effective in improving students' hemoglobin level. Column (2) reports results of the fixed effect model with a robust standard error which controlled for intra-cluster correlation. After controlling for clustering, the significance of the treatment dummy vanishes.

The discrepancy between the two regressions suggests that the increase in hemoglobin levels between the treatment group and the control group may not solely be caused by the supplemental meal program, and that student outcomes are correlated within schools. This situation may occur because the intervention is conducted in school level, and different schools may have implemented the intervention heterogeneously or schools may have experienced some correlated shock at the school level.

Columns (3) and (4) of table 2.3 show the estimation result for HAZ. The results of the two regressions are consistent with each other. The treatment dummy and time dummy are both significant. The positive coefficient in front of the treatment dummy indicates that students in the treatment group tend to have a higher HAZ-scores compared to students in the control group. This result implies that the supplemental meal program has a positive impact on students' physical development.

In the two regressions for the standardized test score (shown in columns (5) and (6) of table 2.3), only the time dummy is significant. This means that students' educational outcome improved over the year. This is as expected because the standardized tests given to the students in the baseline and evaluation wave were the same. As they gain one more year of knowledge, they are expected to have an improvement in the standardized test score. The treatment dummy is not statistically significant in these two regressions, which indicates that there is no significant difference between the treatment group and the control group in their test scores. This result implies that the supplemental meal program does not have any impact on students' gains in math tests. This result is consistent with some other studies (Behrman, 1996; Case, 2005). The major argument behind this is that educational performance is a long-term cumulative result. Although the supplemental meal program may have a short-term impact on students' physical development such as height and weight, it is hard to observe a dramatic change in students' educational performance measured by math test scores within one year.

In terms of height and weight, both regression results are consistent with each other (table 2.4). I found a significant positive impact of the supplemental meal program on students' height and weight. Students in the supplemental meal program group grew 0.6 cm taller than students in the control group, while the students' annual growth in height is 3.3 cm. That is a 26% increase compared to students who received no treatment. As for the impact on weight, the result suggests that supplemental meal program resulted in students in the treatment group growing 0.37 kg (20%) more compared to students in the control group.

The randomized controlled trial studied in this paper has three different nutrition interventions, a multivitamin supplement program, a parent training program, and a supplemental breakfast program. These three different treatment groups share the same control group and there is no overlap between three treatment groups. To compare the impact of different nutrition interventions, I incorporated the data of the other two interventions and applied the fixed model effect to examine their impacts on students' educational and health outcomes. The estimation results are presented in table 2.5 and table 2.6.

For the multivitamin supplement program (shown in table 2.5), its impact on hemoglobin levels is the same as the supplemental meal program. Under the fixed effects model with the default standard error, the treatment dummy is significant. While under the regression with robust standard error that controls for school clustering, the treatment dummy is no longer significant. This also suggests some evidence in vitamin intervention's effectiveness in improving students' hemoglobin level. I found that the vitamin supplement intervention has a positive impact on students' HAZ, and the magnitude is similar to that of the supplemental meal program. The vitamin intervention's net impact on students' height is 0.7 cm, helping students in the treatment group to grow 20% more than students in the control group. However, the result suggests that vitamin supplement intervention does not have any impact on students' weight and educational performances.

Regarding the impact of the parent training program on student hemoglobin levels, the treatment dummy is not significant in any specification, suggesting that the parent training program does not have a significant impact on students' hemoglobin level. The treatment dummy remains insignificant when examining the parent training program's impact on students' height, weight and HAZ. This fact indicates that the parent training program does not have any impact on students' physical development. Regarding test scores, the treatment dummy remains insignificant for both regressions. This result suggests the ineffectiveness of the parent training program in improving students' educational outcomes.

2.5 Conclusion

This paper uses data from a randomized controlled trial in rural China to analyze the impact of a free-breakfast program on students educational and health outcomes. I find that the supplemental breakfast program has a significant positive impact on students' HAZ, an indicator that is believed to be associated with students' educational and economic performance later in life (Dewey and Begum, 2011; Hoddinott et al., 2008; Kingdon, G., 2010). The increase in student's HAZ indicates a reduced gap between the students who participated in the supplemental breakfast program and well-nourished students in their physical development. The increase in students' height over the year-long period is 25% more for students in the treatment group compared to students in the control group. I also found a 20% greater weight gain for students who participated in the breakfast program compared to students who were in the control group. All these facts suggest that the supplemental breakfast program is effective in improving students' physical development.

Although the impact of the breakfast program on student hemoglobin levels is mixed across different specifications, there is some evidence of a positive impact on student hemoglobin levels. As for students' educational performance, the results suggest that providing students with breakfast does not have any impact on students' standardized math test scores. In general, the supplemental breakfast is effective in improving students' health status but not their math test scores.

In addition to examining the impact of the supplemental breakfast program on students' development outcomes, I also examined the two other nutrition interventions: a parent training program and a multivitamin supplement program. Comparing the effectiveness of different intervention impacts on students' outcomes provides important implications for governments and organizations in designing programs to improve school-aged children's developmental outcomes.

The result of the fixed effect model suggests that providing parents with more information does not change outcomes for their children. This result suggests that giving parents more health information is not an effective way of improving students' development outcomes, despite the fact that this method has a comparatively low cost. This result is consistent with other literature that finds a weak effect of information on behavior (Patil et al., 2014;). Patil et al. find that although the information campaign has a modest impact on parents' behavior, the improvement is insufficient to generate positive impact on children's health outcomes.

As for the multivitamin supplements program, the results suggest that the intervention has a significant positive impact on both students' height and hemoglobin levels. However, I did not find any impact on students' weight and standardized math test scores. Comparing with the result from the supplemental breakfast program, one can find that multivitamin supplements have a similar impact on students' outcomes. However, weight gain only happens in the supplemental breakfast program.

In this study, the research center did not combine treatments together due to the time and budget constraints. However, it would be of great interest to examine the combination of treatments' impact on children's health outcomes in the future. Although this study finds that information intervention does not have a significant impact on children's health outcomes, future studies could combine information intervention with other nutrition interventions to see if information could benefit children with the presence of other intervention methods.

One limitation of this study is that one year may not be long enough to observe an improvement in educational outcomes. Further research would be needed to look at the possible long run benefits. Another consideration for policy makers is the cost of the different interventions. While the vitamin and supplement breakfast interventions have similar impacts, the vitamin intervention is likely lower in cost.

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Table 2.1 Variable means for intervention and control groups at baseline survey

Baseline survey	Control Group (1)	Supplemental meal program Group(2)	Difference between diet and control group(3)=(2)-(1)	p-value
Hemoglobin level(g/L)	128.2	128.0	-0.02	0.84
age(year)	9.93	9.93	0	0.91
HAZ	-.83	-.75	0.08	0.21
Height (cm)	132.6	133.1	0.5	0.25
Weight (Kg)	28.6	28.7	0.1	0.7
Percentage of anemic student (%)	12.9	11.6	-1.3	0.53
Percentage of boarding student (%)	43	54	11	0.03**
Percentage of male student (%)	50.3	52.4	2.1	0.50
Education level of mother	2.26	2.31	0.05	0.3
Education level of father	2.6	2.59	-0.01	0.92
Percentage of Children whose parent is away from home (%)	0.36	0.41	0.05	0.08

Note: *- significant at 10%; **- significant at 5%; *** - significant at 1%.

Table 2.2 Dependent variables' mean over different groups before and after intervention

Obs:1185	Baseline survey	Evaluation survey	Difference between evaluation survey and baseline survey	Difference in difference between treatment and control group and between evaluation survey and baseline survey
Hemoglobin level(g/L)				
Supplemental meal group	128.5	132.8	4.3	1.6**
Control group	128.1	130.8	2.7	
HAZ				
Supplemental meal group	-0.75	-0.54	0.21	0.07**
Control group	-0.82	-0.68	0.14	
Test score				
Supplemental meal group	19.1	20.6	1.5	-0.3
Control group	17.8	19.6	1.8	
Height (cm)				
Supplemental meal group	133.1	137.2	4.1	0.5**
Control group	132.6	136.2	3.6	
Weight (Kg)				
Supplemental meal group	28.7	30.8	2.1	0.3**
Control group	28.6	30.4	1.8	

Note: *- significant at 10%; **- significant at 5%; *** - significant at 1%.

Table 2.3 Impact of supplemental meal program on students' hemoglobin level, HAZ, height, weight and standardized test score using student fixed effects

Dependent variable	Hemoglobin level (g/L)		HAZ		Test score	
Estimation method	Default SE	Robust SE	Default SE	Robust SE	Default SE	Robust SE
Treatment(0=no intervention, 1= Received supplemental meal intervention)	2.13*** (0.81)	2.13 (2.08)	0.08** (0.025)	0.08* (0.039)	-0.53 (0.23)	-0.53 (0.29)
Time Dummy(0= Year of 2009,1=Year of 2010)	2.59*** (0.47)	2.59*** (1.26)	0.14*** (0.01)	0.14*** (0.03)	1.87*** (0.14)	1.87*** (0.17)
Boarding status(0=live at home, 1=live at school)	0.98 (1.29)	0.98 (1.34)	0.01 (0.04)	0.01 (0.04)	0.35 (0.38)	0.35 (0.41)
Constant	127.9*** (0.67)	127.9*** (0.72)	-0.82*** (0.02)	-0.82*** (0.02)	17.98*** (0.19)	17.98*** (0.20)
Observations		1184		1173		1088

Note: Standard errors are in parentheses.*- significant at 10%; **- significant at 5%; *** - significant at 1%.

Table 2.4 Impact of supplemental meal program on students' height and weight using student fixed effects

Dependent variable	Height (cm)		Weight (Kg)	
Estimation method	Default SE	Robust SE	Default SE	Robust SE
Treatment(0=no intervention, 1= Received supplemental meal intervention)	0.87*** (0.17)	0.87*** (0.26)	0.37*** (0.1)	0.37* (0.23)
Time Dummy(0= Year of 2009,1=Year of 2010)	3.36*** (0.09)	3.36*** (0.19)	1.81*** (0.06)	1.81*** (0.14)
Boarding status(0=live at home, 1=live at school)	0.24 (0.27)	0.24 (0.22)	0.03 (0.16)	0.03 (0.12)
Constant	132.7*** (0.13)	132.7*** (0.13)	28.5*** (0.08)	28.5*** (0.08)
Observation		1173		1173

Note: Standard errors are in parentheses.*- significant at 10%; **- significant at 5%; *** - significant at 1%.

Table 2.5 Impact of vitamin supplement program on students' hemoglobin level, HAZ and standardized test score using student fixed effects

Dependent variable	Hemoglobin level (g/L)		HAZ		Test score	
Estimation method	Default SE	Robust SE	Default SE	Robust SE	Default SE	Robust SE
Treatment(0=no intervention, 1= received vitamin intervention)	2.01*** (0.78)	2.01 (1.64)	0.1*** (0.03)	0.1** (0.04)	-0.08 (0.23)	-0.08 (0.28)
Time Dummy(0= Year of 2009,1=Year of 2010)	2.59*** (0.46)	2.59* (1.25)	-.31*** (0.02)	-.31*** (0.03)	1.86*** (0.14)	1.86*** (0.17)
Boarding status(0=live at home, 1=live at school)	0.70 (1.38)	0.70 (1.39)	-0.006 (0.05)	-0.006 (0.03)	0.78 (0.42)	0.78 (0.43)
Constant	127.7*** (0.59)	127.7*** (0.72)	2.33*** (0.15)	2.33*** (0.29)	17.59*** (0.18)	17.59*** (0.17)
Observation	1224		1218		1227	

Note: Standard errors are in parentheses.*- significant at 10%; **- significant at 5%; *** - significant at 1%.

Table 2.6 Impact of vitamin supplement program on students' height and weight using student fixed effects

Dependent variable	Height (cm)		Weight (Kg)	
Estimation method	Default SE	Robust SE	Default SE	Robust SE
Treatment(0=no intervention, 1= received vitamin intervention)	0.67*** (0.17)	0.67*** (0.25)	0.11 (0.1)	0.11 (0.25)
Time Dummy(0= Year of 2009,1=Year of 2010)	3.39*** (0.09)	3.39*** (0.19)	1.81*** (0.06)	1.81*** (0.14)
Boarding status(0=live at home, 1=live at school)	0.08 (0.30)	0.08 (0.24)	-0.22 (0.18)	-0.22 (0.17)
Constant	132.3** (1.01)	132.7** (1.9)	28.4*** (0.08)	28.4*** (0.09)
Observation	1218		1218	

Note: Standard errors are in parentheses.*- significant at 10%; **- significant at 5%; *** - significant at 1%.

Table 2.7 Impact of parent training program on students' hemoglobin level, HAZ and standardized test score using within estimates

Dependent variable	Hemoglobin level (g/L)		HAZ		Test score	
Estimation method	Default SE	Robust SE	Default SE	Robust SE	Default SE	Robust SE
Treatment(0=no intervention, 1= received parent training intervention)	-0.23 (.77)	-0.23 (1.86)	0.05 (0.03)	0.05 (0.049)	-0.35 (0.22)	-0.35 (0.25)
Time Dummy(0= Year of 2009,1=Year of 2010)	2.60*** (0.46)	2.60* (1.25)	-0.3*** (0.016)	-0.3*** (0.03)	1.86*** (0.13)	1.86*** (0.17)
Boarding status(0=live at home, 1=live at school)	-0.20 (1.21)	-0.20 (1.05)	-0.01 (0.043)	-0.01 (0.03)	0.51 (0.36)	0.51 (0.36)
Constant	128.42 (0.61)	128.42 (0.65)	-0.8*** (0.02)	-0.8*** (0.18)	17.84 (0.18)	17.84 (0.18)
Observation		1234		1227		1235

Note: Standard errors are in parentheses.*- significant at 10%; **- significant at 5%; *** - significant at 1%.

Table 2.8 Impact of parent training program on students' height and weight using student fixed effects

Dependent variable	Height (cm)		Weight (Kg)	
Estimation method	Default SE	Robust SE	Default SE	Robust SE
Treatment(0=no intervention, 1= received parent training intervention)	0.20 (0.15)	0.20 (0.30)	0.35 (0.2)	0.35 (0.22)
Time Dummy(0= Year of 2009,1=Year of 2010)	3.68*** (0.09)	3.68*** (0.19)	1.82*** (0.06)	1.82*** (0.06)
Boarding status(0=live at home, 1=live at school)	-0.08 (0.24)	-0.08 (0.16)	-0.22 (0.15)	-0.22* (0.13)
Constant	132.7*** (0.12)	132.7*** (0.10)	28.7*** (0.08)	28.7*** (0.08)
Observation		1227		1227

Note: Standard errors are in parentheses.*- significant at 10%; **- significant at 5%; *** - significant at 1%.

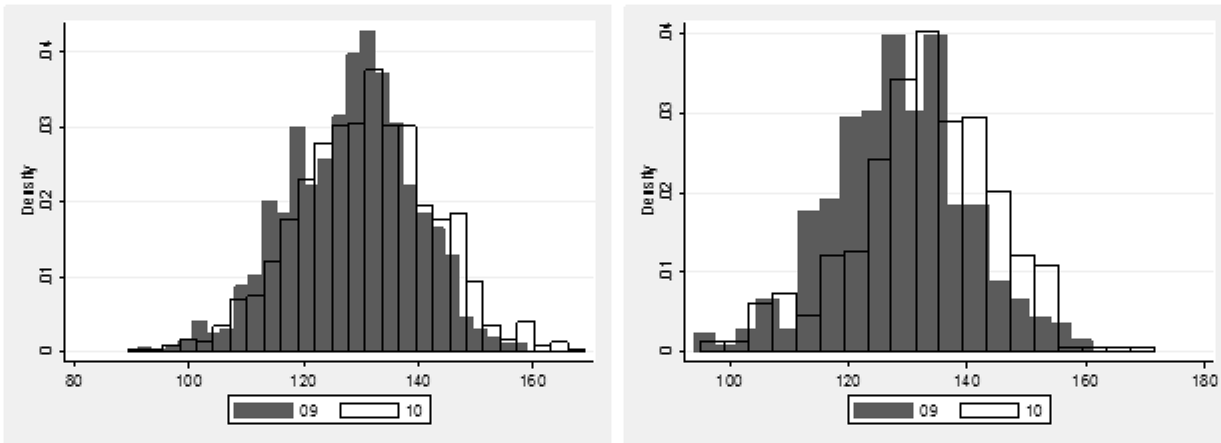

Figure 2.1 Histogram of hemoglobin levels of control (left) and treatment (right) group before and after intervention

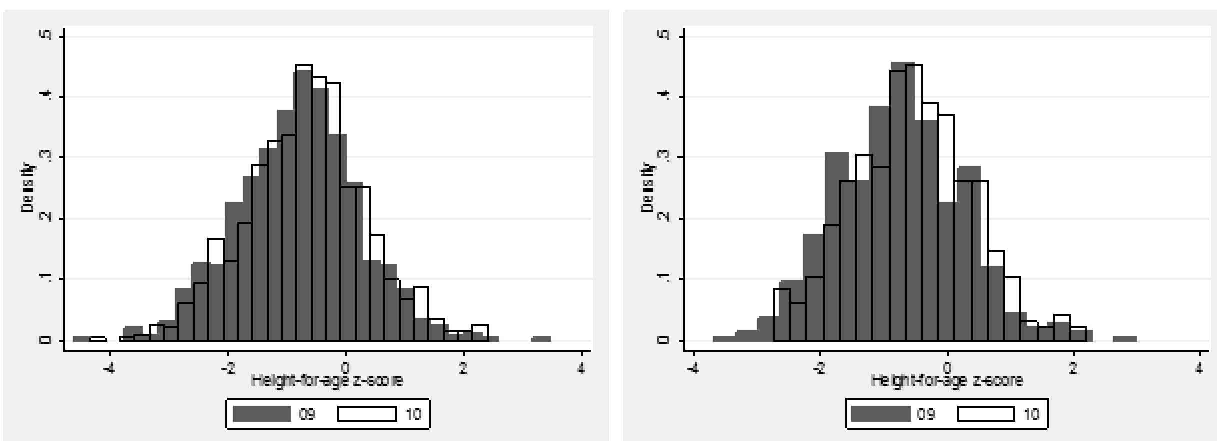

Figure 2.2 Histogram of haz of control (left) and treatment (right) group students before and after intervention

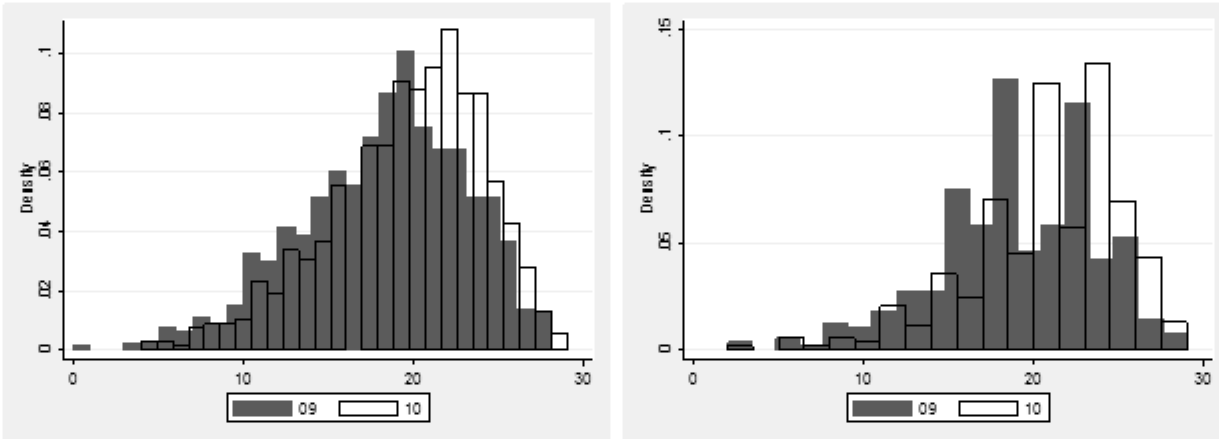

Figure 2.3 Histogram of test score of control (left) and treatment (right) group students before and after intervention

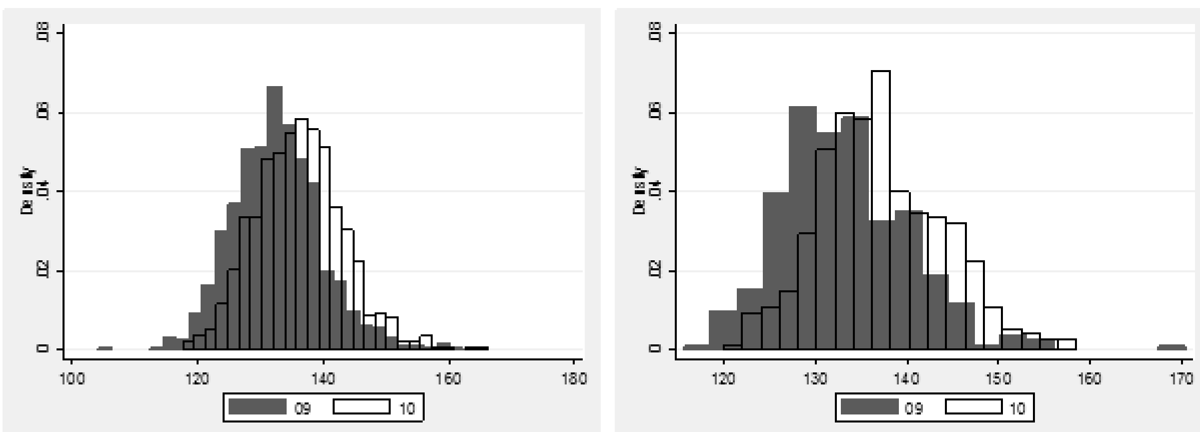

Figure 2.4 Histogram of height of control (left) and treatment (right) group students before and after intervention

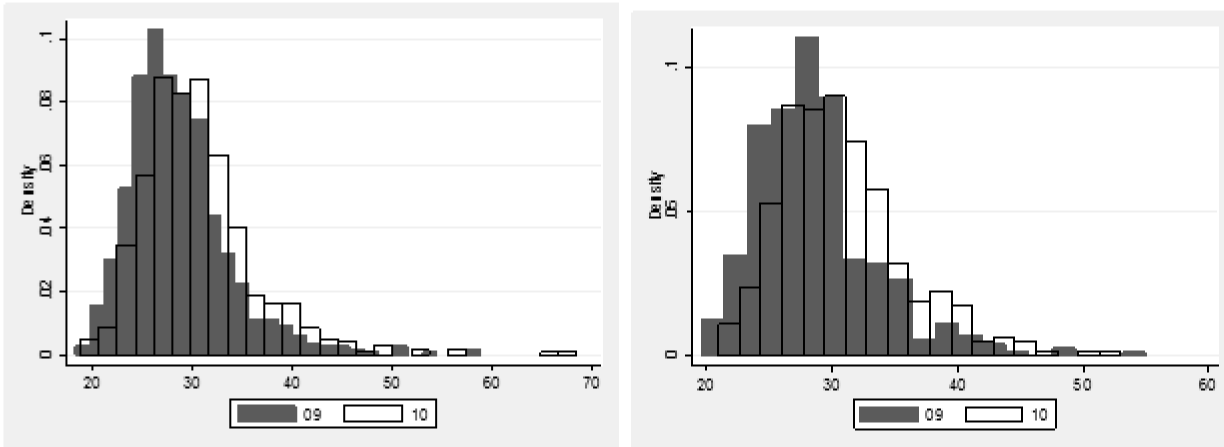

Figure 2.5 Histogram of weight of control (left) and treatment (right) group students before and after intervention

CHAPTER III

HOW DOES THE INCREASING INTERNAL MIGRATION TREND IN CHINA AFFECT HEALTH AND NUTRITION OUTCOMES OF LEFT-BEHIND CHILDREN?

3.1 Introduction

Accompanying the rapid economic growth in China is the big urban-rural gap. The increasing wage difference between rural and urban areas attracts millions of rural residents to migrate to cities in search of work. As a result, 169 million rural residents went out for work in 2015. (Survey of Migrant Workers, China National Bureau of Statistics, 2015, Table 1) and the number is still increasing. This big wave of internal migration caused millions of children to be left behind. This new growing subpopulation of left-behind children has drawn great attention from the public. Despite its degree and scale, the “left-behind children” phenomenon in China remains understudied because of both theoretical ambiguities and empirical challenges.

While much research has studied the impact of parental migration on the left-behind children’s welfare, no consensus has been made on whether the net impact is positive or negative. Theoretically, there are two channels through which parent migration can affect the development of left-behind children. One is through remittance; parents who migrate to urban areas for work usually earn more income. Remittance sent back to the left-behind family will help increase the investment in children, which may have a positive impact on both their education and health outcomes (Yang, 2008; Alcaraz et al., 2012; Gibson and McKenzie, 2014).

The other one is through parental care. Parent migration implies a lengthy separation between parents and children. Living without direct parental care during childhood and adolescence, the most crucial development period, creates a less supportive family environment for left-behind children to grow and develop (Lahaie et al. ,2009; Antman, 2012). Lacking care and intimate relationship with parents may lead to worse physical and psychological development for left-behind children when compared to their peers. Thus, the net impact of parent migration on children is a combination of these two effects, and the sign of the net impact is unclear. It remains a worthy empirical question to examine, especially given the context of China's increasing number of left-behind children.

Articles that study the impact of parental migration impact on left-behind children focus mostly on three aspects: health and nutrition status, education outcomes and emotional well-being. Extensive studies have investigated the effects of parent migration on education. While most of the research measures education by schooling attainment (Antman, 2012; McKenzie and Rapoport 2011), others also use time allocation (Antman, 2011; Chang et al., 2011; Chen, 2013) and school attendance (Gibson and McKenzie, 2014). Comparing the literature on education, less has been done to examine the impact on health outcomes. Hildebrandt and McKenzie (2005) find that the migration of a household member leads to better child health, as measured by birth rate and infant mortality rate in Mexico. While Gibson et al. (2011) find that migration of a household member has a negative impact on children's weight-for-age and height-for-age. In this paper, I'm going to mainly focus on children's health and nutrition outcomes.

Many Chinese scholars have done work in examining the impact of parental migration on left-behind children's health outcomes. However, the existing literature suffers from several shortcomings. First, many studies draw their results based on data from single geographic regions, and thus these studies may lack external validity. For example, Zhang et al. (2014) uses data from only one county in Hunan province to examine the impact of parental migration on children's cognitive outcomes. Zhou et al. (2015) uses data covering nearly 141,000 children coming from 10 provinces, but all of these children come from poor rural areas.

Second, nearly all of the papers suffer from an endogeneity problem because they use cross-sectional data to investigate the migration impact on children's health outcomes. (Gao et al., 2010; Kong and Meng, 2010; Wen and Lin, 2012; Zhou et al., 2015). For example, Zhou et al. (2015) address this problem by comparing left-behind children with children who have both parents and find no significant difference between these two groups in terms of a series of growth indicators such as weight-for-age and height-for-age. Kong and Meng (2010) investigate the educational and health outcomes of the children of migrants (both left-behind and migrated) by comparing them with non-migrant rural children and urban children. The result suggests that left -behind children and migrant children are in a worse position when compared to their peers.

Results drawn from previously mentioned papers are not causal due to the endogeneity problem. Estimation of the causal effect of parental migration on student outcome is problematic due to the fact that migration suffers from a self-selection problem. Migrants and non-migrants may be different in some unobservable characteristics that also have an impact on children's outcomes. Thus, a cross-sectional comparison between children from migrants and non-migrants may pick up the effects of other factors such as different socio-economic status and genetic inheritance.

There are other studies which use different methodology trying to explore the causal relationship, but mostly on other forms of wellbeing such as education and psychological outcomes. Ren and Treiman (2016) try to examine the causal effect of parental migration on children's emotional well-being by using a community fixed effect model. However, this method would only be valid if the omitted variable is constant on the community level. Zhang et al. (2014) use a dynamic panel method to control for endogeneity in parental absence when investigating the impact of parent migration on children's cognitive attainment in China. The result shows significant disadvantage in cognitive attainment for left-behind children with both parents away.

The aim of this paper is to examine the net impact of parental migration on left-behind children's health and nutrition outcomes. It contributes to the existing literature in two ways. First, this paper is among the first to explore causal effects of parental migration on children's health and nutritional outcomes. To the best of my knowledge, there is no other literature using panel data to investigate the consequence of parent migration for children's health. By using a fixed effect model, I will be able to control for the unobserved heterogeneity that might correlate with parents' migration status. Second, I use China Family Panel Survey data which is nationally representative data covering both rural and urban areas in 25 provinces. This data set allows me to get a more comprehensive picture of left-behind children's problems in China and draw conclusions that have broader implications.

3.2 Background

China's migrant population has been growing since China's economic reform in 1978. The number of rural migrants was estimated to be around 50-60 million in the early 90s and increased during the 2000s. This figure has reached to 169 million in 2015 according to an annual survey of migrant workers conducted by the National Bureau of Statistics. As concluded in many studies, the driving force behind this large scale internal migration in China is the big disparity in wages between rural and urban sectors and between regions (Rozelle et al., 1999; Cai, 1999). As shown in figure 3.1, the total number of migrant workers has increased steadily from 140 million in 2008 to 169 million 2015. However, the growth rate has dropped dramatically since 2010 and reaches only 0.3% in 2015.

Among the rural migrant worker group, two thirds are male and one third are female. In 2010, 36% of the rural residents who go out for work are in the age range of 21 to 30. Young males comprise the majority of the group. One consequence of this large wave of internal migration is the left-behind children phenomenon. When young parents leave a hometown and go to big cities for work, it's usually hard for them to bring the whole family. Most of the children are left behind with their grandparents or other relatives. According to the 6th Population Census in 2010, there are approximately 61 million left-behind children in China, accounting for 21.88% of all children in China. This figure is much greater than the number of migrant children who moved to cities with their parents. In terms of age composition, 19.53 million left-behind children fall in the age range of 6-11, making up one third of the whole left-behind children group. In my study, the children surveyed in the CFPS have an age range of 0-15.

The migration flow, which is primarily towards prosperous coastal provinces such as Zhejiang, Guangdong and provinces located near the Chang River Delta, also confirms that migrant workers are seeking economic opportunities. This large-scale internal migration helped China write a successful story of "made in China" since most of the rural migrant workers are the backbone of China's export industry. However, this trend also imparts great social costs to the whole society; left-behind children is one of them. According to Aris Chan (2009), without custody of parents, left-behind children are often more vulnerable to accidents and crime. What's more, long separation from parents causes mental distress and emotional problem for a majority of the group. Lacking proper guidance, some of the emotional problems developed into behavioral problems, leading to higher crime rates among left-behind children (Li, 2015).

3.3 Data

The data used in this study come from the 2010, 2012 and 2014 waves of the China Family Panel Survey, a longitudinal survey conducted by the Institute of Social Science Survey (ISSS) of Peking University, China. Using a multistage, probability proportional to size sampling (PPS) strategy, the baseline survey collected information from nearly 15,000 households across 25 provinces in China in 2010. The follow-up surveys are conducted every other year, and currently three waves of survey data - 2010, 2012, 2014 are available. The survey is designed to collect individual, family, and community-level longitudinal data to track social and economic changes in contemporary China. The survey consists of four parts: community, family, adult and child questionnaires. In this study, I mainly focus on the child and family survey because the dependent variable measuring children health outcomes comes from the child survey and parent migration status is constructed from the family survey.

I construct the sample from the child dataset. 8960 children were surveyed in 2010, and the number of children surveyed in 2012 and 2014 waves are 8576 and 8559 respectively. The difference of numbers between waves is mainly due to combination and split of communities and families. In this study, to run a panel analysis I include children who have at least two years of observation, and the final dataset consists of 8467 children. Combined with the family survey where parental migration status is recorded, this panel data set allows me to explore parental migration's impact on children's health outcomes.

In this study, I use height-for-age z-score, weight-for-age z-score and a self-rated health status to measure children's health outcomes. Height-for-age z-score and weight-for-age z-score are used because they're common health indicators to monitor the growth of children. Besides the measurement of children's physical development, self-rated health status is also used to give a more comprehensive measurement of children's health conditions because it's proven to be a good predictor of future disability, hospitalization and mortality (Singh-Manoux et al. 2006; Goldberg et al. 2001; Benjamins et al.2004). Although self-rated health status has been widely used in the literature, it may suffer from a bias since respondents may adopt different frames of reference when evaluating their health condition. In my analysis, this issue is not a concern since the fixed-effect model studies the causes of changes within a person. All the time-invariant heterogeneity will be removed during estimation. Here, I assume that when people evaluate their health condition, their frames of reference don't change dramatically across the four-year time period (2010-2014).

Height and weight information is obtained from a survey for children ages from 0 to 15. However, the interviews are only given to family members age 10 or above, and the information of children below age 10 is provided by their primary caregivers. Height for age z-scores (HAZ) and weight for age z-scores (WAZ) are calculated using the growth reference data (WHO, 2007), which is the internationally accepted growth reference data. The z-scores are powerful in showing child development compared to a reference group of the same age and gender.

The self-reported health variable comes from question "How would you rate your health status? Answers are coded as 1 to 5 from "very poor" to "excellent". This question is only asked to students whose age is greater or equal to 10. A higher value in this variable indicates a better self-perceived health condition.

The most important independent variable in the study is the parent's migration status, which is obtained from the family survey. In this study, only information of economically-related family members is obtained. A deceased parent or single parent is not considered as a family member and their information is not recorded in the family survey. Thus, the situation of deceased and single parent is excluded from my analysis.

I construct the father and mother's presence variable based on the question "Is family member X currently living in this family?" The variable takes a value of 1 if the parent lives in the family, and 0 if not. There is also a follow-up question asking about the reason why the member does not live in the family. 96% of the response answered "Work away from hometown" and only 4% of the sample gave other reasons including "In prison" AND "Military service". Therefore, a 0 for parent's presence dummy for the most part implies that the parent is away for work. Based on each parent's presence status, I create a dummy for presence of one parent and presence of no parent to distinguish between the impact of absences of one versus both parents. In addition, this study

also controlled for some other factors that might also impact children's health outcomes such as annual household income per capita and family size. This information is also available in the family survey.

Table 3.2 presents summary statistics for children in our final sample. The HAZ and WAZ have an average of -0.57 and -0.38 respectively, indicating a lower or close to average physical development of children in sample compared to the reference group worldwide. The average of self –rated health status is 4.09, denoting good health. Self-rated health status is only obtained for children age 10 or above. This explains a smaller number of observations for self-rated health status. The average annual household income per capita is 8629 yuan with a standard deviation of 11927 yuan suggesting a big variance in household incomes across samples.

Table 3.3 presents statistics of variables across the 4-year survey window. In terms of health outcomes, the self-rated health status doesn't have a clear trend while HAZ and WAZ have increased across time. The annual household income per capita also increased as time passed, indicating a trend of economic development. As for the parental absence status, 19% of fathers went out for work in 2010 and this percentage rose to 25% in 2012. In 2010, only 9% of mothers left the family for work. However, the percentage of mothers who have gone out for work increased to 18% in 2012. The growth rate of the migrant population in my sample is higher than national statistics because two thirds of the sample households are from rural areas. The fact that rural residents have a much higher possibility to go out for work compared to urban residents may account for such difference. The fact that the percentage of fathers' absence is higher than mother's absence confirms the imbalanced sex ratio within the migrant worker population. The large difference between 2010 and 2012 reflect a trend of increasing internal migration for work within the whole country. As for 2014, the percentage of parental absence stays nearly the same as 2012.

Besides the descriptive statistics, I used the percentage of households with absent fathers and absent mothers to create maps showing the geographic distribution of left behind children. From figures 3.2 and figure 3.3, one will observe that Anhui, Chongqing, Guizhou, Hunan and Jiangxi have a high percentage of left-behind children. Chongqing has the highest percentage at nearly 50%. These five provincial-level administrative areas are central provinces with less developed economy. More importantly, these areas are mountainous, which makes agriculture less profitable. This fact explains the high percentage of left-behind children. The five regions with the lowest percentage of left-behind children are Beijing, Tianjin, Shanghai, Zhejiang and

Yunnan. Except for Yunnan, the other four regions are all known for a high level of urbanization and economic development.

3.4 Estimation

The main aim of this paper is to examine the impact of parental migration on children's health outcomes. More specifically, I am interested in examining whether the parent's migration will have an impact on children's HAZ, WAZ and self-perceived health status. Most of the previous studies that try to examine the impact of parental migration on children's welfare lack a valid comparison group. A cross-sectional comparison between left-behind children and children who have both parents overlooks the fact that migration is a highly selective process. The decision to migrate to search for work is usually associated with other social-economic characteristics or unobservable factors that might have an impact on children's wellbeing. The estimation result based on the cross-section analysis is then biased. In this study, I use three waves of the CFPS survey to construct a panel dataset and use a fixed-effect model to estimate the impact of parental migration on children's health. By using the fixed-effect model, I am able to control for all other time-invariant unobservable factors. The main regression model is as follows:

$$Health_{ij} = \alpha_i + \beta_1 Oneparent_{ij} + \beta_2 Noparent_{ij} + X`\Gamma + \mu_{it} \quad (3.1)$$

In the model listed above, the dependent variables are health outcome measures for children (HAZ, WAZ, self-rated health status); and the most interesting independent variables, $\mathrm{Oneparent}_{ij}$ and $\mathrm{Noparent}_{ij}$, are dummy variables indicating whether child *i* lives with one parent and whether the child lives without parents at time period *t* respectively. X_{it} are control variables such as log of family annual income and family size of children *i* at time *t*. In this model, I focus mostly on β_1 and β_2, which captures the effect of having one parent and no parents on children's health outcomes. In all the regressions, I cluster the standard error at county level to account for any common shock on county level.

The results of the fixed-effect model for HAZ, WAZ, self-rated health status are presented in table 3.4, 3.5 and 3.6 respectively. For each dependent variable, I regress the difference of the health measurements on the corresponding changes in parental migration status for the full sample and report the results in column 1. Columns 2 and 3 report results for the boy sample and girl sample separately. Columns 4 and 5 present estimation results for the urban sample and rural sample respectively.

In column 1, one can find that the coefficient for the no-parent dummy variable is negatively significant, meaning that having no parent leads to less gain in HAZ for children, compared to having both parents at home. However, the one-parent dummy is not significant, indicating that having only one parent at home is not associated with any disadvantage in children's HAZ. Thus, the left-behind children with no parent living with them are the most disadvantaged group in terms of HAZ. One thing that needs to be noticed is that the absence of one parent has nearly no adverse impact on children's health outcomes measured by HAZ, while the absence of two parents is directly associated with smaller HAZ gain. This supports the remittances theory, when one parent goes out for work and earns a higher salary, the increase of family investment in children will compensate part of the adverse effect of the missing parental care. But when both parents go out for work, the adverse impact of the lack of parental care outweighs the effect of the remittances thus leading to worse health conditions for children in terms of HAZ. This conclusion is similar to what has been found in previous literature, where Zhang et al. (2014) find that only the absence of both parents leads to significant declines in student educational achievements. The year's variable is also positively significant, suggesting a constant increase in children's HAZ across time. A negative significant coefficient for family size captures the competition of resources between family members.

Columns 2 and 3 show the gender disparity in the effect of parental absence on children's health outcome. For boys, the coefficient of the no-parent dummy remains negative and significant while parental presence dummies are no longer significant for girls. This indicates that the overall negative impact of absence of both parents on children's HAZ is mainly on the boys. There are two possible reasons why parental absences have a significant negative impact on boys but not on girls. First, girls are believed to be more capable of adjusting to stressful changes such as separation than boys. Much other literature also confirms that the absence of a parent has a larger impact on boys than girls. (Cobb-Clark and Tekin,2014; Parke and Clarke-Stewart,2001). Second, preference for a son is still common in China's contemporary society, especially in rural areas. When parents are present, it's highly likely that they allocate resources more favorably towards boys than girls. This is why boys benefit more than girls when having parents around in terms of HAZ. They're also more vulnerable compared to girls when parents are away. The negative significant coefficient of family size in column 3 also supports the theory of the preference for sons. The girls' HAZ will be significantly lower with more family members which indicates that the family decision-maker tends to compromise girls' welfare when resources are limited.

Column 4 and column 5 show the impact of parental absence on children's HAZ for the urban sample and rural sample respectively. For children in urban areas, the one-parent and no-parent dummies are not significant, suggesting that the absence of one parent or both parents does not generate any negative impact on urban children. However, the coefficients of the no-parent dummy for rural children remains significantly negative. This result shows that there's a discrepancy between rural and urban areas in terms of the impact of parental absence on children's HAZ. Children from urban areas do not suffer any negative impact from parental absence, while rural children with both parents absent experience significant lower gains in HAZ compared to their peers.

Table 3.5 presents the regression result for WAZ. Unlike HAZ, the interested dummies are not significant across all specifications, suggesting that parent migration status doesn't have a significant impact on children's WAZ. This result is true for male and female, urban and rural students.

Table 3.6 presents the estimation for self-rated health status. For the full sample, the no-parent dummy is negatively significant with a coefficient of -0.258, meaning that the absence of both parents lowers children's self-health rating by 0.27 standard deviation. This result indicates that children without any parent staying with them feels worse in health condition compared to those children with both parents around. The one-parent dummy is not significant, indicating that the absence of one parent has no significant impact on children's health outcomes measured by self-rated health status. For the boys' sample, the no-parent dummy remains negatively significant; the point estimate suggests that the absence of two parents decreases boys' health ratings by one-third standard deviation. For girls, the parent variables are not significant. This result is consistent with result for HAZ, indicating a gender disparity in the effect of parental impact on children's self-rated health. As for rural and urban samples, the coefficient of no-parent dummy is significantly negative only for children in rural areas, indicating the negative impact of both parents gone for work on self-rated health status is mainly driven by rural children.

3.5 Robustness Check

Although I used panel data and the fixed-effect model to address the endogeneity problem by controlling for all the time invariant factors. This method may not fully address the endogeneity problem because it fails to account for shock that affects both parental migration and children's health condition. Many studies pointed out that economic shock may lead to both decisions of migration and worse children's health conditions. For example, parents that experienced a negative economic shock may decide to go out for work in search of a higher-paying job, and the negative economic shock also has a negative impact on children's health. If the estimation didn't control for the negative economic shock, the worse children's health condition may be attributed to parental migration, when in fact it is caused by the economic shock.

In order to solve this problem, I include the lag of family income to control for the economic shock. The regression results for three dependent variables are reported in table 3.7. For HAZ, the coefficient for the no-parent dummy is -0.28, suggesting that children without parents have significantly lower HAZ compared to children with both parents at home. After controlling for economic shock, the magnitude of the interested coefficient nearly doubled. Another change is that the one-parent dummy becomes positively significant, suggesting that children living with only one parent have higher HAZ than children staying with both parents. This result again can be explained by the remittance theory. Having one parent gone out for work will increase the family income which may outweigh the adverse impact from missing parental care.

As for WAZ, the parental presence dummy remains insignificant. In terms of self-rated health status, the no-parent is still negatively significant; however, both the coefficient magnitude and significance level become smaller after introducing the lag of family income into the regression. Overall, the results are consistent with results from the previous fixed effect model.

3.6 Conclusion

In this paper, I use the China Family Panel Survey, a nationally representative panel survey, to investigate the impact of parental migration on the left-behind children's health outcomes. My measurements of children's health outcomes are HAZ, WAZ and self-perceived health rating. To deal with the endogeneity problem that's associated with migration, I used the panel data and a fixed-effect model to account for any time-invariant heterogeneity among observations.

The results show that the absence of both parents has a significant negative impact on children's health outcomes in terms of HAZ and self-rated health status. These findings suggest that left-behind children are worse off in terms of physical development and self-perceived health status when compared to their peers who live with their parents. I also find a gender disparity in the effect of parental absence on children's health outcomes. The adverse impact is more prominent for boys than girls, indicating that boys are in a more disadvantaged position than girls under the trend of increasing internal migration in China. The discrepancy of results between rural and urban areas suggests that the overall negative impact of the absence of both parents on children's HAZ and self-rated health rating is mainly driven by children in rural areas.

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Table 3.1 Age composition of children population in China, 2010

Age	0-2	3-5	6-11	12-14	15-17	0-17
Level of education	0-2 years	Pre-primary	Primary	Junior Secondary	Senior Secondary	Total
Number of Children(millions)	45.06	45.20	84.54	46.52	57.59	278.91
Number of migrant children(millions)	3.86	5.12	9.29	4.64	12.90	35.81
Number of rural left-behind children(millions)	11.72	11.70	19.53	9.95	8.13	61.03

Source: National Bureau of Statistics, 2010 Population Census

Table 3.2 Summary statistics of main interested variable

Variable	N	Mean	Std.Dev.	Min	Max
Self-rated Health Status	6972	4.09	0.95	1.00	5.00
HAZ	17025	-0.57	1.84	-4.99	4.96
WAZ	20115	-0.38	1.50	-4.97	4.98
Family Size	21905	5.30	1.91	1.00	17.00
Annual Household Income per Capita	20715	8269.25	11927.74	0.20	814600.00

Table 3.3 Statistics of main interested variable across time

Variable	2010		2012		2014	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Self-rated Health Status	4.69	0.59	3.84	0.95	3.88	0.97
HAZ	-0.83	1.87	-0.54	1.84	-0.39	1.79
WAZ	-0.56	1.58	-0.34	1.49	-0.27	1.43
Family Size	5.26	1.86	5.35	1.92	5.28	1.94
Annual Household Income per Capita	6531.03	9903.12	8559.77	10957.72	9724.78	14511.79
Percentage of Households with Father absence	0.19	0.39	0.26	0.44	0.24	0.43
Percentage of Households with Mother absence	0.09	0.29	0.18	0.38	0.18	0.38

Table 3.4 Fixed effect regression result for HAZ

HAZ	(1) ALL	(2) BOY	(3) GIRL	(4) URBAN	(5) RURAL
With No Parent	-0.150*	-0.218**	-0.0839	0.259	-0.180**
	(0.0780)	(0.104)	(0.120)	(0.179)	(0.0899)
With One Parent	0.0800	0.0920	0.0591	0.137	0.0877
	(0.0578)	(0.0811)	(0.0831)	(0.120)	(0.0676)
Family Size	-0.0598***	-0.0218	-0.0922***	-0.0909**	-0.0529**
	(0.0209)	(0.0304)	(0.0287)	(0.0364)	(0.0256)
Log of Family Income	-0.0284*	-0.0120	-0.0436*	-0.0264	-0.0290
	(0.0163)	(0.0226)	(0.0236)	(0.0289)	(0.0197)
Year	0.131***	0.149***	0.108***	0.116***	0.139***
	(0.00843)	(0.0119)	(0.0121)	(0.0140)	(0.0106)
Constant	-262.7***	-299.5***	-216.1***	-232.5***	-279.1***
	(16.96)	(23.98)	(24.34)	(28.13)	(21.31)
Observations	15,462	8,192	7,270	3,787	11,179
R-squared	0.033	0.041	0.025	0.040	0.033

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3.5 Fixed effect regression result for WAZ

WAZ	(1) ALL	(2) BOY	(3) GIRL	(4) URBAN	(5) RURAL
With No Parent	-0.0528	-0.0363	-0.0559	0.0559	-0.0397
	(0.0504)	(0.0678)	(0.0763)	(0.131)	(0.0562)
With One Parents	-0.0405	-0.0902*	0.0225	-0.107	-0.0342
	(0.0386)	(0.0538)	(0.0562)	(0.0886)	(0.0436)
Family Size	-0.00573	-0.00573	-0.00461	0.00165	-0.000684
	(0.0139)	(0.0200)	(0.0195)	(0.0269)	(0.0164)
Log of Family Income	0.00896	0.0170	-0.000188	0.0273	0.00427
	(0.0111)	(0.0151)	(0.0164)	(0.0215)	(0.0129)
Year	0.0300***	0.0473***	0.00909	0.0308***	0.0297***
	(0.00575)	(0.00805)	(0.00837)	(0.0104)	(0.00696)
Constant	-60.85***	-95.58***	-18.72	-62.25***	-60.31***
	(11.56)	(16.19)	(16.84)	(20.82)	(13.99)
Observations	18,209	9,630	8,579	4,129	13,501
R-squared	0.003	0.008	0.000	0.006	0.003

Clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3.6 Fixed effect regression result for self-rated health status

Health-Rating	(1) ALL	(2) BOY	(3) GIRL	(4) URBAN	(5) RURAL
With No Parent	-0.258**	-0.313**	-0.197	-0.0463	-0.326**
	(0.120)	(0.133)	(0.170)	(0.191)	(0.131)
With One Parents	0.0196	-0.0875	0.141	-0.211	0.0478
	(0.0643)	(0.0991)	(0.0885)	(0.163)	(0.0717)
Family Size	0.0133	0.0473	-0.00487	0.0134	0.00144
	(0.0279)	(0.0429)	(0.0326)	(0.0377)	(0.0373)
Log of Family Income	0.0355***	0.0482**	0.0175	0.0891***	0.0240
	(0.0135)	(0.0189)	(0.0226)	(0.0313)	(0.0170)
Year	-0.224***	-0.222***	-0.224***	-0.203***	-0.238***
	(0.0109)	(0.0127)	(0.0141)	(0.0162)	(0.0131)
Constant	455.3***	451.0***	454.3***	411.4***	483.7***
	(21.85)	(25.49)	(28.31)	(32.48)	(26.36)
Observations	6,412	3,333	3,079	1,480	4,690
R-squared	0.188	0.183	0.195	0.180	0.193

Clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3.7 Fixed effect regression result controlling for economic shock

VARIABLES	(1) HAZ	(2) WAZ	(3) Health-Rating
With No Parent	-0.280**	-0.0133	-0.184*
	(0.119)	(0.0751)	-0.11
With One Parent	0.148*	-0.0924	-0.0362
	(0.0898)	(0.0571)	(0.100)
Family Size	-0.0738**	-0.0175	0.00420
	(0.0327)	(0.0208)	(0.0385)
Log of Family Income	-0.0612**	-0.00105	0.0539*
	(0.0284)	(0.0182)	(0.0316)
Lag of Log Family Income	-0.0471	0.00333	0.0258
	(0.0300)	(0.0192)	(0.0315)
Year	0.101***	-0.00711	-0.0267
	(0.0171)	(0.0112)	(0.0188)
Constant	-202.2***	14.07	57.03
	(34.44)	(22.44)	(37.72)
Observations	7,735	8,440	3,279
R-squared	0.017	0.001	0.005

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

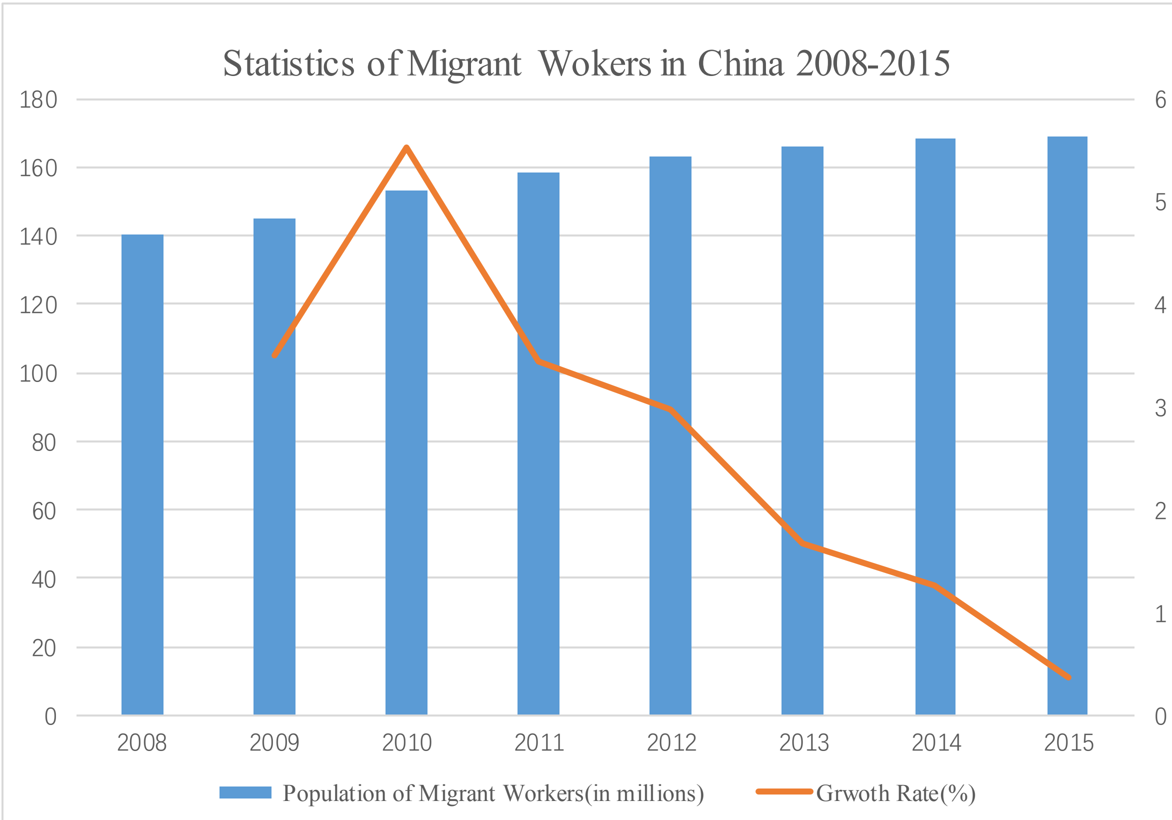

Figure 3.1 Population of migrant worker in China 2008-2015

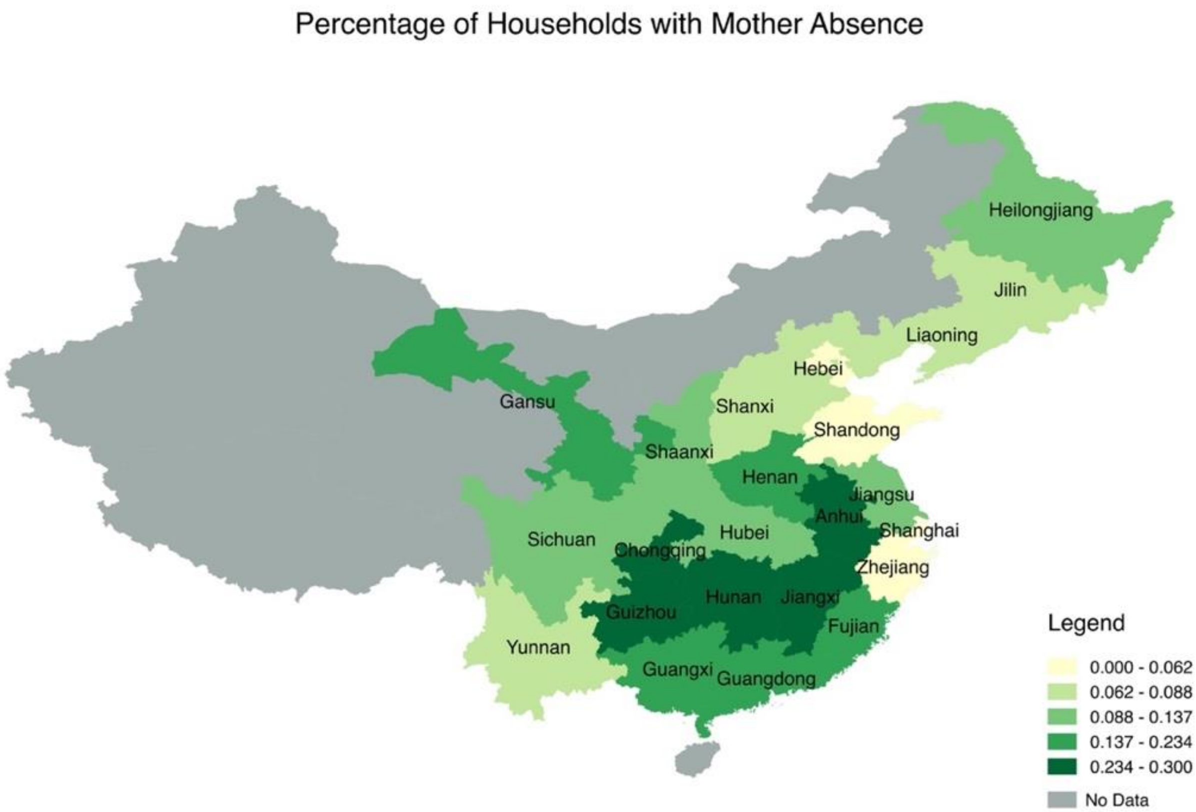

Figure 3.2 Percentage of households with absent mother by province

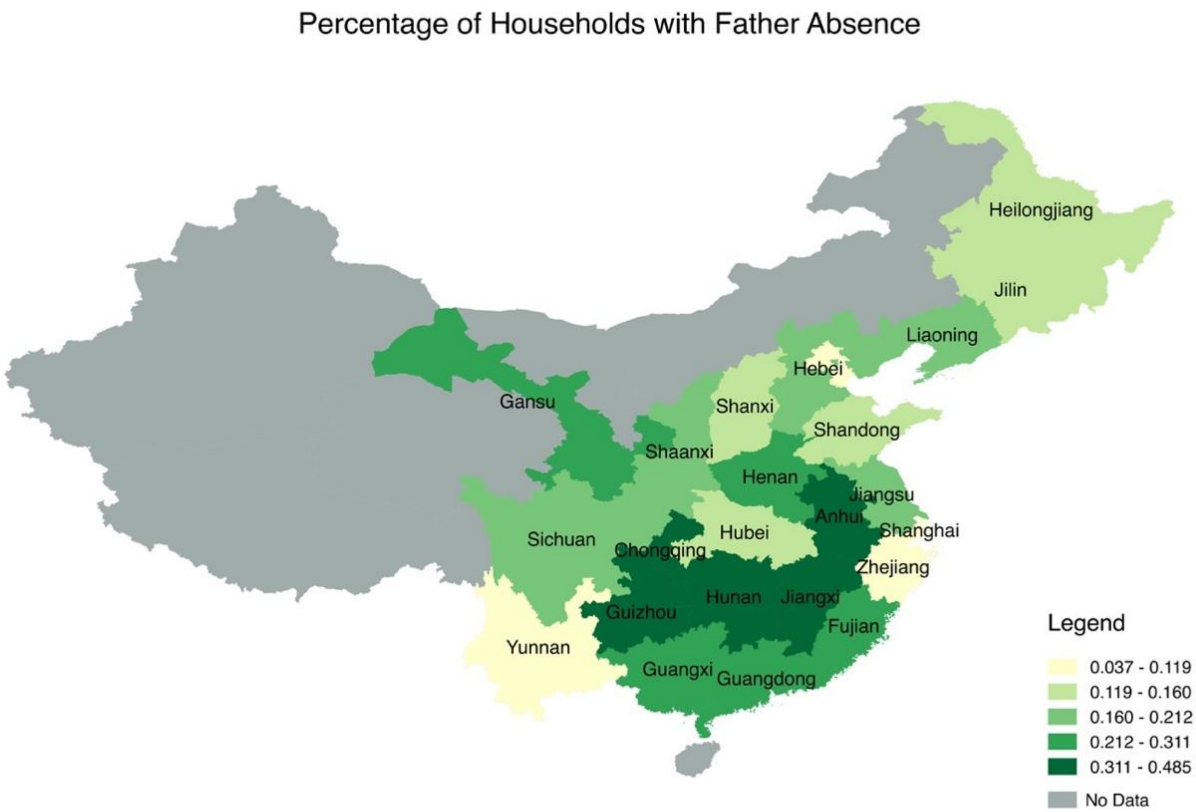

Figure 3.3 Percentage of households with absent father by province

CHAPTER IV

THE DETERMINANTS AND EFFECTIVENESS OF SHADOW EDUCATION IN CHINA

4.1 Introduction

Stevenson and Backer first raised the issue of shadow education in 1992. It refers to private supplementary tutoring offered outside formal schooling. Shadow education is a worldwide phenomenon that has attracted much attention from scholars due to its important implications on the current education system. China has also witnessed a growing trend of shadow education during the past decades.

Although China does not have official statistics on the scale of shadow education at national level, some city-level studies show that extracurricular tutoring is prevalent. Zhang (2011) found that 28.8% of Grade 12 students participated in shadow education. The result is drawn from a sample of 6043 students in Jinan city- capital of Shandong Province. A survey of 985 Grade 9 students in Chongqing city found that 44.2% of students had received private tutoring. (Zhang and Bray, 2015)

Many scholars consider the increasing trend of shadow education in China to be driven by several factors. First is rapid economic growth. Before 1978, China was under a strict socialist regime which did not allow the private provision of education. Following economic reform, China's economy experienced unprecedented growth, which also encouraged the expansion of private tutoring. In addition to economic growth, the college entrance exam "Gaokao" results in intense competition for higher education and increases the demand for private tutoring. Confucian culture also contributes to the growth of shadow education. Many scholars believe that the prevalence of shadow education in East Asia is closely related to the prevalence of Confucian values in Asian countries. Confucian values place emphasis on diligence and the correlation between increased effort and better performance. (Liu 2012; Southgate 2009; Tu,1996; Zhang 2014). China, the origin of Confucian culture, is the perfect environment for supplementary tutoring to grow. Despite the growth of shadow education, most of the literature on the subject in China uses data in Hong Kong and Macau; very few studies use nationally representative data from mainland China.

A major concern of shadow education is that it may lead to greater education inequality. While public education tries to provide equal educational access to all students, shadow education may help certain students more than others. To investigate whether shadow education increases education inequality, two questions are critical. First, are certain children are more likely to use shadow education? Second, is the use of shadow education effective in improving children's education performances?

This paper uses a nationally representative household survey to investigate two research questions. First, what are the social determinants of shadow education in China? Second, how does the use of shadow education affect children's math and Chinese test scores?

4.2 Literature Review

There is a small amount of literature on shadow education using cross-country data. International assessments, such as The Third International Mathematics and Science Study (TIMSS) and Program for International Student Assessment (PISA) have been used to investigate the prevalence of shadow education across countries (Baker et al. 2001; Southgate

2009). Baker et al. (2001) find that variables that describe how much mass education is institutionalized within a country such as public expenditure and gross enrollment rates are significant in explaining the use of shadow education. Lower public expenditure and lower enrollment rates lead to greater use of shadow education. Thus, shadow education is used as a private supplement to an underdeveloped public education system. Southgate (2009) finds that inequality at the national level also has an impact on the use of shadow education. Higher levels of inequality usually lead to higher participation in shadow education.

In addition to investigating national determinants of shadow education use, scholars also explore determinants of shadow education from a micro perspective (Assaad and El-Badawy 2004; Stevenson and Baker 1992; Lee et al. 2004; Tansel and Bircan 2006; Dang 2007). Household income, parents' education level, and living in an urban area are common factors found to have a significant impact on participation in shadow education.

Another strand of literature on shadow education explores the effectiveness of supplementary tutoring in improving students' education outcomes. However, the research results are inconclusive. While some find a significant positive impact of tutoring on students' academic performances (Stevenson and Baker 1992; Liu 2012), results from other studies suggest that extra schooling was not significantly associated with children's test scores. (Ha & Harpham 2005; Lee et al. 2004). There is also contrary evidence in Singapore suggesting that having a private tutor is counter-productive (Tan, 2009).

According to Bray (2010), the complication of the definition and nature of shadow education accounts for the inconsistency of empirical evidence. The studies use different ways to define shadow education; some of them include both fee-free and fee-paying tutoring while others would count non-academic as well as academic activities towards shadow education.

Some studies aggregate different types of tutoring together, overlooking the fact that the quality of individual, small group, and big class tutoring vary greatly. In other words, whether shadow education is effective in improving education performance is too broad a question to ask. Researchers should control for types, quantities, and qualities of shadow education to get findings that are more informed.

There are also smaller scale investigations and qualitative studies that focus on shadow education in China. Most of the studies focus on city-level data including Shenzhen, Jinan, Chongqing and Hong Kong (Bray 2013; Tang 2009; Zhang 2014, Zhang& Bray 2015). Zhang (2015) uses data from Chongqing to investigate the factors underlying shadow education demand and the role of teachers' power in shaping the demand for private tutoring. Bray (2013) uses descriptive statistics and qualitative research methods to explore the impact of private tutoring in the lives of Hong Kong students.

In this paper, I use the China Family Panel Survey, which is nationally representative data covering both rural and urban areas in 25 provinces in China to study the two research questions: what are the socio-economic determinants of shadow education, and what are its impact on student's standardized test scores? It contributes to the existing literature in two ways. First, I use China Family Panel Survey data, which is nationally representative data. This dataset allows me to study shadow education participation in both rural and urban areas. Second, I include the time and money spent on shadow education in addition to dummy indicating whether children participated in shadow education. These two variables allow me to control for the quantity and quality of shadow education.

4.3 Data

This paper uses data from the 2010 and 2014 waves of the China Family Panel Survey (CFPS). CFPS is a longitudinal survey, aimed at tracking changes in all aspects of contemporary China, including economy, education, population and health. The Institute of Social Science Survey (ISSS) of Peking University, China launched the survey in 2010. Using a multistage, probability proportional to size sampling (PPS) strategy, the baseline survey collected information from nearly 15000 households across 25 provinces in China. The population of these 25 provinces accounts for 94.5 percent of the total population in China. Due to the high coverage of Chinese population, the sample in CFPS study is considered a nationally representative sample.

The CFPS consists of four questionnaires: community, family, adult and child. In this study, I mostly focus on the child and family questionnaires because these two cover most of the variables needed to answer the research questions. The child questionnaires are only given to children age 15 and under. It is composed of two parts, one completed by children and another part completed by the children's primary caregiver.

To answer the first research question, what are the social determinants of shadow education, I construct a dummy variable indicating whether students participated in any form of shadow education from the survey question in child questionnaires. The explanatory variables included in the regression are from the individual, household, school and regional levels. Individual level characteristics include children's age, gender and nutrition condition measured by height for age Z-score (HAZ). Family level variables include mother's education, parent's expectation on children's education level and annual family income per capita. For mother's education, I constructed two dummies, one indicating that the mother has completed secondary education, the other one indicating that the mother has completed post-secondary education. As for macro factors, I include a key school dummy and an urban dummy to control for school and regional characteristics.

I use the 2014 wave survey to investigate this research problem because this is the latest CFPS wave. My analysis mainly focused on school-aged children (age 6 and above) in the sample. The final sample size is 5098 children ages between 6 and 15.

To investigate the second research question, the effectiveness of shadow education in improving children's test scores, I constructed a panel dataset from the 2010 and 2014 waves of the survey. The number of children surveyed in the 2010 and 2014 waves is 8960 and 8559, respectively. The difference of numbers between waves is mainly due to the combination and split of communities and families. Only 5359 children who have both years of observation are included in the panel dataset.

To measure children's academic performances, a standardized word test and math test were given to children age 10 and above as part of the survey. Thus, the final sample size is 1625 children ages between 10 and 15. The word test consists of 34 questions, while the math test has 24 questions. I use math and word test scores as consistent measurements of children's academic performance.

As for the main explanatory variable, I used three different variables to describe children's participation in private tutoring activities. First, I created a dummy variable to indicate whether a student has ever participated in any extracurricular tutoring activities. In addition to the dummy variable, I used the time and money spent on private tutoring as measurements for the quantity and quality of shadow education received by children. I obtained all this information from the child survey. I calculated the time spent on shadow education based on responses to the question

"In the most recent month when he/she was not on vacation, how much time per week on average did the child spend on extracurricular tutoring?" I calculated expenditure on shadow education based on the question "How much did you spend on extracurricular tutoring for this child in the past year?" Children's primary caregivers answer these questions. Other time-varying variables are also included as control variables.

Table 4.1 presents summary statistics for school-aged children (age 6 and above) in the sample of the 2014 wave survey. The shadow education dummy has an average of 0.15 indicating that 15% of school-aged children in the sample have participated in shadow education. This number is lower than many of the previous studies, which state that nearly half of the students received private tutoring (Bray 2013; Tang 2009; Zhang 2014, Zhang 2015). This discrepancy is understandable because most of the previous studies only use data from cities. Children in urban areas tend to have higher probability in attending private tutoring because of the fierce competition. Another reason is that this survey defines extracurricular tutoring as tutoring provided by private institutes but not schools. Some of the previous studies do not distinguish between tutoring provided by schools and private institutes. Children in my sample on average spend 702 RMB ($100) every year and 1.2 hour per week on shadow education.

There is a comparatively balanced sex ratio in the sample, with 53% boys and 47% girls. On average, children in the sample have a family size of five people. As for mother's education, 41% of mothers have completed secondary education while only 6% of mothers obtained a degree above high school. In the 2014 sample, 23% of children are from "key school". Children from urban areas only occupy 38% of the total sample. The average score for math and word tests is 10 out of 24 and 21 out of 34 respectively.

In table 4.2, I present the shadow education related variables and the test scores by region. From table 4.2 one can observe that there is a large disparity in shadow education related behavior between rural and urban areas. For the participation rate, 27.6% of children from urban areas have participated in extracurricular tutoring, while only 7.5% of children in rural areas attended tutoring. The shadow education participation rate for urban children is nearly four times that of rural children. This statistic suggests great inequality in shadow education use between urban and rural areas. The same trend occurs for shadow education expenditure. Urban students who participated in shadow education on average spent 4108 yuan for tutoring each year, which is three times the amount spent by rural children. However, the time spent on tutoring does not follow the same trend; urban children who participated in shadow education on average spend 9.5 hours per week, which is less than rural children who spend 12.9 hours per week.

Before the investigation of the first research question, I compared individual, family and school characteristics across the two groups of children: those who participates in extracurricular tutoring and those who does not. I show the results in table 4.3. There are significant differences in nearly all variables between these two groups except for gender and age. Children who participated in shadow education usually have higher family income, smaller family size, and their parents tend to have a higher education level. To determine the socioeconomic determinants of shadow education in China, I use a logit regression to investigate this question more rigorously.

To investigate the impact of shadow education on students' standardized scores, I used the 2010 and 2014 years of the survey to construct a panel dataset. Table 4.4 presents statistics of main variables across the 4-year survey window. Both the math and word standardized test scores have increased over time. The annual household income per capita also rose from 2010 to 2014, indicating a trend of economic development. As for the shadow education variables, the average expenditure on tutoring was 127 Yuan in 2010, which rose to 552 (inflation adjusted) Yuan in 2014. The average time spent on shadow education per week increased from 9 to 10.5 hours. The surge in expenditures suggests an increase in intensity of shadow education use during the 2010-2014 interval.

Table 4.5 provides a summary of the standardized test scores across groups based on the change in their shadow education participation dummies. The first column shows the change of shadow education status between 2010 and 2014. For example, 0-0 indicates that the children have not participated in shadow education during the time of study. 0-1 denotes children who participated in shadow education in 2014 but not in 2010. 1-1 stands for children who have participated shadow education in both years. 1-0 means that children received shadow education in 2010 but did not receive any in 2014. For math score, one can observe that students who did not use shadow education in both years experienced an increase of 4.43 points in standardized math test score. For students who participated in tutoring in 2014, their math scores have increased by 6.31 whatever their status is in 2010. Students who quitted shadow education have an increase of 5.96 points in math test. This trend suggests that participation of shadow education may lead to a bigger increase in children's math test scores. However, the word test score does not exhibit such a pattern. To examine the impact of shadow education on both word and math tests more rigorously, I employed a fixed effect model and the results are carefully discussed in the next section.

4.4 Estimation Results

4.4.1 Determinants of Shadow Education

To investigate the determinants of shadow education use, I use two different variables to measure the participation in shadow education. One variable is the dummy indicating whether children have participated in any extracurricular tutoring; another variable is the annual expenditure on extracurricular tutoring. Accordingly, I use a logistic regression and a Heckman two-stage estimation to investigate the problem. I use Heckman two-stage estimation because the shadow education fee is only observable for students who participated in shadow education.

I list estimation results for the logistic and the Heckman two-stage estimation in table 4.6. The first column presents the marginal effect of the variables on shadow education participation. For individual level variables, age and gender are not significant in explaining the participation decision, only HAZ is positive significant. This result means that boys and girls have the same probability of receiving shadow education. The positive significant coefficient of HAZ suggests that students who are in better health condition have a higher possibility of participating in extracurricular tutoring. In terms of family characteristics, all variables are positive significant. This result is quite intuitive because the decision of whether to receive extracurricular tutoring is not usually made by children themselves. It is more likely to be a family decision. With higher family income, more educated mothers and higher expectation from parents, parents are more likely to enroll their children in extracurricular tutoring. The marginal effect of whether mothers completed secondary education is large. Comparing children whose mothers have degrees below high school, children whose mothers completed post-secondary education are 15% more likely to participate in extracurricular tutoring activities. Whether children live in urban or rural areas also has a big impact on children's participation in shadow education. Children from urban areas are

12% more likely to receive shadow education compared to rural children. This result confirms that there is a significant disparity between rural and urban areas in shadow education participation. The key school dummy has a positive coefficient, suggesting that children in key schools are more likely to attend private tutoring. This result is predictable since students in key school are more competitive, thus leading to higher probability in using shadow education.

The second column in table 4.6 presents the Heckman two-stage estimation result for annual spending on shadow education. In this regression, only children who have received shadow education are included in the sample to investigate the variation of spending on private tutoring within the group of children who participated in shadow education. All individual characteristics are significant in explaining annual expenditure on shadow education. Age and HAZ are significantly positive, suggesting that family tends to spend more in shadow education for older children and children with better health. The coefficient for gender dummy is -1112 which means that boys' annual shadow education expenditure is 1112 Yuan less than that of girls. Although gender does not play a role in determining whether children receive shadow education or not, it has an impact in determining shadow education spending. Families tend to invest more in girls on shadow education and this may help to alleviate education inequality between genders. In terms of family factors, household income has a significantly positive impact on shadow education spending, but mother's education level and the education expectation from parents here are no longer significant.

4.4.2 Effectiveness of Shadow Education

The second research question of this paper is to examine the impact of shadow education's impact on children's academic performance measured by standardized test scores. Most of the previous studies that try to examine the impact of shadow education on children's education outcomes suffer from the endogeneity problem. The endogeneity problem exists for several reasons: first is that there may be reversal causality between children's test scores and their decision in whether to participate in shadow education. For example, children who do poorly in school may have a higher likelihood of participating in shadow education so that they can catch up with other students. Another reason is that this decision also involves self-selection; there are covariates that influence both children's academic performance and shadow education participation such as children's innate ability and parent's concern for students' academic performance. The estimation result based on the cross-section analysis is then biased.

In this study, I use two waves of CFPS survey to construct a panel dataset and use a fixed effect model to estimate the impact of shadow education on children's academic performance. By using the fixed effect model, I am able to control for all other time-invariant unobservable factors, such as student's innate ability. The main regression model is as follows:

$$Standardized\ Test\ Score_{it} = \alpha_i + \beta_1 Shadoweducation_{it} + X`\Gamma + \mu_{it} \quad (4.1)$$

In the model listed above, the dependent variables are standardized math and word test scores and the key independent variables are variables measuring shadow education participation. I use a dummy indicating whether children participated in shadow education together with money and time spent on shadow education to measure shadow education in a more comprehensive way. X stands for a vector of control variables such as log of family annual income and family size of children i at time t. In this model, I focus mostly on β_1 which captures the effect of shadow education on children's test scores. In all the regressions, I cluster the standard error at county level to account for any common shock on county level.

I present the results of the fixed effect model for math and word test scores in tables 4.7 and 4.8 respectively. For each dependent variable, I regress the difference of the test scores on the corresponding changes in shadow education status, time, and money spent on shadow education and report the results in column 1, 2 and 3 respectively.

In column 1, the coefficient for the shadow education dummy is not significant, meaning that participating in shadow education does not have a significant impact on student standardized math test scores. However, using the dummy variable solely excludes information about the quality and quantity of shadow education. In column 2, I use weekly time spent on shadow education to measure the use of shadow education more precisely. The coefficient is positive significant, suggesting that weekly time spent on private tutoring has a significant impact on children's math test scores. More time spent on shadow education will lead to a higher standardized math test score. In column 3, I use the log of annual expenditure on shadow education to measure both the quantity and quality of shadow education received. The coefficient of spending on shadow education is significant at 1% level and positive. This result again confirms the positive impact of shadow education on children's math test scores. More money spent on shadow education lead to better performances on math tests. The year dummy is positive significant across all specification meaning that children have better performance in the same math test after four years.

Table 4.8 presents the regression results for word test scores. Unlike math test scores, the shadow education variables are not significant across all specification, suggesting that the use of shadow education does not have a significant impact on children's word test score. There are several possible explanations why children benefit from shadow education in math tests but not in word tests. One possible reason is that I am not able to separate the shadow education expenditure and time spent on shadow education across different subjects. The survey only asks about the annual shadow education expenditure and weekly time spent on shadow education without specifying what type of private tutoring classes the student has had. Math, as the most popular subject in shadow education, may occupy a majority of the shadow education usage (Bray, M. & Unesco, 1999). It is then reasonable to expect more significant gain in math test scores from shadow education due to the limitation of measurements that I used in the study.

4.5 Conclusion

In this paper, I use the China Family Panel Survey, a nationally representative panel survey, to investigate two research questions. First, what are the socio-economic determinants of shadow education? Second, is shadow education effective in improving children's educational outcomes as measured by the standardized test scores? To deal with the endogeneity problem that is associated with the second research question, I used the panel data and a fixed effect model to account for any time-invariant heterogeneity among observations.

Findings reveal that children's nutrition conditions, family income, mother's education, parent's expectation, whether they live in rural or urban area and whether they attend key school all have a positive impact on the probability of shadow education participation. The most prominent two factors are mother's education and whether they live in rural or urban areas. This result suggests that there is a high level of inequality in shadow education use between urban and rural area.

As for the effectiveness of shadow education, the results are mixed. I found no significant impact of shadow education on children's standardized test scores when using the private tutoring participation dummy variable alone. After including time and money spend on shadow education to control for variation in shadow education's quantity and quality, I found shadow education has a significant positive impact on children's math test score but not word test scores.

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Table 4.1 Summary statistics

	Observation	Mean	Standard Deviation	Min	Max
Shadow education dummy	5088	0.15	0.36	0	1
Hours spent on extracurricular tutoring per week	5098	1.60	6.0	0	70
Money spent on extracurricular tutoring last year	4807	701.65	2806	0	100000
Age	5098	10.36	2.91	6	15
Gender	5098	0.53	0.50	0	1
Family size	5098	5.11	1.88	1	17
Percentage of Mother Completed Secondary Education	5006	0.41	0.49	0	1
Percentage of Mother Completed Post- Secondary Education	5006	0.06	0.23	0	1
Annual Household Income per Capita (Yuan)	4694	9553.17	10158.24	0.25	170000
Key school	4275	0.23	0.42	0	1
Urban	5067	0.38	0.49	0	1
Word test score	2558	21.37	7.50	0	34
Math test score	2559	10.43	4.56	0	24

Table 4.2 Shadow education and test score between rural and urban area

	Urban（1）	Rural (2)
Percentage of students participating in extracurricular tutoring	27.6	7.5
Hours spent on extracurricular tutoring per week	9.5	12.9
Money spent on extracurricular tutoring last year	4108	1397
Word Test Score	22.19	19.33
Math Test Score	10.69	9.13
Number of Observation	5272	3245

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Table 4.3 Individual-, family-, regional- characteristics across groups

	Sample participated in extracurricular tutoring (1)	Sample did not participate in extracurricular tutoring (2)	p-value
Age	10.36	10.35	0.90
Percentage of male student (%)	0.52	0.53	0.48
Percentage of student from key school(%)	0.33	0.21	0.00***
Percentage of student from urban area(%)	0.69	0.32	0.00***
Family Size	4.49	5.22	0.00***
Family Income per Capita	15561.9	8493.64	0.00***
Percentage of Mother Completed Secondary Education	0.52	0.46	0.00***
Percentage of Mother Completed Post-Secondary Education	0.22	0.06	0.00***
Education Expectation	6.04	5.64	0.00***
Word Test Score	23.76	20.95	0.00***
Math Test Score	11.87	10.18	0.00***
Number of Observation	784	4314	

Table 4.4 Statistics of main interested variable across time

	2010		2014	
Variable	Mean	Std. Dev.	Mean	Std. Dev.
Math test score	7.85	2.96	10.46	4.51
Word test score	17.99	6.88	21.36	7.39
Shadow education fee	134.86	873.53	552.49	2360.15
Shadow education time	9.05	11.83	10.46	12.03
Family income per capita	6428.24	9853.36	9452.88	10296.04

Table 4.5 Change in test scores across groups based on shadow education change

Change in Shadow Education Dummy from 2010 to 2014	Number of Observation	Mean Test Score Change
Math Test Score		
0-0	1194	4.43
0-1	124	6.31
1-1	88	6.31
1-0	158	5.96
Word Test score		
0-0	1194	7.63
0-1	124	5.71
1-1	88	7.27
1-0	158	6.74

Table 4.6 Regression result for the determinants of shadow education

VARIABLES	(1) Shadow Education	(2) Shadow Education Fee
Gender	-0.0129	-1,112**
	(0.0113)	(521.2)
Age	-0.000406	321.3***
	(0.00225)	(98.85)
HAZ	0.0165***	548.9
	(0.00466)	(343.2)
Mother Completed Secondary Education	0.0723***	1,057
	(0.0151)	(1,451)
Mother Completed Post- Secondary Education	0.152***	3,711
	(0.0238)	(2,804)
Education Expectation from Parent	0.0154**	-3.488
	(0.00716)	(385.4)
Annual Family Income Per Capita	0.0279***	862.4*
	(0.00701)	(521.3)
Key School	0.0346**	
	(0.0141)	
Urban	0.125***	1,381
	(0.0183)	(2,378)
Constant		-4,442
		(12,142)
Observations	3,505	577
R-squared	0.15	0.152

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4.7 Regression result for math standardized test score

VARIABLES	(1) Math Score	(2) Math Score	(3) Math Score
Shadow Education Dummy	-0.445		
	(0.508)		
Weekly Time Spent on Shadow Education		0.0683*	
		(0.0387)	
Log of Annual Shadow Education Expenditure			0.236***
			(0.0734)
Self-rated Health	0.107	-0.0811	0.0680
	(0.196)	(0.516)	(0.196)
Father Lives with Child	0.125	-0.173	0.106
	(0.564)	(2.113)	(0.572)
Mother Lives with Child	-0.211	0.194	-0.237
	(0.750)	(2.595)	(0.745)
Annual Family Income per capita	4.96e-06	-1.36e-05	2.86e-06
	(1.95e-05)	(3.04e-05)	(1.94e-05)
Year	1.214***	1.661***	1.169***
	(0.0679)	(0.158)	(0.0690)
Constant	-2,435***	-3,335***	-2,345***
	(137.0)	(318.6)	(139.3)
Observations	2,966	2,294	2,948
R-squared	0.466	0.643	0.472

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4.8 Regression result for word standardized test score

VARIABLES	(1) Word Score	(2) Word Score	(3) Word score
Shadow Education Dummy	-0.635		
	(0.713)		
Weekly Time Spent on Shadow Education		-0.00656	
		(0.0511)	
Log of Annual Shadow Education Expenditure			0.0284
			(0.104)
Self-rated Health	0.251	1.449**	0.249
	(0.275)	(0.681)	(0.278)
Father Lives with Child	0.0195	-3.534	0.301
	(0.793)	(2.786)	(0.813)
Mother Lives with Child	0.477	1.592	0.316
	(1.052)	(3.420)	(1.058)
Annual Family Income per capita	-1.42e-05	-3.46e-06	-1.31e-05
	(2.74e-05)	(4.00e-05)	(2.76e-05)
Year	1.928***	2.115***	1.914***
	(0.0953)	(0.208)	(0.0980)
Constant	-3,862***	-4,242***	-3,835***
	(192.4)	(420.0)	(197.8)
Observations	2,965	2,293	2,947
R-squared	0.517	0.597	0.512

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1