DISCUSSION PAPER SERIES

IZA

IZA DP No. 5182

Child Health and the Income Gradient: Evidence from China

Yi Chen
Xiaoyan Lei
Li-An Zhou

September 2010

Forschungsinstitut
zur Zukunft der Arbeit
Institute for the Study
of Labor

Child Health and the Income Gradient: Evidence from China

Yi Chen
University of California, Los Angeles

Xiaoyan Lei
China Center for Economic Research, Peking University and IZA

Li-An Zhou
Peking University

Discussion Paper No. 5182
September 2010

IZA

P.O. Box 7240
53072 Bonn
Germany

Phone: +49-228-3894-0
Fax: +49-228-3894-180
E-mail: iza@iza.org

IZA Discussion Paper No. 5182
September 2010

ABSTRACT

Child Health and the Income Gradient: Evidence from China*

Though the positive income gradient of child health is well documented in developed countries, evidence from developing countries is rare. Few studies attempt to identify a causal link between family income and child health. Utilizing unique longitudinal data from the China Health and Nutrition Survey, we have found a positive, age-enhancing income gradient of child health, measured by height-for-age z scores. The gradient is robust to alternative specifications and a comprehensive set of controls. Using the fact that the rural tax reform implemented since 2000 created an exogenous variation in family income across regions and over time, we explore a causal explanation for the income gradient, and find that it has a very strong independent causal effect on child health.

JEL Classification: I10, I12, O15

Keywords: child health, income gradient, rural tax reform

Corresponding author:

Xiaoyan Lei
China Center for Economic Research
Peking University
Beijing 100871
China
E-mail: xylei@ccer.pku.edu.cn

* We would like to thank the China Health and Nutrition Survey, funded by NIH (R01-HD30880, DK056350, and R01-HD38700), and the Carolina Population Center and the Chinese CDC for providing these data.

1. Introduction

The relationship between family income and child health is important, as it has been shown in related literature that children in poorer health are less likely to attain higher levels of education. Exacerbated by their poorer health, these less educated children face a lower likelihood of success competing in the labor market in adulthood (see Currie (2009) for an excellent review). Following two pioneering papers by Case et al. (2002) and Currie and Stabile (2003) that utilize U.S. and Canadian data respectively, and establishing that the gradient is greater for older children than for younger children, a volume of literature has been devoted to demonstrating the presence of the income gradient in different contexts, and to investigating the underlying mechanisms. It has been shown that the gradient exists in several developed countries, and even in those with a universal care system such as the UK and Canada, though the age-enhancing effect is not always found (Currie et al., 2007; Propper et al., 2007; Murasko, 2008; Condliffe and Link, 2008; and Khanam et al., 2009). Mechanisms for translating family income to child health are identified to include genetics, health at birth, child nutrition, family lifestyle, parental health, insurance, and education, but no consensus has been reached on what the income gradient's driving force is, and what contributes to the residual effects of income (Case et al., 2002; Currie et al., 2007, 2008; Khanam et al., 2009; Chen and Li, 2009).

Existing empirical studies have focused primarily on the developed world. Few studies have explored the problem in the context of developing countries. These income gradients may be quite different from each other for at least three reasons. First, while malnutrition is not common in developed countries, it can be prevalent in developing countries, thus making the marginal effect of increased household income relatively large. Second, regional differences in the child health income gradient are generally not a serious concern in developed countries. However, the vast urban-rural difference in almost every aspect may worsen the situation by enlarging the income gradient in developing countries. Third, public health care systems are generally poorly equipped (Eggleston et al., 2008), and medical services are unevenly distributed in developing countries.

Another shortcoming of existing literature is the lack of depth in identifying the causal effect of family income on child health. The majority of current studies apply ordinary least squares (OLS) to identify the correlation between family income and child health, and several papers attempt to exploit the panel nature of the data, or include as many controls as possible to avoid the omitted variables bias (Currie et al., 2007; Khanam et al., 2009). However, very few papers explicitly address the endogeneity of family income.[1] There may be some unobserved heterogeneity that affects both family earnings and child health. Poorer households may rely on their children's labor for additional income, which in turn negatively affects the children's health.

It is important to identify the causal effects of family income on child health, because if these effects do not exist, or do not flow from family income to child health, then policy interventions that increase family income will not necessarily improve child health. However, attempting to identify a causal relationship is tremendously difficult. The challenge is in finding exogenous sources of variation in family income that are orthogonal to child health. This condition is rarely satisfied. For example, in the United States, the welfare programs devoted to boosting income for poor families generally encourage an increase in the parental labor supply, which in turn may reduce the time spent on child care and thus negatively affect child health. Duflo (2000) made use of the extension of the Age Pension Program in South Africa and found that it had an impact on the weight-for-height and height-for-age z scores for girls born after the reform.

In this paper, we reference the rural tax reforms that began in 2000 which significantly increased farmers' income, but were unrelated to children's health in rural areas. Prior to the reform, Chinese farmers suffered from paying extra fees to village and township governments. During the 2000–2002 period, the Chinese central government launched a tax-for-fee reform in rural areas to abolish all kinds of fees implicitly or explicitly levied on farmers, despite an increase in the agricultural tax rate. This reform succeeded in increasing farmers' overall income.[2] We use the rural tax reform as the instrumental variable for family income by exploiting the fact that it was not universally, but gradually implemented across the whole country, which creates exogenous variation in family income across regions and over time.

The key dataset used in this paper comes from the China Health and Nutrition Survey (CHNS). This longitudinal household survey covers nine provinces, with seven waves since 1989. It contains detailed information on family income, child

[1] Duflo (2000, 2003) and Himaz (2008) are notable exceptions in this regard.
[2] See Section 5 for a detailed introduction of the tax reform.

health, parental characteristics (such as education and health) as well as socioeconomic indicators at the community level. We have 16,246 complete person-year observations with which to conduct our empirical analysis.

With this dataset, we find a positive, age-enhancing income gradient of child health measured by height-for-age z scores. The gradient is robust to alternative specifications and a comprehensive set of controls. We also find a significant regional difference in how health is affected: urban children are more sensitive to income than are rural children. Using the rural tax reform as an instrumental variable, we find that family income has a very strong independent causal effect on child health.

This study contributes to the current literature in three respects. It offers systematic empirical evidence on the income gradient of child health in China—the largest and most populous developing country—confirming the robustness of many findings obtained in the context of developed countries. It explores multiple mechanisms through which family income potentially affects child health, providing a comparison with empirical results obtained from developed countries. Finally, we utilize a natural experiment—the rural tax reform—to identify causality between family income and child health, with which more policy relevant implications can be drawn.

The remainder of the paper is organized as follows. Section 2 introduces the data used for this paper and provides summary statistics. Section 3 examines the correlation between family income and child health. Section 4 explores the channels of the income gradient for child health. The IV estimation dealing with the endogeneity problem is provided in Section 5. Section 6 concludes with policy implications.

2. Data and Summary Statistics

Datasets Used

The main dataset used for this study was compiled from the China Health and Nutrition Survey (CHNS)[3]. The CHNS is a longitudinal household survey conducted in nine Chinese provinces: Guangxi, Guizhou, Heilongjiang, Henan, Hubei, Hunan, Jiangsu, Liaoning, and Shandong. The survey is currently composed of seven waves, from 1989, 1991, 1993, 1997, 2000, 2004 and 2006. Since the questionnaires and

[3] See http://www.cpc.unc.edu/projects/china for a detailed description of the CHNS data.

sampling in the first wave are quite different from those used in the remaining six waves, only the latter six are used in our analysis. The CHNS is one of the few datasets from a developing country that provides extensive information on both child anthropometrics and household income, as well as parental characteristics, such as education and health. The survey sample typically consists of approximately 4,400 households for 19,000 individuals in each wave. After limiting the above sample to children aged 0 to 17 years, and excluding observations without complete information on height or household income of children, we end up with 16,246 person-year observations for subsequent analysis, or 3,845, 3,416, 2,903, 2,682, 1,865 and 1,535 observations in the six waves, respectively. This by nature is not a balanced sample; we can see that there is a significant drop in observations from the second wave to the last one. However, the size of the overall sample without age restrictions varies little across waves[4]. This is not a result of sample attrition, but of the fact that we restrict our sample to children aged 0 to 17, leading to a substantial change in the age structure in each subsequent wave. Note that this is consistent with the trend found in the population. From Appendix Figure A1 we see that the fraction of children aged 0 to 17 declines over time, from 32.5% in 1991 to 16.6% in 2006. From the China Statistical Yearbook, those under 20 accounted for 34.1% of the total population in 1995, but this figure dropped to 27.3% in 2006. Moreover, from the 2007 China Statistical Yearbook, the fraction of the population aged 15-19 in 2006 was much higher than for those aged 0-4 (8.8% vs. 5.1%). To visualize, 877 total newborns entered the sample over the five waves, while 2,601 adults left during the same interval.

The second dataset used is the China Sub-Provincial Public Finance Statistics (1998 - 2006), compiled by the Budget Department of the China Ministry of Finance. This dataset provides approximately 2,000 financial statistics observations per year (e.g., fiscal revenue, fiscal expenditure, etc.) for each county and prefecture-level city in China. This information can be used to construct the instrumental variable necessary for identification, which will be described in detail later.

[4] The sample sizes in six waves are, respectively, 12,834, 11,895, 11,800, 12,517, 11,359, and 10,953. The sample size increases from 1997 to 2000 because one more province is included in the survey since 2000.

Variable Definition

In this paper, the key measure for child health is the height-for-age z score, which has long been shown to be a particularly good short and long term health indicator for children in developing countries (Thomas et al., 1991; Strauss and Thomas, 1998), and has been widely used as a proxy for health status for Chinese children (Chen and Li, 2009; Mangyo, 2008). It has been shown in related literature that taller children tend to attain higher levels of education, earn more money, and are more likely to be employed in the future (Case and Paxson, 2010). They also tend to live better lives in adulthood (Deaton and Arora, 2009) and are more likely to be in better health and cognitive shape in mid-life to old age (Case and Paxson, 2008a, 2008b). For robustness purposes, weight-for-age will also be used as an alternative measure.

The height-for-age score is defined as:

$$Z_{ij} = \frac{h_{ij} - \bar{h}_j}{\sigma_j}$$

Where h_{ij} represents the height of the *i*th child in group *j*, and the group is defined over the children's gender and age (in months), respectively. $\bar{h}_j$ and σ_j are the international mean and standard error of height in group j from the WHO Multicentre Growth Reference Study (MGRS)[5]. Weight-for-age z scores can be calculated accordingly[6]. We exclude the top 0.5% and bottom 0.5% height-for-age z scores of the sample because these extreme values are most likely caused by measurement or coding errors[7] (Mangyo, 2008). In addition, the children's self-rated health (only available for children over 12 in survey waves after 1993) will be applied as an alternative measure for a child's health. It is a categorical variable with the values 1=Excellent, 2=Good, 3=Fair, and 4=Poor. Although there is solid evidence supporting self-rated health to be a strong predictor of mortality in adults (Idler and Angel, 1990; Idler and Kasl, 1995; Idler and Benyamini, 1997), much less is known about whether it is as efficient in evaluating the health of children. In previous literature, parent-rated child health has been widely applied as a proxy for child health

5 For details of the study visit the WHO website at http://www.who.int/childgrowth/mgrs/en/

6 Since the WHO provides the standard of weight only for children below 10, we automatically restrict the sample to children under 10 when turning to weight-for-age z scores.

7 Our basic results are robust to the including of these extreme values, except the standard errors are a bit larger because of the measurement error.

(Case et al. 2002; Currie and Stabile, 2003; Currie et al., 2007[8]), but this subjective measure can be colored by a parent's own health status (Currie, 2002). Admittedly, it is hard for children to evaluate their own general health conditions precisely and comprehensively because of their limited cognitive abilities. However, we still have reason to believe that it provides information not otherwise captured by the anthropometric z scores. Furthermore, it can reveal supplementary insight into children's mental conditions to compensate for the lack of mental health measures in the data.

The CHNS provides detailed information on the sources of household income including wages, business operations, subsidies, pensions, and agricultural activities (all expressed in 2006 Chinese yuan). To control for families' sanitary situations, we define dummy variables to indicate whether or not a family drinks tap water and uses a flush toilet. We represent household health investments in children with whether the children have health insurance, and whether they had received preventive health service in the past year. To proxy for access to medical facilities, the distance to the nearest medical facility (at the community level), and whether the facility is a beyond-county-level hospital are used to represent convenience and quality of the medical services available. Parental characteristics include age, level of education, health condition, and health behavior (smoking and drinking)[9].

One particularly noteworthy feature of the CHNS is its extensive record of family diet (including how much is wasted), so the actual nutritional intake of each child can be derived from the data. Specifically protein, fat, calories, and carbohydrates are taken into account. The z scores for nutrition can be defined in a manner similar to the anthropometric z scores, except that the mean and standard error of each group are derived directly from the CHNS sample, as there is no international standard for it.

Summary Statistics

Table 1 shows the summary statistics. The first column illustrates the general picture of the entire sample of children under 18, while the remaining two sets of columns disaggregate the sample by residency and gender. The children are on average 10 years old, with 53 percent being boys and 27 percent living in urban areas.

---

[8] Children of 13-15 years rated themselves in this paper.

[9] Some of the variables have a missing value. For detailed information on missing values, see Table A1 in the Appendix.

Anthropometric z scores show that Chinese children are generally below the international growth standard. Although a large proportion of them had received immunizations in the past year, only a few had a certain type of medical insurance. Preventive health service is extremely rare amongst Chinese children. As for family income, thanks to the astonishing growth of the Chinese economy, the average per capita income rose from 2,141 yuan in 1991 to 5,431 yuan in 2006 (overall household income per capita is 3,331 yuan). Most households drink tap water (61%) but just a few (22%) have in-house flush toilets. As expected, very few mothers had ever smoked (2%), but the proportion is much larger for fathers (71%).

There is a large difference between urban and rural residents. The urban are wealthier and enjoy better social welfare. This is also reflected in their offspring. Urban children are taller and heavier than their rural counterparts[10]. They take in more nutrition except for carbohydrates, which are contained in foods such as rice and bread and are more frequently consumed in low-SES families. Rural children are also subject to worse sanitary conditions than their urban counterparts (51% versus 87% have access to tap water, while 13% versus 43% have access to flush toilets). Rural parents typically attain less education, with only 20% of rural fathers having graduated from senior high school or above, compared to 35% in urban areas. The difference in mothers' education is even larger, at 12% rural versus 29% urban, and fewer rural children are covered by medical insurance (18% versus 29%). Gender differences in these variables are in general less obvious than regional differences.

Figure 1 illustrates the univariate correlation between child health and household income using the locally weighted polynomial regression (Lowess). It is clear that child health, as measured by anthropometric z scores, improves with household income, while the height score increases at a faster pace. Self-rated health (not plotted) shows a similar pattern.

3. Correlation between Family Income and Child Health

Basic Regression Results

In this section the income gradients will be analyzed in a multivariate framework. Column (1) of Table 2 displays results from the ordinary least squares estimation in

[10] It is interesting to note that despite lower anthropometric z scores, rural children tend to rate their health higher. There is still no satisfactory explanation for this seemingly contradictory phenomenon.

which the height-for-age z scores are regressed on household income and a set of basic demographic variables, including age, gender, residency, and family size. The estimated coefficient on household income is statistically significant at the 1 percent level. The effect of household income on child health turns out to be economically important: a doubling of household income is associated with a 0.086 standard deviation growth in height[11]. This can be translated to a 0.55 centimeter increase in height. Prior literature has shown that childhood height has a very important impact on future performance. For example, Thomas and Strauss (1997) showed that a 1% increase in a man's height is associated with a 2.4% increase in wage. This result is robust to setting household income in the linear form, or using height directly instead of the standardized z-score[12].

The coefficients for age are statistically insignificant, indicating that the gap between Chinese children's height and the international standard does not vary significantly across age. There is no significant observed difference between boys and girls. The urban-rural discrepancy, as pictured in Table 1, is much greater than the gender difference. Conditional on household income, urban children are 0.279 standard deviations taller than rural kids.

We next examine whether age-enhancing effects exist in China. Due to the limited size of the sample, we divide it into three age categories: ages 0–6, ages 7–11, and ages 12–17. The results, shown in Columns (2)-(4), strongly support a steepening gradient, and the coefficients for the three groups are, respectively, 0.087, 0.134, and 0.137, and they are all significant at the 1 percent level.

Columns (5)-(7) explore the time trend of the gradient. To increase estimation efficiency, we combine two waves together to generate a period. The correlation between family income and child health falls in the passing decades, which is consistent with the trend in the United States (Currie et al., 2008). This may be partly due to the efforts that the Chinese government has made in recent years to improve medical services for poor and rural residents.

Regional Difference in the Income Gradient

In the previous table, we see a significant coefficient for the "urban" dummy for

[11] $0.123*\ln 2 \approx 0.086$.

[12] If income is set in linear form, result indicates a 10,000 yuan increase in income leads to a 0.0491 SD increase in height. And using height directly shows that a doubling of income is associated with a 0.73 centimeters increase in height.

all specifications, indicating a large regional difference in child health. In this section, we analyze urban and rural samples separately to further investigate this difference. Figure 2 plots the relationship between height-for-age z scores and income, by residence. From this graph we find that urban children are much healthier than their rural counterparts regardless of income levels. This indicates that given the same level of family income, rural children may suffer from other disadvantages, which are likely to be worse sanitary conditions, lower quality medical access, and inadequate nutrition. In addition, we observe a positive income gradient in both urban and rural areas, implying the positive correlation between family income and child health is independent of location and income levels. Third, the income gradient in rural areas is flatter at lower income levels, resulting in a smaller gap in income gradients at these levels. This may be because for very poor rural families, an increase in income is mainly used for basic living expenses and not on child health. Only when income reaches a certain threshold such that the basic needs of the family are met, will additional income be spent on non-necessities such as better nutrition.

Table 3 shows regression results by residence. Despite the different gradients observed in the figure, after controlling for basic demographic variables, the income gradient at the mean level appears slightly larger in urban areas than in rural areas, which is consistent with the steeper slope of urban children in Figure 2.

Alternative Income & Health Measures

The measure for household income that we have thus far used is current total family income. Theoretically, child health may be more closely correlated with the permanent income of a household if parents make consumption decisions primarily in accordance with their permanent income streams. In order to examine the effects of permanent income on child health, we take advantage of the panel nature of CHNS and its rich information on income sources to construct multiple measures of the permanent income. These measures include: 1) income from the previous wave; 2) the average of the incomes from current and previous waves; and 3) income from more permanent sources, such as wage earnings and retirement income.

Table 4 investigates the correlation between different income measures and child health. Besides current household income, Column (1) adds family income from the previous wave, irrespective of whether the child had been born at the time. Both income measures are positively correlated with child health, and the coefficients of the two income measures are very similar (0.103 versus 0.098), indicating that the income effect is not temporary, but is sustained over time. Column (2) uses the average of these two income measures, and unsurprisingly, the coefficient is roughly equal to the sum of the two coefficients found in Column (1). Column (3) separates family income into several categories by source. Among these different sources, wage and retirement income reflects income from work and pension funds, and subsidies include one-child subsidy, gas subsidy, electricity subsidy, and other subsidies provided by the work unit or local government. These two categories of income stream embody the more permanent nature of family incomes. Income from family businesses may be more unstable across years and may be a transitory income. We see that different income measures have different correlations with child health: coefficients of wage income, retirement income, and subsidies are significantly positive, while that of family businesses are insignificant. This result indicates that permanent income is a more important determinant of child health. Farming income even shows a negative effect. This may be because having higher farming income actually indicates that a family relies more on agriculture, and thus is poorer.

We next explore alternative health measures (the weight-for-age z score and self-rated health) in addition to the height-for-age z score. As shown in the left hand panel in Table 5, the income gradient is positive and statistically significant in terms of weight-for-age z scores, and the effect exhibits an age-enhancing pattern: children aged 6–9 have a coefficient four times that of ages 0–5. Self-rated health data are only available for children over age 12. We examine both the ratings (ranging from one to four) directly as well as the dummy variable “bad health” indicating whether self-rated health is fair or poor. As shown in Column (4), self-rated health, where a lower value is healthier, improves with income. From Column (5), we can see that children in families with higher incomes are less likely to rate their health as fair or poor.

In summary, multiple incomes and health measures all show a positive and age-enhancing gradient. In the next section, we will investigate the mechanisms underlying the income gradient.

4. Mechanisms Underlying the Income Gradient

The previous section presents robust results on the income gradient in China. In this section we will explore the channels through which family income correlates with child health, with results reported in Table 6.

Column (1) is the basic regression with control of household income and age, age squared, gender, the urban dummy, and household size. In Columns (2)-(5), we add variables indicating potential channels, and Column 6 reports the results including all related variables.

Column (2) adds variables for sanitary conditions, health investment, and access to medical facilities. As expected, children living in families with better sanitary conditions turn out to be healthier. Having medical insurance also has a large positive effect, in contrast to findings for industrialized countries (Currie and Lin, 2007), where insurance generally does not matter. These effects are robust when parental education and health are included (Column (6)), the inclusion of which only reduces the coefficient slightly (from 0.148 to 0.122), indicating that insurance has a relatively independent effect on child health. A possible interpretation for the difference is that China still lacks a well-functioning nationwide medical insurance system. The scarcity in medical resources has made it extremely expensive and difficult to visit a doctor. Therefore, if illness occurs, children with insurance coverage are able to afford better medical treatment and recover more quickly. Furthermore, access to medical services also improves a child's health. Children are healthier where they live closer to a medical facility, or where their nearest facility is of higher quality (beyond-county level). Including these variables reduces the magnitude of, but does not eliminate the income gradient, implying that the income gradient we previously identified partly captures the effects of medical access on child health.

Parental age and education are included in Column (3), and parental health and behaviors are included in Column (4). Parental education, especially maternal education, has been shown to be an important determinant of child health (Strauss and Thomas, 1998; Currie and Moretti, 2003; Chen and Li, 2009). We achieve a similar result, as shown in Column (3). Children with mothers who have completed primary school are 0.151 standard deviations taller than those with mothers who are illiterate or did not graduate from primary school. The effect is magnified with each successive education level, from 0.245 for junior high school to 0.389 for senior high and above. A similar pattern is observed with respect to fathers' education, albeit uniformly with a smaller magnitude. This confirms the well-documented finding that a mother's education is more important in determining a child's health. With respect to parental health status and health behaviors, as expected, taller parents generally have taller offspring. The smoking behavior of fathers does not have a significant effect, while maternal smoking severely affects a child's health. This is possibly due to the fact that mothers in general spend more time with their children. Whether the father or mother is a heavy drinker does not affect a child's height[13]. In addition, inclusion of these variables (parental education and health) reduces the income gradient from 0.123 to 0.098 and 0.094 respectively, implying that the income gradient actually reflects part of the effects of parental characteristics on a child's health.

Column (5) discusses the role of nutrition, which turns out to be an important determinant of a child's height (particularly protein and fat). Its importance in explaining the income gradient is similar to that of parental health. After controlling for nutritional intake, the coefficient of income falls from 0.123 to 0.093, similar to the case when parental height and health behaviors are controlled.

Column (6) controls for all of the relevant variables mentioned above, which account for approximately 59.4% of the overall income gradient. In Column (7), we exclude variables that follow closely with household income (such as insurance and nutrition) and only include predetermined (or exogenous) variables. For instance, sanitary conditions and medical facilities are determined mainly by the supply of public infrastructure, and parental education is a predetermined characteristic independent of family income. The income effect estimated from this specification likely reflects the genuine income effect, regardless of the channels through which it works (e.g., insurance and nutrition). We can see that the log of family income has a coefficient of 0.066, and all other control variables have expected signs.

5. From Correlation to Causality

Section 4 analyzed the relationship between child health and family income in a multivariate context. However, the question is whether the estimated coefficient on income reflects the real causal effect. Omitted variables and the simultaneity problem

[13] Due to the nature of the household survey, CHNS does not have information on parents who are not living with their children. Therefore, children with a parent missing are dropped from the regression in these two columns. For rural and urban areas, the underlying reasons for missing may be different. In rural areas it is more likely due to parents' migration while in urban areas it is more likely due to parents' divorce or separation. This may cause bias towards different directions. We compare the characteristics of the two subsamples with and without parent missing both for urban and rural areas and find that the difference is not large (see Appendix Table A2). We also compare the basic regressions (Column (1) in Table 6) with those two subsamples and find no significant difference, which means including parental information and excluding the sample with parents missing may not cause significant bias in our results.

may bias our estimation. Perhaps the most plausible omitted variable here is health status at birth, which is correlated with both family income and current health status. However, this variable is not available in our dataset. This omitted variable may lead to upward bias as the gradient increases with age, and even worse, we cannot exclude other omitted variables confounding our estimation. As for the simultaneity problem, children in developed countries are normally assumed not to contribute to family income. Child health thus mainly casts influence on family income via parental labor supply; that is, parents need to spend more time taking care of sick children, and thus reduce their labor supply. Or, they may have to work more to earn enough money for medical expenses. However, in developing countries, child labor supply is not negligible. Thus, there can be an additional source of simultaneity for our study; healthier children may earn more in the labor market and can contribute more to family income. They may otherwise be more successful in pursuing higher education, and thus enter the labor market later[14].

In short, although we have obtained the correlation between family income and child health, the omitted variable and simultaneity issues limit our ability to interpret the correlation as causal. More effort is needed to achieve a causal interpretation.

In this section, we exploit a unique tax reform undertaken by the Chinese government to identify the causal effects of family income on child health. Searching for exogenous variation in family income to identify causal effects has been explored by very few researchers, as it is difficult to find such an exogenous shock that is not directly correlated with child health[15]. Let us start with background on the Chinese rural tax reform.

The Tax-for-fee Reform and Family Income

Since the mid-1990s, China's intergovernmental finance has moved from fiscal revenue sharing to tax sharing, resulting in a sharp drop in the fiscal capacity of local governments.[16] In order to meet the challenges of shrinking revenues and increasing

---

[14] We run regressions of child health on the labor supply of their parents as well as their own and find the correlations are in generally significant, indicating the possibility of endogeneity due to the reverse causality. Results are available from the authors upon request.

[15] The policy experiments explored in the literature which potentially provide exogenous variations in household income include the age pension program in South Africa (Duflo, 2000, 2003; Case, 2001), Samurdhi in Sri Lanka (Himaz, 2008), and the Aid to Families with Dependent Children Program in the United States (Currie, 1995; Mayer, 1997).

[16] See Ter-Minassian and Fedelino (2008) for more details about China's fiscal reform and its consequences on the financial conditions of local governments.

fiscal liabilities, local governments had to increase their dependence on fee collection.[17] As a result, local fees, together with an agriculture tax, placed a huge burden on farmers. Beginning in the early twenty-first century, Chinese central government launched the rural "tax-for-fee" reform, eliminating all local fees levied on farmers, and legitimizing only a single agricultural tax (see Yep (2004) for details of the reform). The agricultural tax was modestly increased to help compensate for the subsequent loss in local governments' revenues. The reform was first introduced in Anhui province in 2000, and gradually expanded to cover the entire country. As for the nine provinces involved in CHNS, Jiangsu underwent reform in 2001, Liaoning and Guangxi in 2003, with all others earlier in 2002.

For the purposes of our analysis, this reform has one important feature worth noting. The pre-reform local fees charged on farmers were only partly legitimate. A significant part of fee collection stemmed from the selfish impulses of village or township leaders and was not permitted by a higher-level authority. The increased agricultural tax to compensate for losses in local fiscal revenues could only match those fees that were legitimate. Thus, the reform succeeded in reducing financial burden on farmers, and increased their disposable incomes (Sato et al., 2006).

We do not have the information on local fees collected at each county to measure the potential increase in farmers' income caused by the reform, since fees were mostly informal and thus rarely recorded. However, we do have information on local revenues collected from agriculture taxes. As previously mentioned, agriculture taxes had increased to partially compensate for the loss in local fiscal revenues from abolished fees (Yep, 2004). To the extent that the agricultural tax rate and base in China had been quite stable over time, the big change in the agricultural tax immediately after the reform should largely represent the amount compensating the loss in local fees. A county with a larger increase in agricultural tax means that it had previously charged even larger fees, and thus there was a larger reduction in fiscal revenue due to the reform, as well as a larger reduction in the financial burden on farmers in that county. We then argue that the increased agricultural taxes (on a per capita basis) due to the reform can be used as a proxy for the extent to which famers' disposable incomes increased due to the reform.

Table 7 shows the trend for the average county-level agricultural tax per capita

[17] Local fees are mainly composed of charges for public utilities, fees in return for service, surcharges on agricultural taxes, and earmarked levies for specific purpose funds (such as education).

(CPI adjusted) in each province sampled in CHNS. The dark line illustrates the timing of the reform in each province. Note that all nine sample provinces have exhibited a relatively stable agricultural tax (on the per capita basis), but experienced a notable rise after the reform, with variations in magnitude. This is reinforced in Figure 3 where we plot mean agricultural taxes across time, and the reform year for each province is marked as zero for comparison purposes. The significant decline in agricultural taxes after the reform was due to a policy launched by the central government that mandated all agricultural taxes to be phased out by 2006.

For the reform to be a valid instrument for family income, two conditions must be satisfied. First, the reform must significantly influence family income. Second, it should not have a direct effect on child health other than through family income.

To evaluate its effect on income, a difference-in-differences (DID) model is employed:

$$Y_{ijt}=\alpha R_i+\beta \text{After}_{it}+\gamma R_i\cdot \text{After}_{it}+\delta \mathbf{X}_{ijt}+v$$

Y_{ijt} refers to the family income of jth child in ith county in period t. After_{it} indicates whether county i has experienced the reform in period t. $\mathbf{X}_{ijt}$ represents other control variables.

R_i represents the extent to which county i was affected by the reform. It is defined as the difference in agricultural tax per capita immediately before and after the reform in each county. In order to correct for the changes in trends that may not be due to the reform itself, we further add a de-trend term in the calculation. Specifically, R_i is defined as follows:

$$R_i=0 \text{ for urban areas}$$

$$R_i=\text{tax}_{iT}-\text{tax}_{i(T-1)}+(\text{tax}_{i2000}-\text{tax}_{i1997})/3 \text{ for rural areas}$$

where T represents the year of the reform. The first difference is the before-after change in tax, and the second difference is the mean level of difference across time prior to the reform. Then the value of R_i represents the potential of county i for the reform to have an effect on the reduction in local fees. In the regression, we will use the log form of R_i. Notice that the way we define R_i treats urban areas as a comparison group not subject to the policy change. The DID method identifies the effect of the reform on family income where γ is the parameter of interest. The results, reported in Table 8, show that the reform does have a positive and significant effect on household income. The first stage F statistic in Column (4) where sufficient variables are controlled is 18.34, which is well-beyond 10 (rule of thumb for weak instruments proposed by Staiger and Stock (1997)) and also exceeds the threshold value under 10% relative bias toleration (16.38 for our case, see Stock and Yogo (2005) for details), suggesting our instruments are unlikely to be weak.

Validity Tests

To check the validity of the instrument, we split time ranges as follows: 1991–2000, 2000–2004, 2004–2006 (the first three columns in Table 9). We expect that the reform should only have an effect on income during the 2000–2004 range, since all nine provinces implemented their reforms during that period. In the meantime, we should not see significant effects during the period in which there were no reforms (i.e., before 2000 and after 2004). This lets us exclude the possibility that the positive DID outcome may be due to some unobserved local factors. As seen in Table 9, only the effect during the reform period (2000 through 2004) is significant, while it is not in other periods (before 2000 and after 2004). This lends strong support to our hypothesis that the DID result accurately captures the reform effect.

Additionally, the reform occurred only in rural areas, so it should not affect family income in urban areas. The last two columns in Table 9 show that if R_i in urban areas were set equal to the value of rural areas in the same county instead of zero, the reform does not have any effect, but it does affect rural areas. This finding further supports our hypothesis.

A second condition for a valid instrument is whether or not the reform has a direct effect on child health other than through family income. Two related issues should be addressed here. First, while the reform relieved some financial burden for farmers, local governments were expected to have a harder time because of shrinking revenue sources, which may lead to a drop in the supply of public goods, including public medical facilities (Kennedy, 2007), thus affecting public health. We deal with this problem by controlling for families' access to medical facilities. Another issue is that reform may change the behavior of children and their parents. For example, by changing the marginal cost of farming, the reform may affect the labor supply of children, which is shown to be correlated with child health (Beegle et al., 2004; O'Donnell et al., 2005; Wolff and Maliki, 2008). It may also impact child health through parental behavior; if parents spend more time on farming, they have less time for child care. From Table 10, however, it seems that the reform does not have a significant effect on labor force participation, either for children or for parents.

In summary, we find a strong correlation between the reform and family income, but do not find evidence of a direct effect of the reform on child health. We therefore can use it as an instrument for family income to identify its health effects.

Instrumental Variable Estimation Results

Table 11 gives estimation results, using the reform as an instrument for family income. The four columns include progressively more controls. The results show that family income does have an important causal effect on child health. The magnitudes of the effects fall with the inclusion of more controls but always remain significant. The IV estimates are much larger than the previous OLS ones. For example, comparing the OLS estimate in Column (1) of Table 2 with the IV estimate in Column (1) of Table 11, we see that the effect of household income substantially increases from 0.123 to 1.071. The IV estimate shows that if household income is doubled, it will translate into a 4.8 centimeter increase in child height, which is equivalent to 3.7 percent of the mean height of children. This finding confirms that family income does capture some of the effects of parental characteristics (education, health, etc.), household facilities, and access to medical services, but it also has a direct causal effect on child health. There must be other sources through which income plays a significant role.

6. Conclusions

Existing literature has found a positive correlation between family income and child health mostly in developed countries, and the age-enhancing effect in some contexts. Using the China Health and Nutrition Survey, this paper confirms the existence of a significant positive and age-enhancing income gradient for child health in China, the largest of the developing countries. The results are robust to using different health and income measures. We also compare the income gradient patterns between different subgroups by residence. We find that the gradient is larger for urban children than for their rural counterparts.

The study reveals several important factors that play a significant role in protecting child health in China. These factors include parental education and health, mothers' smoking behavior, household sanitary conditions, access to medical facilities, health insurance coverage, and nutritional intake. Some of these are consistent with findings from other studies, but some are not. For example, there is evidence that insurance is not important in protecting child health in the United States (Case et al., 2002). The income gradient remains robust after all of these factors are included, implying that income has both direct and indirect effects on child health.

We also attempt to identify causal effects using an experiment implemented in China. The panel nature of the dataset enables us to use a DID method to identify the effect of the exogenous tax-for-fee reform on family income, and then to further identify the causal effect of family income on child health. Through this process, we find that family income does have a significant positive effect on child health. We also find that under the IV specification, the effect of income on child health becomes much larger than under the OLS specification. This effect remains positive and significant even when the predetermined familial environments (sanitary conditions, access to medical services, etc.) and parental characteristics (health, education, etc.) are controlled.

The policy implications of this paper are clear. First, the positive income effect on child health implies that the subsidy programs that increase income for the poor may be an effective way to improve the health of children from poorer families. Given the importance of child health on future career performance, this implies a relief for future income inequality. The age-enhancing effect further indicates a long-term health benefit from these subsidy programs. Second, the less desirable health conditions in the rural areas, given the same levels of income, indicates that although reducing income-inequality is a major focus of currently policies, equally important is to improve those health-related conditions in the rural areas. Third, the flatter income gradient among the very poor rural population highlights the fact that a proportion of Chinese people may still struggle for basic necessities, and are unable to invest in their children's health. Public welfare programs need to be large enough to meet basic needs before they can help improve child health. Fourth, the multiple channels identified also highlight the specific ways that child health can be improved. Some factors that may not be a problem in developed countries, such as improving access to medical services, household sanitary conditions, and increasing health insurance holding, are still important tasks to undertake in developing countries such as China.

References

Beegle, Kathleen; Dehejia, Rajeev and Gatti, Roberta. "Why Should We Care About Child Labor? The Education, Labor Market, and Health Consequences of Child Labor," NBER Working Paper, 2004.

Case, Anne. "Does Money Protect Health Status? Evidence from South African Pensions," NBER Working Paper, 2001.

Case, Anne; Lubotsky, Darren and Paxson, Christina. "Economic Status and Health in Childhood: The Origins of the Gradient." *American Economic Review*, 2002, 92(5), pp. 1308-34.

Case, Anne and Paxson, Christina. "Stature and Status: Height, Ability, and Labor Market Outcomes." *Journal of Political Economy*, 2008, 116(3), pp. 499-532.

Case, Anne, and Paxson, Christina. "Height, Health, and Cognitive Function at Older Ages." *American Economic Review Papers and Proceedings*, 2008, 98(2): 463–67.

Case, Anne and Paxson, Christina. "Causes and Consequences of Early Life Health," NBER Working Paper, 2010.

Chen, Yuyu, and Li, Hongbin. "Mother's Education and Child Health: Is There a Nurturing Effect?" *Journal of Health Economics*, 2009, 28(2), pp. 413-26.

Condliffe, Simon and Link, Charles. "The Relationship between Economic Status and Child Health: Evidence from the United States." *American Economic Review*, 2008, 98(4), pp. 1605-18.

Currie, Alison; Shields, Michael A. and Price, Stephen Wheatley. "The Child Health/Family Income Gradient: Evidence from England." *Journal of Health Economics*, 2007, 26(2), pp. 213-32.

Currie, Janet. "Healthy, Wealthy, and Wise: Socioeconomic Status, Poor Health in Childhood, and Human Capital Development." *Journal of Economic Literature*, 2009, 47(1), pp. 87-122.

____. Welfare and the Well-Being of Children. Chur, Switzerland: Harwood Academic, 1995.

Currie, Janet; Decker, Sandra and Lin, Wanchuan. "Has Public Health Insurance for Older Children Reduced Disparities in Access to Care and Health Outcomes?" *Journal of Health Economics*, 2008, 27(6), pp. 1567-81.

Currie, Janet and Lin, Wanchuan. "Chipping Away at Health: More on the Relationship between Income and Child Health." *Health Affair*, 2007, 26(2), pp.

331-44.

Currie, Janet and Moretti, Enrico. "Mother's Education and the Intergenerational Transmission of Human Capital: Evidence from College Openings." *Quarterly Journal of Economics*, 2003, 118(4), pp. 1495-532.

Currie, Janet and Stabile, Mark. "Socioeconomic Status and Child Health: Why Is the Relationship Stronger for Older Children?" *American Economic Review*, 2003, 93(5), pp. 1813-23.

Deaton, Angus and Arora, Raksha. "Life at the Top: The Benefits of Height." *Economics & Human Biology*, 2009, 7(2), pp. 133-36.

Duflo, Esther. "Child Health and Household Resources in South Africa: Evidence from the Old Age Pension Program." *American Economic Review*, 2000, 90(2), pp. 393-98.

____. "Grandmothers and Granddaughters: Old-Age Pensions and Intrahousehold Allocation in South Africa." *World Bank Economic Review*, 2003, 17(1), pp. 1-25.

Eggleston, Karen; Li, Ling; Meng, Qingyue; Lindelow, Magnus and Wagstaff, Adam. "Health Service Delivery in China: A Literature Review." *Health Economics*, 2008, 17(2), pp. 149-65.

Himaz, Rozana. "Welfare Grants and Their Impact on Child Health: The Case of Sri Lanka." *World Development*, 2008, 36(10), pp. 1843-57.

Idler, E L and Angel, R J. "Self-Rated Health and Mortality in the Nhanes-I Epidemiologic Follow-up Study." *American Journal of Public Health*, 1990, 80(4), pp. 446-52.

Idler, Ellen L. and Benyamini, Yael. "Self-Rated Health and Mortality: A Review of Twenty-Seven Community Studies." *Journal of Health and Social Behavior*, 1997, 38(1), pp. 21-37.

Idler, Ellen L. and Kasl, Stanislav V. "Self-Ratings of Health: Do They Also Predict Change in Functional Ability?" *Journals of Gerontology*, 1995, 50B(6), pp. S344-S53.

Kennedy, John James. "From the Tax-for-Fee Reform to the Abolition of Agricultural Taxes: The Impact on Township Governments in North-West China." *The China Quarterly*, 2007, 189(-1), pp. 43-59.

Mangyo, Eiji. "The Effect of Water Accessibility on Child Health in China." *Journal of Health Economics*, 2008, 27(5), pp. 1343-56.

Mayer, Susan. What Money Can't Buy: Family Income and Children's Life Chances.

Cambridge, Massachusetts: Harvard University Press, 1997.

O'Donnell, Owen; Rosati, Furio and van Doorslaer, Eddy. "Health Effects of Child Work: Evidence from Rural Vietnam." *Journal of Population Economics*, 2005, 18(3), pp. 437-67.

Propper, Carol ; Rigg, John and Burgess, Simon. "Child Health: Evidence on the Roles of Family Income and Maternal Mental Health from a Uk Birth Cohort." *Health Economics*, 2007, 16(11), pp. 1245-69.

Sato, Hiroshi; Li, Shi, and Yue, Ximing. "The redistributive impact of taxation in rural China, 1995-2002: an empirical study using the 1995-2002 CASS CHIP surveys." Working Paper, 2006.

Staiger, Douglas and Stock, James. "Instrumental Variables Regression with Weak Instruments." *Econometrica*, 1997, 65(3), pp. 557-86.

Stock, James; Yogo, Motohiro and Andrews, Donald. "Testing for Weak Instruments in Linear IV Regression," Identification and Inference for Econometric Models: Essays in Honor of Thomas Rothenberg. Cambridge University Press, 2005,

Strauss, John and Thomas, Duncan. "Health, Nutrition, and Economic Development." *Journal of Economic Literature*, 1998, 36(2), pp. 766-817.

Ter-Minassian, Teresa and Fedelino, Annalisa. "Fiscal Policy and Reforms: Toward Realizing a Harmonious Society", Chapter 4 in Public Finance in China: Reform and Growth for a Harmonious Society, Jiwei Lou, Shuilin Wang (eds), The World Bank, 2008, pp. 53-76.

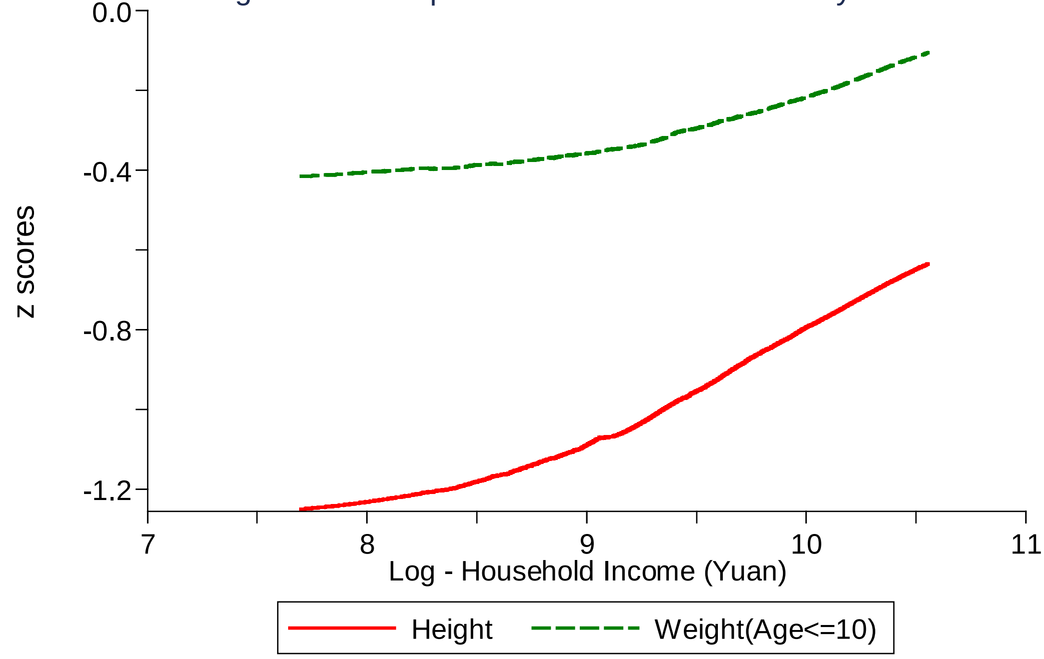
Thomas, Duncan; Strauss, John and Henriques, Maria-Helena. "How Does Mother's Education Affect Child Height?" *The Journal of Human Resources*, 1991, 26(2), pp. 183-211.

Thomas, Duncan and Strauss, John. "Health and Wages: Evidence on Men and Women in Urban Brazil." *Journal of Econometrics*, 1997, 77(1), pp. 159-85.

Wolff, Francois-Charles and Maliki. "Evidence on the Impact of Child Labor on Child Health in Indonesia, 1993-2000." *Economics & Human Biology*, 2008, 6(1), pp. 143-69.

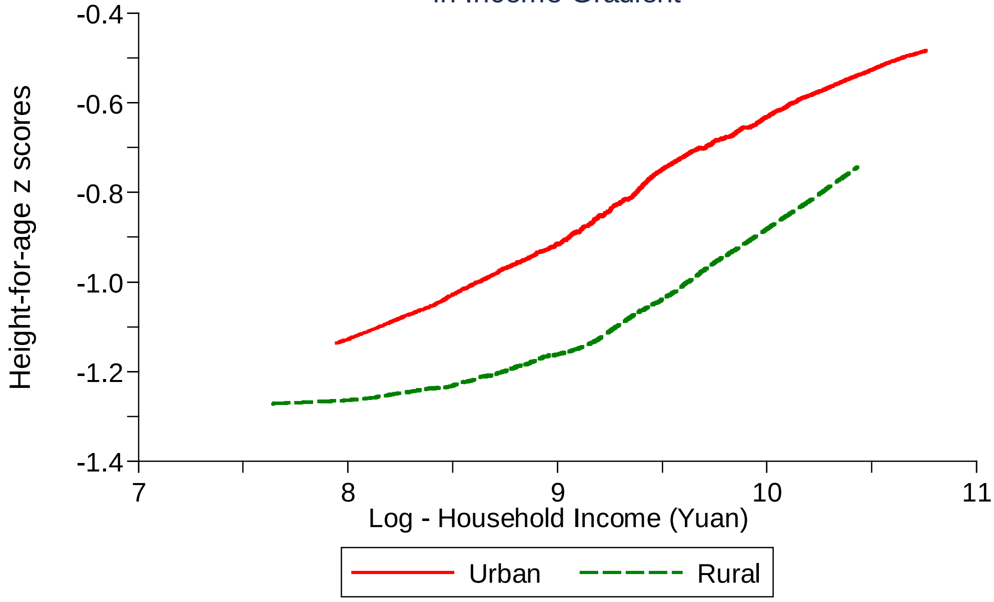
Yep, Ray. "Can Reform Reduce Rural Tension in China? The Process, Progress and Limitations." *The China Quarterly*, 2004, 177(1), pp. 42-70.

Figure 1: Anthropometrics z Scores and Family Income



Source:China Health and Nutrition Survey, 1991,1993,1997,2000,2004,2006
Age: 0-17 if not specified, bandwidth=0.8

Figure 2: The Urban-Rural Difference in Income Gradient



Source:China Health and Nutrition Survey, 1991,1993,1997,2000,2004,2006
Age: 0-17, bandwidth=0.8

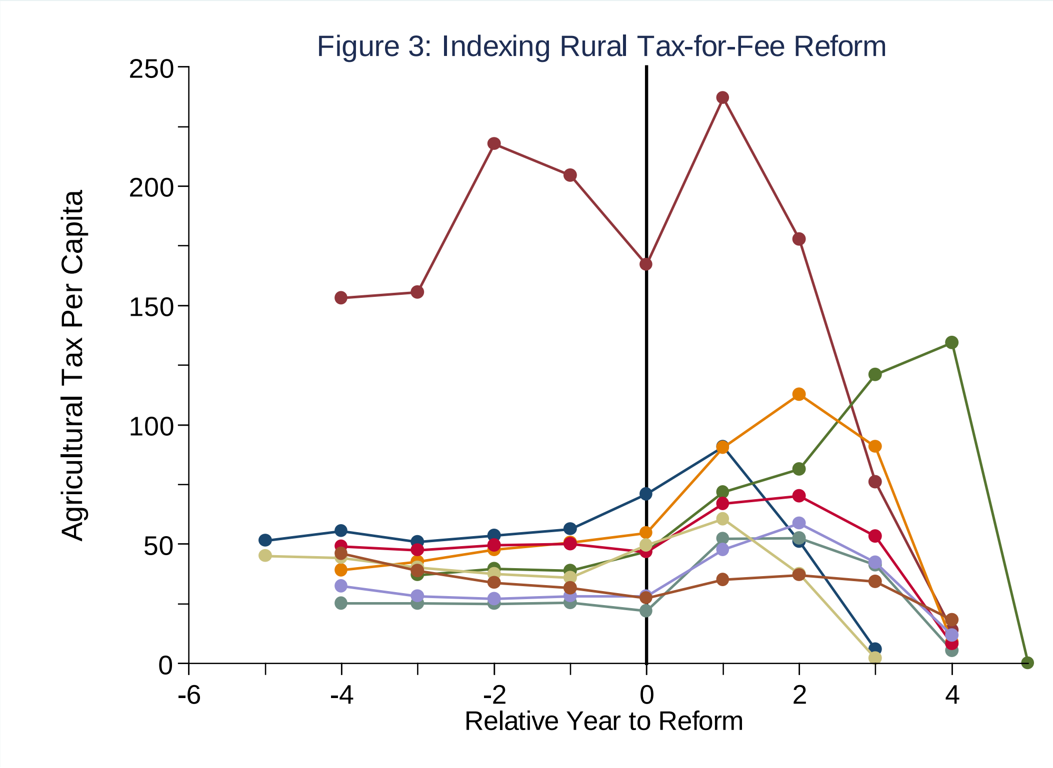


Figure 3: Indexing Rural Tax-for-Fee Reform
Agricultural Tax Per Capita
250
200
150
100
50
0
-6
-4
-2
0
2
4
Relative Year to Reform

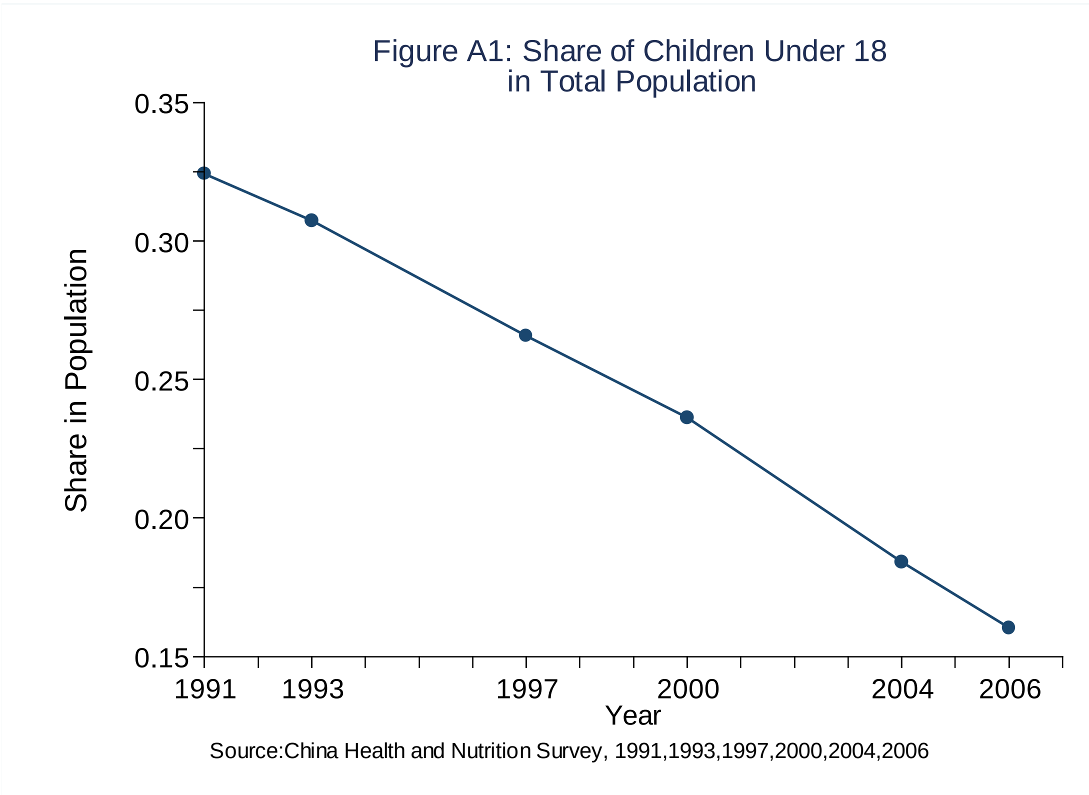


Figure A1: Share of Children Under 18
in Total Population
Share in Population
0.35
0.30
0.25
0.20
0.15
1991
1993
1997
2000
2004
2006
Year
Source:China Health and Nutrition Survey, 1991,1993,1997,2000,2004,2006

Table 1: Summary Statistics

	All	By Residence		By Gender	
		Urban	Rural	Male	Female
Basic Demographic Variables					
Age	10.01	10.30	9.90***	9.95	10.07°
Male	0.53	0.51	0.54***		
Urban	0.27			0.26	0.28°°°
Height (cm)	130.25	133.17	129.18***	130.84	129.59°°°
Weight (kg)	31.09	33.10	30.35***	31.52	30.62°°°
Health-Indicating Variables					
Height for age z-score	-1.01	-0.78	-1.10***	-1.02	-1.01
Weight for age z-score (age<10)	-0.32	-0.20	-0.36***	-0.30	-0.34°°°
Self-rated health[a] (age≥12)	1.97	2.05	1.94***	1.96	1.98
Nutrition Intake Variables					
Daily protein intake (g)	54.60	57.51	53.50***	56.87	52.08°°°
Daily fat intake (g)	51.81	62.98	47.60***	53.67	49.75°°°
Daily calorie intake (g)	1857.93	1859.67	1857.27	1933.64	1773.68°°°
Daily carbohydrate intake (g)	290.81	263.89	300.99***	303.30	276.91°°°
Medical Service Variables					
Have medical insurance	0.21	0.29	0.18***	0.21	0.21
Receive immunizations last year (age≤12)	0.72	0.68	0.74***	0.72	0.72
Receive preventive health service last year	0.05	0.08	0.04***	0.05	0.05
The nearest facility is a beyond-county level hospital	0.32	0.31	0.32	0.32	0.32
Distance to the nearest facility (km)	0.38	0.41	0.38**	0.39	0.38
Family Background Variables					
Household income per capita[b] (yuan)	3330.98	4489.03	2905.65***	3356.47	3302.48
Drinking tap water	0.61	0.87	0.51***	0.60	0.62°°
Using in-house flush toilet	0.22	0.43	0.13***	0.21	0.22
Mother's age	36.50	36.60	36.46	36.45	36.56
Mother's height	155.49	155.76	155.39***	155.64	155.31°°°
Mother-Illiterate	0.27	0.18	0.30***	0.26	0.28°°°
Mother-Primary school	0.24	0.16	0.26***	0.24	0.23°°
Mother-Junior high school	0.33	0.36	0.31***	0.33	0.32
Mother-Senior high school or above	0.17	0.29	0.12***	0.17	0.17
Mother ever smoked	0.02	0.02	0.02	0.02	0.02
Mother being heavy drinker[c]	0.02	0.04	0.01***	0.02	0.02
Father's age	38.13	38.65	37.95***	38.04	38.24°
Father's height	165.98	166.46	165.80***	165.96	165.99
Father-Illiterate	0.11	0.10	0.11**	0.10	0.11
Father-Primary school	0.23	0.15	0.26***	0.23	0.23
Father-Junior high school	0.42	0.40	0.43***	0.42	0.43
Father-Senior high school or above	0.24	0.35	0.20***	0.24	0.24
Father ever smoked	0.70	0.71	0.70	0.69	0.72°°°
Father being heavy drinker	0.28	0.32	0.27***	0.27	0.29°
Observations	16246	4364	11882	8574	7672

Notes:

Source: China Health and Nutrition Survey, 1991, 1993, 1997, 2000, 2004, 2006. Age 0-17 if not specified. * indicate regional difference significant at 10%; ** significant at 5%; *** significant at 1%. °,°°,°°° refer to gender difference. Missing variables not imputed in this table.

a. Self-rated health: 1-excellent, 2-good, 3-fair, 4-poor. b. Income all inflated to 2006 CPI. c. heavy drinkers are defined as people who drink 3-4 times or more per week.

Table 2: Age Profiles of the Income Gradients of Children's Health

Dependent Variable:		By Age			By Wave		
Height-for-Age z scores	All	Age 0~6	Age 7~11	Age 12~17	1991&1993	1997&2000	2004&2006
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Household income (log)	0.123***	0.081***	0.134***	0.137***	0.156***	0.114***	0.078***
	(0.009)	(0.018)	(0.017)	(0.014)	(0.015)	(0.017)	(0.017)
Age	0.006	-0.320***	0.029	-0.075	-0.013	-0.015	0.058***
	(0.008)	(0.040)	(0.137)	(0.130)	(0.011)	(0.014)	(0.017)
Age squared/100	-0.035	3.909***	-0.234	0.250	0.086	0.027	-0.301***
	(0.038)	(0.490)	(0.714)	(0.431)	(0.056)	(0.067)	(0.081)
Male	-0.002	0.001	0.068**	-0.075***	-0.011	-0.012	0.028
	(0.015)	(0.030)	(0.027)	(0.023)	(0.023)	(0.026)	(0.034)
Urban	0.279***	0.278***	0.339***	0.223***	0.306***	0.291***	0.190***
	(0.018)	(0.035)	(0.031)	(0.027)	(0.027)	(0.030)	(0.039)
Household size	-0.044***	-0.011	-0.049***	-0.091***	-0.047***	-0.071***	-0.016
	(0.007)	(0.011)	(0.012)	(0.011)	(0.010)	(0.012)	(0.014)
Observations	16165	4663	5385	6117	7251	5557	3357
R-Squared	0.172	0.152	0.183	0.203	0.126	0.153	0.160

Notes:

Source: China Health and Nutrition Survey, 1991, 1993, 1997, 2000, 2004, 2006. * significant at 10%; ** significant at 5%; *** significant at 1%. Robust standard errors are in the parenthesis. Wave dummies and province dummies are included in all regressions.

Table 3: Regional Difference in the Income Gradient

Dependent Variable: Height-for-Age z scores	(1) Urban	(2) Rural
Household income (log)	0.126***	0.117***
	(0.017)	(0.011)
Age	0.027*	-0.002
	(0.016)	(0.009)
Age squared/100	-0.140*	0.006
	(0.074)	(0.044)
Male	0.007	-0.003
	(0.029)	(0.018)
Household size	-0.081***	-0.033***
	(0.013)	(0.008)
Observations	4346	11819
R-Squared	0.205	0.148

Notes:

Source: China Health and Nutrition Survey, 1991, 1993, 1997, 2000, 2004, 2006. * significant at 10%; ** significant at 5%; *** significant at 1%. Robust standard errors are in the parenthesis. Wave dummies and province dummies are included in all regressions.

Table 4:The Relationship between Child Health and Family Permanent Income

Dependent Variable: Height-for-Age z scores	**(1)**	**(2)**	**(3)**
Household income (log)	0.103***		
	(0.010)		
Household income last wave (log)	0.098***		
	(0.010)		
Average household income in last two wave (log)		0.207***	
		(0.013)	
Non-retirement wage income (log)			0.013***
			(0.002)
Retirement income (log)			0.018***
			(0.004)
Income from subsidies[a] (log)			0.028***
			(0.003)
Net income from household business (log)			0.003
			(0.002)
Income from farming (log)			-0.029***
			(0.002)
Income from other sources (log)			0.001
			(0.002)
Age	0.007	0.005	0.009
	(0.008)	(0.008)	(0.008)
Age squared/100	-0.041	-0.031	-0.043
	(0.041)	(0.041)	(0.038)
Male	-0.002	-0.002	0.003
	(0.016)	(0.016)	(0.015)
Urban	0.242***	0.241***	0.120***
	(0.019)	(0.019)	(0.019)
Household size	-0.048***	-0.049***	-0.013*
	(0.007)	(0.007)	(0.007)
Observations	14146	14359	15940
R-Squared	0.173	0.171	0.200

Notes:

Source: China Health and Nutrition Survey, 1991, 1993, 1997, 2000, 2004, 2006. * significant at 10%; ** significant at 5%; *** significant at 1%. Robust standard errors are in the parenthesis. Wave dummies, and province dummies are included in all regressions.

Table 5: The Income Gradient using Other Measures of Health Status

Dependent Variable:	**Weight-for-Age z scores[a]**			**Self-Rated Health[b]**	**Bad Health[c]**
	Age 0~9	**Age 0~5**	**Age 6~9**	**Age 12~17**	**Age 12~17**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Household income (log)	0.034***	0.013	0.052***	-0.067***	0.075**
	(0.009)	(0.015)	(0.011)	(0.022)	(0.030)
Age	-0.205***	-0.334***	0.023	0.458***	-0.329**
	(0.014)	(0.035)	(0.118)	(0.108)	(0.167)
Age squared/100	1.439***	3.278***	-0.082	-1.548***	1.130**
	(0.114)	(0.490)	(0.726)	(0.371)	(0.569)
Male	0.047***	0.046**	0.045**	-0.044	-0.016
	(0.014)	(0.022)	(0.018)	(0.042)	(0.055)
Urban	0.199***	0.200***	0.199***	0.206***	-0.315***
	(0.017)	(0.026)	(0.023)	(0.047)	(0.059)
Household size	0.003	0.017**	-0.014*	0.037*	-0.036
	(0.006)	(0.008)	(0.008)	(0.020)	(0.026)
Observations	7543	3622	3921	3002	3002
(Pseudo) R-Squared	0.218	0.215	0.221	0.037	0.033

Notes:

Source: China Health and Nutrition Survey, 1991, 1993, 1997, 2000, 2004, 2006. * significant at 10%; ** significant at 5%; *** significant at 1%. Robust standard errors are in the parenthesis. Wave dummies and province dummies are included in all regressions.

a. OLS model used. b. Order probit model used and coefficients reported. Self-rated health - available only for children older than 12 since wave 1997. 1-excellent, 2-good, 3-fair, 4-poor. c. Probit model used and coefficients reported. Bad rated health defined as self-rated health either being fair or poor.

Table 6: The Mechanism of Translating Household Income into Child Health

Dependent Variable: Height-for-Age z scores	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Log-household income	0.123***	0.087***	0.098***	0.094***	0.093***	0.050***	0.066***
	(0.009)	(0.009)	(0.010)	(0.010)	(0.009)	(0.010)	(0.010)
Drinking tap water		0.109***				0.018	0.029
		(0.018)				(0.018)	(0.018)
Using in-house flush toilet		0.260***				0.106***	0.135***
		(0.022)				(0.023)	(0.023)
Have medical insurance		0.148***				0.121***	
		(0.020)				(0.020)	
Receive preventive health service last year		0.041				0.031	
		(0.037)				(0.037)	
Distance to the nearest often-visited medical facility		-0.018**				-0.024**	-0.024***
		(0.009)				(0.009)	(0.009)
The nearest often-visited medical facility is a beyond county-level hospital		0.069***				0.037**	0.037**
		(0.018)				(0.018)	(0.018)
Mother's age			0.008***			0.004	0.004
			(0.003)			(0.003)	(0.003)
Mother-primary school			0.151***			0.064***	0.066***
			(0.025)			(0.023)	(0.023)
Mother-junior high school			0.245***			0.100***	0.107***
			(0.025)			(0.024)	(0.024)
Mother-senior high school or above			0.389***			0.149***	0.160***
			(0.030)			(0.029)	(0.029)
Mother's height				0.035***		0.033***	0.033***
				(0.002)		(0.002)	(0.002)
Mother ever smoked				-0.179***		-0.161***	-0.168***
				(0.054)		(0.055)	(0.055)
Mother being a heavy drinker				-0.092*		-0.106**	-0.099*
				(0.054)		(0.053)	(0.054)
Father's age			-0.003			0.006**	0.006**
			(0.003)			(0.003)	(0.003)
Father-primary school			0.113***			0.059**	0.069**
			(0.031)			(0.029)	(0.029)
Father-junior high school			0.165***			0.077***	0.089***
			(0.031)			(0.029)	(0.029)
Father-senior high school or above			0.259***			0.110***	0.126***
			(0.033)			(0.032)	(0.032)
Father's height				0.039***		0.036***	0.037***
				(0.002)		(0.002)	(0.002)
Father ever smoked				-0.009		-0.006	-0.003
				(0.018)		(0.018)	(0.018)
Father being a heavy drinker				0.002		-0.009	-0.001
				(0.018)		(0.017)	(0.018)
Protein z score					0.142***	0.064***	
					(0.016)	(0.016)	
Fat z score					0.126***	0.081**	
					(0.032)	(0.032)	
Calorie z score					-0.135**	-0.082	
					(0.068)	(0.067)	
Carbohydrate z score					-0.005	0.033	
					(0.049)	(0.048)	
Observations	16165	16165	14184	14184	16165	14184	14184
R-Squared	0.172	0.189	0.196	0.259	0.187	0.276	0.269

Notes:

Source: China Health and Nutrition Survey, 1991, 1993, 1997, 2000, 2004, 2006. * significant at 10%; ** significant at 5%; *** significant at 1%. Robust standard errors are in the parenthesis. Corresponding dummy variables indicating missing of a variable (see Table A1). Wave dummies and province dummies are included in all regressions. Other control variables includes age, age squared, male, urban dummy and household size.

Table 7: The Time Trend of Average County-Level Agricultural Tax Per Capita

Year	Liaoning	Heilongjiang	Jiangsu	Shandong	Henan	Hubei	Hunan	Guangxi	Guizhou
1997	51.41	153.28	37.15	39.30	25.15	49.07	32.56	45.09	46.22
1998	55.39	155.47	39.57	42.61	25.19	47.57	28.13	44.35	39.02
1999	51.00	217.76	38.85	47.74	25.07	49.49	27.24	40.11	33.73
2000	53.67	204.52	46.87	50.55	25.57	50.02	28.12	37.63	31.57
2001	56.22	167.01	71.74	54.58	22.13	46.65	28.19	36.00	27.45
2002	71.09	236.93	81.55	90.64	52.17	66.98	47.76	49.55	35.09
2003	90.71	177.87	121.11	112.73	52.44	70.25	58.65	60.60	36.93
2004	51.12	76.19	134.42	90.92	41.41	53.47	42.43	37.64	34.46
2005	6.04	13.91	0.01	8.93	5.41	8.01	11.77	2.25	18.31

Source: Author's calculation based on China Sub-Provincial Public Finance Statistics (1998-2006)

Table 8: The Effect of Tax-for-Fee Reform on Household Income

Dependent Variable: Household Income (Log)	**(1)**	**(2)**	**(3)**	**(4)**
Log(Δagricultural tax p.c.)	-0.081***	-0.084***	-0.103***	-0.103***
	(0.015)	(0.015)	(0.016)	(0.016)
After	0.501***	0.374***	0.350***	0.353***
	(0.042)	(0.041)	(0.044)	(0.044)
Log(Δagricultural tax p.c.)*After	**0.044*** **	**0.042*** **	**0.060*** **	**0.059*** **
	(0.013)	**(0.013)**	**(0.014)**	**(0.014)**
Age	-0.017**	-0.016**	-0.010	-0.011
	(0.007)	(0.007)	(0.007)	(0.007)
Age squared/100	0.114***	0.103***	0.098***	0.099***
	(0.034)	(0.033)	(0.034)	(0.034)
Urban	0.158***	-0.015	-0.093*	-0.095*
	(0.050)	(0.050)	(0.052)	(0.052)
Male	-0.010	-0.003	-0.007	-0.009
	(0.014)	(0.014)	(0.014)	(0.014)
Household size	0.112***	0.126***	0.125***	0.125***
	(0.006)	(0.006)	(0.006)	(0.006)
Household Facility and Access to Medical Service	No	Yes	Yes	Yes
Parental Education	No	No	Yes	Yes
Parental Health	No	No	No	Yes
Observations	14006	14006	12269	12269
R-Squared	0.144	0.180	0.216	0.220
Cragg-Donald F statistic	11.09	10.51	18.89	18.34

Notes:

Source: China Health and Nutrition Survey, 1991, 1993, 1997, 2000, 2004, 2006. * significant at 10%; ** significant at 5%; *** significant at 1%. Robust standard errors are in the parenthesis. Corresponding dummy variables indicate missing of a variable (see Table A1). Wave dummies and province dummies are included in all regressions.

Table 9: Robustness Check on the Effect of Tax-for-Fee Reform

Dependent Variable:	**Test by Waves**			**Test by Region**	
Household Income (Log)	**2000 versus 2004**	**1991, 1993 versus 1997, 2000**	**2004 versus 2006**	**Rural**	**Urban**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Log(Δagricultural tax p.c.)	-0.063**	-0.094***	-0.037	-0.112***	0.089**
	(0.031)	(0.017)	(0.038)	(0.017)	(0.036)
After	0.030	0.285***	0.082	0.373***	0.312*
	(0.055)	(0.030)	(0.068)	(0.109)	(0.186)
Log(Δagricultural tax p.c.)*After	**0.038***	**0.016**	**0.019**	**0.077****	**0.027**
	(0.020)	**(0.010)**	**(0.025)**	**(0.033)**	**(0.062)**
Age	-0.022	-0.012	-0.039**	-0.021***	-0.014
	(0.013)	(0.007)	(0.016)	(0.008)	(0.016)
Age square/100	0.105	0.092**	0.195**	0.135***	0.061
	(0.067)	(0.036)	(0.082)	(0.040)	(0.081)
Urban	0.233**	0.137**	0.163		
	(0.100)	(0.054)	(0.126)		
Male	-0.038	-0.007	-0.036	-0.004	-0.066*
	(0.029)	(0.015)	(0.036)	(0.017)	(0.036)
Household size	0.121***	0.121***	0.068***	0.105***	0.105***
	(0.012)	(0.006)	(0.015)	(0.007)	(0.016)
Observations	3878	11135	2871	9926	2152
R-Square	0.114	0.126	0.105	0.124	0.167

Notes:

Source: China Health and Nutrition Survey, 1991, 1993, 1997, 2000, 2004, 2006. Age 0-17. * significant at 10%; ** significant at 5%; *** significant at 1%. Robust standard error in the parenthesis. Wave dummies and province dummies are included in the regression but not reported.

Table 10: The Effect of Tax-for-Fee Reform on Family Labor-Force Participation

	Father	Mother	Child
	(1)	(2)	(3)
Log(Δagricultural tax p.c.)	-0.081	-0.080**	0.034
	(0.050)	(0.040)	(0.050)
After	-0.935***	-0.967***	0.059
	(0.089)	(0.076)	(0.116)
Log(Δagricultural tax p.c.)*After	**0.041**	**0.024**	**0.029**
	(0.027)	**(0.022)**	**(0.036)**
Age	0.131***	0.145***	-1.284***
	(0.018)	(0.015)	(0.269)
Age square/100	-0.187***	-0.197***	5.495***
	(0.022)	(0.020)	(0.885)
Urban	-0.738***	-0.600***	-0.566***
	(0.165)	(0.132)	(0.170)
Household size	-0.045**	-0.011	0.086***
	(0.018)	(0.015)	(0.020)
Household income (log)	0.189***	0.143***	-0.114***
	(0.023)	(0.019)	(0.028)
Primary school	0.094	-0.239***	
	(0.084)	(0.057)	
Junior high school	-0.147*	-0.456***	
	(0.077)	(0.054)	
Senior high school or above	-0.110	-0.413***	
or above	(0.082)	(0.061)	
Child being male	0.002	0.011	-0.144***
	(0.042)	(0.034)	(0.046)
Observations	12621	12998	5291
R-Square	0.123	0.117	0.241

Notes:

Source: China Health and Nutrition Survey, 1991, 1993, 1997, 2000, 2004, 2006. Age 0-17. * significant at 10%; ** significant at 5%; *** significant at 1%. Robust standard error in the parenthesis. Wave dummies and province dummies are included in the regression but not reported.

Table 11: IV Estimation of the Effect of Household Income on Child Health

	(1)	(2)	(3)	(4)
Log-household income	**1.071****	**1.102****	**0.673****	**0.541****
	(0.423)	**(0.451)**	**(0.284)**	**(0.268)**
Log(Δagricultural tax p.c.)	0.064*	0.071*	0.033	0.022
	(0.038)	(0.042)	(0.034)	(0.031)
After	-0.185	-0.164	-0.059	-0.012
	(0.304)	(0.249)	(0.178)	(0.167)
Age	0.020	0.020	0.009	0.008
	(0.013)	(0.013)	(0.011)	(0.010)
Age squared/100	-0.130*	-0.130*	-0.056	-0.058
	(0.072)	(0.071)	(0.056)	(0.052)
Urban	0.101	0.162**	0.121	0.129*
	(0.103)	(0.079)	(0.075)	(0.070)
Male	0.010	0.007	-0.010	-0.026
	(0.022)	(0.022)	(0.019)	(0.018)
Household size	-0.161***	-0.168***	-0.118***	-0.100***
	(0.048)	(0.058)	(0.036)	(0.034)
Household Facility and Access to Medical Service	No	Yes	Yes	Yes
Parental Education	No	No	Yes	Yes
Parental Health	No	No	No	Yes
Observations	14006	14006	12269	12269

Notes:

Source: China Health and Nutrition Survey, 1991, 1993, 1997, 2000, 2004, 2006. * significant at 10%; ** significant at 5%; *** significant at 1%. Robust standard errors are in the parenthesis. Corresponding dummy variables indicate missing of a variable (see Table A1). Wave dummies and province dummies are included in all regressions.

Table A1: Missing Variables in CHNS

Variables	Percentage of Missing
Drinking tap water	0.65%
Using in-house flush toilet	0.65%
Have medical insurance	1.66%
Receive preventive health service last year	2.30%
Distance to the nearest medical facility	4.67%
The type of the facility	4.67%
Mother's education level	0.85%
Mother's height	4.44%
Mother ever smoked	3.42%
Mother being a heavy drinker	3.91%
Father's education level	0.52%
Father's height	13.09%
Father ever smoked	9.23%
Father being a heavy drinker	9.62%
Protein intake	5.21%
Fat intake	5.37%
Calorie intake	5.16%
Carbohydrate intake	5.26%

Notes:

Source: China Health and Nutrition Survey, 1991, 1993, 1997, 2000, 2004, 2006. Age 0-17.

Table A2: The Differnce of Children between Families with Both Parents Live in and Families with either Parent not in Home

	Urban		Rural	
	Both parents live in home	**Either parents not**	**Both parents live in home**	**Either parents not**
Basic Demographic Variables				
Age	10.27	10.53	9.89	9.97
Male	0.51	0.48	0.54	0.53
Height (cm)	132.89	135.23*	129.14	129.55
Weight (kg)	32.91	34.49**	30.33	30.51
Health-Indicating Variables				
Height for age z-score	-0.80	-0.70*	-1.10	-1.09
Weight for age z-score	-0.21	-0.11*	-0.36	-0.35
Self-rated health (age⩾12)	2.05	2.08	1.92	2.02
Nutrition Intake Variables				
Daily protein intake (g)	57.31	58.92	53.77	51.01
Daily fat intake (g)	62.59	65.82*	47.38	49.70
Daily calorie intake (g)	1855.57	1889.65	1862.74	1806.09
Daily carbohydrate intake (g)	264.00	263.12	302.49	286.91
Medical Service Variables				
Have medical insurance	0.29	0.24**	0.17	0.22
Receive immunizations last year (age⩽12)	0.68	0.67	0.74	0.72
Receive preventive health service last year	0.08	0.08	0.04	0.04
Family Background Variables				
Household income per capita (yuan)	4571.97	3882.55***	2888.91	3059.95
Drinking tap water	0.86	0.90**	0.50	0.63
Using in-house flush toilet	0.42	0.48**	0.13	0.16
Observations	3839	525	10719	1163

Notes:

Source: China Health and Nutrition Survey, 1991, 1993, 1997, 2000, 2004, 2006. Age 0-17. * significant at 10%; ** significant at 5%; *** significant at 1%.