# The Growth of Poor Children in China 1991-2000:

# Why Food Subsidies May Matter

*Lars Osberg**

*Jiaping Shao**

*Kuan Xu**

**ABSTRACT**

How did the rapid growth in per capita income and rising income inequality during 1991-2000 in China affect the health status of Chinese children, given that the disappearance in the 1990s of subsidized food coupons simultaneously increased the importance of money income in enabling consumption of basic foods by poor families? Using the China Health and Nutrition Survey (CHNS) data for 1991, 1993, 1997 and 2000 on 4,400 households in nine provinces, we examine the height-for-age of Chinese children aged 2 to 13, with particular emphasis on the growth of children living in poor households. We use mean regression and quantile regression models to isolate the dynamic impact of poverty status and food coupon use on child height-for-age. Our principal findings are: (i) controlling for standard variables (e.g., parents' weight, height, and education) poverty is correlated with slower growth in height between 1997 and 2000 but not earlier; (ii) in 2000, poverty is negatively correlated with strong growth in height-for-age; and (iii) food coupon use in earlier periods correlates positively with growth in height-for-age. The general moral is the crucial social protection role that subsidized food programmes can potentially play in maintaining the health of poor children.

* Department of Economics, Dalhousie University, Halifax, Canada

**KEYWORDS**

poverty, child development, food subsidies, economic growth, height for age, China

**ACRONYMS**

BMI body mass index

CHNS China Health and Nutrition Surveys

WHO World Health Organization

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# 1 INTRODUCTION

Health is both a direct determinant of individual wellbeing and a precondition for enjoyment of material affluence. This paper focuses on the health status of children because child health affects both the current wellbeing of children and their future health, economic productivity and personal wellbeing (Strauss and Thomas, 1998). We ask whether changes in the average height-for-age of Chinese children, (an important indicator of child health status) reflect the increase in China's per capita GDP, whether the poverty that remains adversely affects child health and whether the 1990s reforms to China's food subsidy system have increased the importance of income poverty in explaining child health.

The paper documents the general advances in average physical stature, measured by average height-for-age, of Chinese children during the 1991-2000 period. However, China has experienced rapid growth in per capita income and rising income inequality in the context of huge social, economic and public policy transition. As the economy moved from a central planning system towards a market model, the social protection system weakened substantially. Greater income inequality and reduced social protection can both be expected to increase the real economic deprivation of the least well-off. Might this imply that income poverty and rising food prices now matter more than they used to in explaining child health and individual height-for-age in China? We present some evidence on the decline in food subsidies and outline a framework for analysis.

To analyse the determinants of child health, we use robust least squares regressions for growth in height (for the 1991-93, 1993-97 and 1997-2000 periods) to examine the changing role played by income poverty and the impact of less social protection for Chinese families in influencing child height-for-age. Because we expect a non-uniform impact across children with different social and economic backgrounds, quantile regression models are also used to estimate the varying marginal impact of the determinants of height-for-age.

Section 2 presents the basic overview and a brief discussion of the data used. In section 3, our framework for analysis and variable selection are discussed. Section 4 reports the empirical results based on robust least squares regression and quantile regression models. Concluding remarks are given in section 5.

## 2 OVERVIEW

In 1980, GDP per capita in China was US$708[1] but by 2003 that had risen six-fold to US$4,344. Over the 1991-2000 period which we study, the average annual real growth rate of per capita GDP in China was 9.2 per cent. This strong growth in per capita income has continued (2007 saw a further 11.7 per cent increase)[2] but it has also passed some people by. One research question that this suggests is: How are children in poor families doing?

As an indicator of child wellbeing, we use the anthropometric measurement, height-for-age *z*-score (HAZ), defined as:

$$HAZ_i = \frac{\text{(height of child i - median height of children of same sex and age)}}{\text{(standard deviation of height of children of same age and sex)}},$$

to measure long-term health status (see Habicht et al., 1974; Graitcer and Gentry, 1981). In this paper, height-for-age is normalized using data for US children collected by the National

[1] World Bank PPP, constant 1995 international dollars. Unless otherwise noted, all aggregate data in this section are based on the PPP constant 1995 dollars, drawn from the World Bank web site. http://devdata.worldbank.org/dataonline/ .

[2] In the first quarter of 2007, GDP grew at a 11.7 per cent annual rate (*China Daily*, 2007).

Center for Health Statistics as the growth standards reference population,[3] i.e., US data are used to calculate the median and standard deviation of the distribution of heights, by gender and by age in months.

This measurement is recommended by the World Health Organization (WHO) as 'the best system for analysis and presentation of anthropometric data'.[4] Mansuri (2006: 3) has also recently argued:

> Child height, in particular, is a good indicator of underlying health status and studies have shown that children experiencing slow height growth are found to perform less well in school, score poorly on tests of cognitive function, and have poorer psychomotor skills and fine motor skills. They also tend to have lower activity levels, interact less frequently in their environments and fail to acquire skills at normal rates.

In Sen's terminology of 'capabilities' and deprivation,[5] child height-for-age is both a direct measure of the capability of a population to grow to its physical potential[6] and a correlate of the development within individuals of a wide range of cognitive and social capabilities.

Why might the poor growth of deprived children matter? Alderman, Hoddinott, and Kinsey (2006) analyse the consequences of childhood malnutrition and find that improvements in

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[3] CDC (2000) and WHO (2006).

[4] See WHO at www.who.int/nutgrowthhdb/about/introduction/en/index4.html

[5] See Sen (1987, 1999).

[6] Although the regressions reported in Tables 5 and 6 use child height normalized for sex and age based on population estimates drawn from US data, we are not implicitly assuming that the ultimate physical potential of societies with differing genetic composition are identical, just that they are some scalar multiple (which might be 1) of US values at each age and gender.

height-for-age in childhood are positively correlated with adult height and the number of years at school. Wadsworth and Kuh (1997) argue that early-life development is associated with a range of adult outcomes, including blood pressure, respiratory function and schizophrenia. Cooper et al. (2001) note that children with a low growth rate in height and weight have an increased risk of hip fracture in adulthood. Sawaya et al. (2003) suggest an association between childhood nutritional stunting and increased risks of obesity and chronic degenerative diseases in later life. Chang et al. (2002) find that previously stunted children are likely to have poorer cognition and school achievement. Furthermore, children are not just 'future adults'—they are citizens in their own right, and therefore their wellbeing *now* has a direct claim to consideration in social decision making.

HAZ has been used as a child health measure across countries (e.g., Graitcer and Gentry, 1981; Thomas, 1990; Attanasio et al., 2004) or for children of different ethnic/racial background within countries (e.g., Yip, Scanlon, and Trowbridge, 1992). The evidence suggests that a child's environment plays a dominant role in influencing child health. In particular, Thomas, Lavy, and Strauss (1996) find that public policy, in particular the food policy in developing countries, is an important influence. In any country, food prices help determine the availability of food to the poor, but in the specific case of China, food was partly rationed in the earlier part of the 1991-2000 period and as the country's economy moved toward the market model, rationing was gradually eliminated. Hence, money income became more important for obtaining food, and therefore more important for child health (see Pritchett and Summers, 1996; Haddad et al., 2003).

Many authors note the dramatic increase in income inequality that has accompanied China's rapid economic growth (e.g., Khan and Riskin, 1998; Gustafsson and Shi, 2002). For the period examined in this paper, Wu and Perloff (2005: 29) estimate that the Gini index of inequality in money incomes rose from 0.345 in 1991 to 0.407 in 2000. To put this in context, Luxembourg Income Survey data[7] indicate that over the same period the Gini index of money income inequality rose from 0.281 to 0.302 in Canada and from 0.338 to 0.368 in the United States, while falling from 0.266 to 0.248 in the Netherlands and from 0.309 to 0.280 in Switzerland. Thus China in 2000 had both a substantially higher level of income inequality than any developed country and a comparatively large rate of increase over the 1991 to 2000 period.[8] Hence, at the same time as family money income became more important for child nutrition, it also became significantly more unequally distributed.

What impacts might these trends have had on child height for age?

This paper uses micro data from the China Health and Nutrition Surveys (CHNS), conducted by the Carolina Population Center at the University of North Carolina in 1989, 1991, 1993, 1997, and 2000.[9] Extremely detailed data on many variables of interest were collected on about 4,400 households (16,000 individuals) in nine provinces. Within each province, 4 counties were selected using a multistage, random cluster process. The provincial capital and a lower income city were selected when feasible. Villages and townships within the counties and urban and suburban neighbourhoods within the cities were selected randomly. This paper uses observations on children between 2 and 13 years in the 1991 and 2000 data waves – a period when GDP per capita increased by 125 per cent (from ¥1,760 in 1991 to ¥3,960 in 2000, expressed in 1990 yuan).

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[7] See http://www.lisproject.org/keyfigures/ineqtable.htm.

[8] In Appendix A, Figure A2 provides a picture of the greater dispersion that has accompanied higher average incomes in China.

[9] Data in survey year 1989 are not used because the variable that indicates child-parents relation and some parents' variables (i.e., smoker or drinker) were not collected. Full data documentation is available at http://www.cpc.unc.edu/china.

It is clear in the data that Chinese children of any given age are now, on average, significantly taller than they were during earlier (and poorer) periods in China's history. On average, boys aged 2 to 13[10] in our dataset were 5.78 per cent shorter than American boys of a similar age in 1991, but by 2000 the differential had shrunk to 4.03 per cent. The differential for girls was a bit larger in 1991 (5.85 per cent) but decreased by more (to 3.35 per cent in 2000). To put it another way, 30 per cent of the average height-for-age differential between the USA and China for boys, and 43 per cent of the average height-for-age differential for girls, disappeared in only nine years, i.e., between 1991 and 2000.

Figure 1 plots the average height in 1991 and 2000 of Chinese children, by age and gender, as a proportion of the US average for the same age and gender for ages 2 to 18.[11] The convergence in average height which is apparent in Figure 1 is exactly what one would expect rising per capita income and better nutrition to produce.[12] GDP per capita in China grew from US$422 in 1991 to US$949 in 2000 (constant 2000 US$) – an increase of 124.8 per cent. For our full cross-section of CHNS respondents, average height-for-age increased from -1.30 to -0.75, a 42.3 per cent increase.[13] The elasticity of average child height-for-age

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[10] Dibley et al. (1987) emphasize the problems in assessing height-for-age in children under 2. This paper focuses on ages 2 to 13 because we want to explain individual variation in HAZ and differentials in timing of the onset of puberty may introduce substantial noise into the measurement of adolescent growth rates. Nevertheless, Figure 1 includes teens to illustrate that there has been a *general* increase in average height-for-age among Chinese children.

[11] Figure A1 in Appendix A presents the distribution of height-for-age for the 2 to 13 age group in the two years.

[12] See Pritchett and Summers (1996) or Sahn and Alderman (1997). Alderman et al (2005) conclude that the positive impact of GDP growth on indicators of child malnutrition, although varying somewhat by country, was just as strong in the 1990s as in the earlier decades. Thomas, Lavy, and Strauss (1996) emphasize the positive role of basic public services, such as immunization and the provision of common drugs, and the negative impact of rising food prices on child height-for-age in the Côte d'Ivoire.

[13] See Appendix Table B2.

with respect to real GDP per capita in these data is therefore about +0.34, which can be seen as anthropometric confirmation of an improvement in *average* wellbeing.

Insert Figure 1 about here

However, although height-for-age between 1991 and 2000 shifted up in China for most children, the shortest saw smaller increases than most others. In Table 1 all children aged 2 to 13 in the CHNS dataset are ordered by HAZ and the absolute size of the increase in HAZ for each height decile is compared with the change in HAZ for the 10th (top) decile. From the 3rd to the 10th decile, there was a large and fairly uniform increase, an increase in HAZ of approximately 0.5. Over the 1991 to 2000 period, the third decile of Chinese children moved decisively into normal range, while the second decile made significant progress (a 0.40 increase in HAZ or about 80 per cent of the HAZ change for the tenth decile). However, the shortest 10 per cent of children remained very much below the US norm (on average, with HAZ at –3.18 in 2000 after a 0.19 increase from the 1991 level) and experienced the smallest change.

If the definition of 'stunting' is taken to be HAZ more than two standard deviations below the mean, about one sixth of Chinese children were in this category in 2000, which was a substantial improvement over the 1991 figure of 28 per cent.[14] Children with HAZ more than

[14] Percentage of the 2-13 age group with HAZ < -3 and HAZ < -2 in entire sample available in CHNS

| | 'Severely malnourished' HAZ < -3 | 'Stunted' HAZ < -2 |
|---|---|---|
| 1991 | 7.23% | 28.49% |
| 1993 | 6.27% | 24.86% |
| 1997 | 3.94% | 19.71% |
| 2000 | 4.27% | 16.43% |

[1991: n=1659; 1993: n=1390;1997:n=1123; 2000:n=813] Computations by authors.

three standard deviations below the norm can be classified as 'severely malnourished' (Mansuri, 2006). In the early 1990s there was clear progress in reducing this percentage, but this is not apparent between 1997 and 2000. Although most Chinese children are catching up with rich nations' height norms very quickly, how can one explain those children who are being left behind?

Insert Table 1 about here

The emphasis of this paper is on the possible role that money income poverty, food coupons and food prices could play in explaining children's height-for-age[15],but there are a number of possible measures of poverty. Because the '2 dollars per day per person' criterion is familiar in the development literature, we will focus on the econometric results obtained when this poverty criterion is used (which we calculate as being equivalent to ¥1072 per person in 1990 prices). In this paper we use a dummy variable indicating whether income was, or was not, above the US$2 per day poverty line in a particular year.[16]

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Svedberg (2006: Table 6) provides estimates of the prevalence of stunting in China as a whole which differ somewhat in level, but agree closely in trend, with the CHNS data.

[15] See also Wagstaff (2002) and Wagstaff et al. (2003).

[16] Reddy and Minoiu (2006) examine some of the implications of the 13 alternative poverty lines used in the literature in the analysis of Chinese data. In another study (Osberg and Xu, 2008) we argue that China's rapid growth has made the poverty line of half the median equivalent income relevant, but the trend in per capita income numbers reported in Table 3 of Wagstaff and Lindelow (2005) using CHNS data are not congruent with the observed trends from the Chinese national statistics. Hence, this paper relies on the US$2 (PPP) per day criterion, but as Osberg and Xu note (2008: 430): 'in China in 2003 a relative poverty line (half median equivalent income) may not actually have been so different from an absolute ($2 per day) poverty line, in practice'.

The 1991-2000 period that we study represents a period of many rapid social changes, and for the purposes of this paper, the elimination of food subsidies and ration coupons and food price increases were particularly important. Tables 2 and 3 document the subsidies and ration coupons received by Chinese households and show the shrinkage in coupon receipt over the period 1991 to 1997.[17] Among the subsidies available in 1991, the most common were food coupons enabling the purchase of rice, flour, and cooking oil at below market prices. These coupons could be sold, and their value to recipients was equal to the differential between the market price and the coupon price. For recipient households, the average market value of coupons on rice, flour and cooking oil alone was approximately ¥543, which would represent an appreciable fraction (about 16.5 per cent) of the income of a three person family living at the US$2 per day poverty line of about ¥1,100 per person.

Meng et al. (2005: 710) have emphasized the importance of the elimination of subsidies for poor households:

> Although urban China has experienced spectacular income growth over the last two decades, increases in inequality, reduction in social welfare provision, deregulation of grain prices, and increases in income uncertainty in the 1990s have increased urban poverty. ….We find that the increase in poverty in the 1990s is associated with the increase in the relative food price and the need to purchase items that were previously provided free or at highly subsidized prices by the state, i.e., education, housing and medical care. In addition, the increased saving rate of poor households, which is due to an increase in income uncertainty,

[17] Unfortunately these variables are omitted by the 2000 CHNS data.

contributes significantly to the increase in poverty measured in terms of expenditure.

Although food coupons served to buffer the importance of money income and afforded a measure of social protection from market income fluctuations, they were not targeted particularly on the poor. As Table 3 indicates, rural households were much less likely than urban household to receive food coupons, even in 1991.[18] Within both rural and urban areas, non-poor households were actually somewhat *more* likely than poor households to receive ration coupons, as Table 3 shows. Nevertheless, even if non-poor households also received ration coupons, about half of the urban poor in 1991 derived significant benefits from them.

Insert Tables 2 and 3 about here

Du et al. (2004) use the detailed data on diets included in the CHNS to analyse nutritional trends in China. They conclude that the income elasticity for food group consumption differs significantly by income level. They argue that 'the current nutrition transition seems to be occurring faster among the poor than among the rich' and increasingly 'the burden of disease relating to poor diets may be shifting to the poor' (2005: 1512-3). As Table 3 indicates, consumption of rice and wheat flour fell from 1991 to 1997 among poor and non-poor alike, but as the budget constraint on food consumption shifted from 'cash income plus food coupon' to 'cash income' at least the non-poor could afford higher quality calorie sources. However, across the income distribution from 1991 to 2000, the first and second deciles received much smaller absolute increases in income than the top decile.

[18] The food ration coupons were distributed to the non-farming population; only those rural residents who had non-farming jobs were entitled to receive food ration coupons.

Insert Table 4 about here

## 3 FRAMEWORK FOR ANALYSIS

The CHNS data for the 1991-2000 period offer an opportunity to analyse both income/poverty and food rationing via food coupons and their role in influencing child health. We use $H_{a,s,i,t}$ to denote the height-for-age of child *i* at time *t*, whose age is *a* and sex is *s*. $H_{a,s,i,t}$ can be written as a function of age (*a*), sex (*s*), and:

[1] person-specific influences, including genetic endowment; what some might call ‘nature’ (*X*);

[2] household specific influences, including socioeconomic variables and nutrition, which vary over time, and might be called ‘nurture’(*N*);

[3] general environmental conditions not specific to the household (*E*), and

[4] a random term ($\varepsilon_{it}$) which is a summary of various unknown factors. Some variables in [1]-[3] may be time-varying in their impact while some may be time-invariant. A general functional form may be written as:

$$H_{a,s,i,t} = f(a_i, s_i, X_{it}, N_{it}, E_{it}) + \varepsilon_{it} \quad (1)$$

for all *i* and *t*.

In general, both current and past influences of factors *X*, *N*, and *E* will matter, hence these can be scalar variables as well as vectors of variables such as $X = [x_1, x_2, \cdots]$, $N = [n_1, n_2, \cdots]$, and $E = [e_1, e_2, \cdots]$. (Multiple lagged factors are restricted by the natural boundary of age.) Hence the model given by Equation (1) is general enough for our purpose. Median child growth charts are plots of the forecasted height $h(a,s)=\hat{f}(a,s,\hat{X},\hat{N},\hat{E})$ against age $a$ where $\hat{X}$, $\hat{N}$ and $\hat{E}$ are the factor values corresponding to the median height given age (measured in months) and sex. Typically, one chart is for male ( $s = male$ ) and the other is for female ( $s = female$ ) and surrounding the median growth charts, growth curves are graphed at various quantiles.

The subject of interest is HAZ of individual children over time. Let $HAZ_{it}$ be the height-for-age z-score of individual child $i$ at time $t$, which is derived from

$$HAZ_{it} = \frac{H_{a,s,i,t} - h(a,s)}{\sigma_{H_{a,s}}}, \tag{2}$$

where $H_{a,s,i,t}$ is the height of individual child $i$ at time $t$, and $\sigma_{H_{a,s}}$ is the standard deviation of the height variation from the median height of the reference population (for a given age and sex).

Using the information in Equation (2), we can modify Equation (1) into

$$HAZ_{it} = \frac{H_{a,s,i,t} - h(a,s)}{\sigma_{H_{a,s}}} = \frac{1}{\sigma_{H_{a,s}}}[f(a_i, s_i, X_{it}, N_{it}, E_{it}) - h(a,s) + \varepsilon_{it}] \tag{3}$$

Linearizing $f(a_i, s_i, X_{it}, N_{it}, E_{it}) - h(a,s)$ and permitting fixed individual and time effects, we have:

$$f(a_i, s_i, X_{it}, N_{it}, E_{it}) - h(a,s) = g(a_i, s_i, X_{it}, N_{it}, E_{it}) = a_i + b_t + cX_{it} + dN_{it} + fE_{it} \tag{4}$$

and rewrite the right-hand side of Equation (3)

$$HAZ_{it} = \alpha_i + \beta_t + \gamma X_{it} + \delta N_{it} + \eta E_{it} + v_{it} \tag{5}$$

where $\gamma = \frac{c}{\sigma_{H_{a,s}}}$, $\delta = \frac{d}{\sigma_{H_{a,s}}}$, , and $v_{it} = \frac{\varepsilon_{it}}{\sigma_{H_{a,s}}}$. Note that the right-hand side variables can be scalars or vectors and hence the coefficient associated with these variables can be scalars or vectors.

If we examine $\Delta HAZ_{it} = HAZ_{it} - HAZ_{it-1}$ over a particular period, we can 'difference out' permanent unobserved variables and the earlier impact of person-specific influences. If any variable from *X*, *N* and *E* is individually specific and time-invariant, differencing it between $t$ and $t-1$ will eliminate it from the dynamic model. However, if a variable is not time-invariant, differencing will show its impact for the span of time under consideration.

If we want to analyze the dynamics of $HAZ_{it}$, we can obtain, from Equation (5),

$$\Delta HAZ_{it} = (\beta_t - \beta_{t-1}) + \gamma \Delta X_{it} + \delta \Delta N_{it} + \eta \Delta E_{it} + u_{it} \quad (6)$$

where $u_{it} = v_{it} - v_{it-1}$. Sometimes, Equation (6) is better estimated as:

$$HAZ_{it} = (\beta_t - \beta_{t-1}) + \lambda HAZ_{it-1} + \gamma \Delta X_{it} + \delta \Delta N_{it} + \eta \Delta E_{it} + u_{it} \quad (7)$$

The above model is readily estimated by the data we have.

In this study we use a set of variables such as parent height/weight for $X_{it}$, a set of variables such as income, poverty status, poverty gap, health insurance for $N_{it}$, and a set of variables such as tap water and geographical region for $E_{it}$.

Our specific hypothesis is that during the 1991-2000 period, children's overall health condition (as measured by HAZ) might have become more sensitive to poverty status and rising food prices, because food coupons were gradually eliminated in the later part of said period and the income distribution became less equal in 2000 compared to that in 1991. We hypothesize that the decrease in social protection implies that $\delta < 0$ in Equation (7) if

$(N_{it} - N_{it-1})$ measures poverty status during the 1997-2000 period, but the earlier presence of food coupon implies $\delta$ may not be significantly negative during the earlier part of the 1991-2000 period.

What offsetting factors might prevent poverty trends from adversely affecting child health? A unique aspect of the Chinese context is the concentration of family resources on one child which is inherent in the country's 'one child' policy, a factor which may tend to mitigate the adverse effect of income poverty on child health that is apparent in other countries' data. In common with other countries, the secular trend to higher levels of maternal education can also be expected to affect child health positively.

In estimating the role played by time varying socioeconomic factors in the determination of child height-for-age [$N_{it}$ in the terminology of Equation (1)], it is also essential to control for the continuing influence of predetermined variables ($X_i$). A prime example is the height and weight of the father and mother. The exact role that genetics plays in determining height may be complex, but the heights of parents correlate with the height of their children, either because of genetic endowments (Strauss, 1990) or due to family background effects such as ethnic differences, household diet preferences and previous favourable or unfavourable environmental influences unmeasured by current data. Genetic inheritance can be expected to influence both height-for-age and the growth rate, at any point in time, of height-for-age.

Parents' ages when the child is borne may influence parenting skills (Paxson and Schady, 2005), which may also represent a continuing influence. Very young or very old mothers may have less healthy children, so the ages of father and mother at the child's birth and a quadratic form of mother's age are also included (Strauss, 1990). Education has often been found to play a significant role. Strauss (1990) finds positive significant effects for both maternal and paternal education on children's weight, and strong impact of local wage rates, the health environment and the quality of health infrastructure in rural Côte d'Ivoire. Thomas (1990) notes that in Brazil, Ghana, and the United Sates, the education of the mother has a larger positive impact on the height of her daughter. Thomas, Strauss, and Henriques (1991) find that mother's education affects children's height significantly in both the rural and urban areas of Northeast Brazil. Alderman, Hentschel, and Sabates (2001) observe both a direct link in rural Peru between the caregivers' education and their children's health and a shared knowledge effect of women's education on children's health in other households. The education variable available for this study is the number of years of formal education completed, which is available for both mother and father.

As general proxies for the possible influence of environmental factors, we include dummy variables for the province of residence. Among the time varying environmental variables ($E_{it}$), we include access to tap water, since the importance of sanitary water supply is emphasized by Dillingham and Guerrant (2004).[19]

Income is measured only in the survey years, so we are missing the income and poverty status of households in intervening years. The income variable reported is the logarithm of equivalent individual income,[20] but we also experiment with other specifications (such as unadjusted household income, linear or in logs), none of which affects the result that 'income' is statistically insignificant in all specifications, for the population as a whole.

If one controls for initial height-for-age [as in Equation (7)], one is estimating the correlation

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[19] We also try other environmental variables, such as having a flush toilet, but these are statistically insignificant.

[20] We use the LIS equivalence scale, which calculates the equivalent income of each household member as: $y_i = \frac{y_f}{{n_f}^{0.5}}$ where $y_f$ is total household income and $n_f$ is the number of persons in the household.

between a child's growth in height and their individual characteristics. Since height, at any age, is just the sum of growth in height over previous ages, a dataset such as the CHNS that measures height at different times can be seen as providing evidence on child growth over the 1991-93, 1993-97 and 1997-2000 periods.

## 4 EMPIRICAL RESULTS

This section reports the empirical evidence from robust least squares and quantile regression models. Using robust least squares regression models[21] we first examine growth in height-for-age separately for the 1991-93 period (when food subsidies were initially in place) and for the 1993-97 and 1997-2000 periods (when food subsidies had largely been abolished). Using quantile regression models we then show the varying marginal impact of income poverty on height-for-age during the 1997-2000 period.

In these three periods, there were 1230 children aged 2 to 11 in 1991, who aged to be 4 to 13 years in 1993, 638 children aged 2 to 9 in 1993, who aged to be 6 to 13 in 1997 and 583 children aged 2 to 10 in 1997 who were between 5 to 13 in 2000. In each period, the health of children, as measured by HAZ, is followed in terms of initial health and changes in health.

As shown in Table 5, there are some notable changes in structure between periods, e.g., the importance of urban residence in the 1997-2000 period, compared to its insignificance in the two earlier periods. The insignificance of the 'female' dummy variable is also an important negative result—if gender preference in child nutrition were operative within Chinese

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[21] The models chosen are selected from many alternative specifications based on the standard model selection criteria.

households, one might have expected to observe Chinese girls making less rapid progress than boys in height-for-age, but (as noted earlier) on average girls have a greater increase in HAZ than boys between 1991 and 2000 and none of our econometric results support this hypothesis.

Poverty status in initial year is observed in the 1997-2000 period, and is negative and statistically significant (at 10 per cent) in 1997, while in the 1991-93 and 1993-97 periods, poverty status in either initial year or final year is not statistically significantly associated with height-for-age.[22] The estimated coefficient on 1997 poverty status implies that the empirical magnitude of the negative height differential associated with a one year poverty spell would be about 1.4 cm for a 13-year old boy. If the impact of poverty on height is approximately linear in time, this would imply that long term poverty (e.g., four years) could have quite a substantial impact on the height of poor children.

In the 1991-93 and 1993-97 periods, the use of food coupons in the end year by the household is statistically significant (at 10 per cent) and positively associated with growth in height-for-age. Since more rapid growth in the 1991-93 period would increase a child's height-for-age in 1993, and thereby decrease the chances of rapid *growth* between 1993 and 1997, the observation of a statistically significant *positive* coefficient on 1993 food coupon use in the initial year in the 1991-93 regression and a statistically significant *negative* coefficient on the same variable in the 1993-97 regression is entirely explicable, but as Table 3 notes, food coupon use in 1993 was very low.

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[22] We include the poverty lines in both initial and final years because: (i) each period covers a different number of years, the inclusion of both poverty lines gives a better control for poverty dynamics in each period, (ii) as the periods examined here witnessed significant changes in incomes and poverty status, the poverty line in initial year alone is insufficient, and (iii) the exclusion of the poverty line in the final year causes the goodness of fit of these models to fall relative to that of the models in this paper.

Based on Tables 3 and 5, we would argue that: (i) poverty status is not, before 1997, associated with slow growth in height-for-age; (ii) in the 1997-2000 period household income poverty in initial year is correlated with poorer growth in height-for-age among children aged 2 to 13; and (iii) in both 1991-93 and 1993-97 periods, food coupon use in the final year was positively associated with growth in height-for-age.

We phrase our findings in terms of correlations because we cannot, strictly speaking, prove causation.[23] However, in our view the reverse causality possibility (that low height-for-age of children aged 2-13 may somehow cause family income poverty) is implausible in the Chinese context. The number of household members is about 4.3-4.5 people when the one-child policy is in place.[24] That is, typical Chinese families have one or two grandparents in addition to one child and two parents. The presence of grandparents, who typically take care of the one grandchild, weakens any possible feedback from child health status to labour incomes of the parents.

The robust least squares regression models presented in Table 5 illustrate the average link between height-for-age and its determinants, but there is likely to be substantial heterogeneity in this relationship across the HAZ distribution. Quantile regression models are potentially particularly interesting for studying child growth if we are interested in finding out how income poverty affects children differently across the HAZ distribution.

For the 1997-2000 period, Figure 2 presents plots the marginal impact (and 95 per cent confidence interval) of poverty lines on HAZ using both the quantile regression model

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[23] The CHNS dataset does not contain (and it is hard to imagine) a 'natural experiment' in which poverty status is randomly assigned. Instrumental variable techniques are constrained by the non-availability of plausible and robust instruments.

[24] See Appendix Table B2.

reported in Table 6 and the robust least squares regression model for the same period reported in Table 5. Figure 2, which graphs quantile estimates of the impact of income poverty in 1997 and 2000, indicates that the quantile point estimates of the impact of income poverty status in 1997 vary relatively little, and are fairly close to the robust least squares estimates – hence little is gained by using quantile regression models, at least for understanding the impact of poverty. In 2000, however, the least squares estimates of a negative impact of poverty on height-for-age on average do not reveal the large variation in the impact of poverty, in particular, the increasingly large negative association between income poverty and child height-for-age in the top percentiles of the HAZ distribution in 2000.

This observation is further supported by the results in Table 6, which presents the quantile estimates of the marginal impacts of the factors that influence children's height-for-age at four points in the HAZ distribution (0.2, 0.4, 0.6, 0.8) for the cohort of children aged 2-10 in 1997 who were 5-13 in 2000. Table 6 shows that poverty dummy variables in the initial and final years, 1997 and 2000, have statistically significant negative association with height-for-age at 60 and 80 percentiles. This finding is not revealed in the robust least squares models, and is consistent with the hypothesis that that when no food coupons were available in the 1997-2000 period, income poverty began to matter for children's height-for-age, in particular by limiting the likelihood of large growth spurts.

## 5 CONCLUSION

In discussing the implications of our results we are well aware of the audacity it would require to draw firm conclusions about the wellbeing of approximately 20 per cent of the world's population based on these regressions run on this sample data. China's 1.3 billion people span an incredible diversity of life circumstances. Despite the many virtues of the

CHNS data, we would not argue that 4,400 households in nine provinces can fully capture that diversity, and, due to sample selection and variable non-response, the sample size we can work with for analysis is much smaller. We therefore interpret our results as suggestive, rather than conclusive, and our hope is that further work, with larger datasets, can provide a more definitive conclusion.

Our results do, however, suggest that income poverty became more important for child health when food coupons were no longer available. If it is the case that the shortest decile of Chinese children are being left behind as their compatriots catch up in stature with children in affluent nations, and if it is the case that income poverty can negatively affect height-for-age if appropriate food subsidies are not available, the sheer number of Chinese children aged 2 to 13 who are in the bottom income decile (approximately 13 million[25]) would be enough to make the issue important.

As well, the role played by food coupons in the early 1990s in child health and the role of income poverty in 1997-2000 in China may also be a reminder that the mechanisms of access to basic foodstuffs matter for child development—in all countries. As Haddad et al. (2003: 108) recently argue: 'Income growth can play an important role in reducing malnutrition but it is not enough. We suggest that (but cannot prove in this study) that increasing the number and effectiveness of direct nutrition interventions is crucial if nutrition targets are to be met'. Subsidies to basic food availability were a feature of social policy delivery until fairly recently in developed countries and are still prominent in the social policy of many less

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[25] *The China Statistical Yearbook* 2004 reports the population aged 0 to 14 to be 165,645,000, implying that the 2 to 13 population is approximately 130 million.

developed countries.[26] Hence, we think that there may be a general moral that, even when aggregate economic growth is as outstandingly robust as in China, subsidies to the availability of basic foods can fill an important social protection role. In reforming social policy in developing countries, the role that food subsidies play in mitigating the impacts which household income poverty would otherwise have on the long-run growth and development of children should at least be considered. Some Chinese scholars have suggested that China can now afford the cost of providing more social protection: this paper suggests that there may be significant benefits for the most vulnerable Chinese children.[27]

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[26] In the UK, Margaret Thatcher was labelled 'Thatcher, milk-snatcher' by ending a free school milk programme in 1971, when she was Minister of Education. See http://news.bbc.co.uk/onthisday/hi/dates/stories/june/15/newsid_4486000/4486571.stm.

[27] See Zheng (2006).

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FIGURE 1A
HEIGHT AS PER CENT OF CDC NORM FOR MALES AGE 2 TO 18

(24-month moving average)

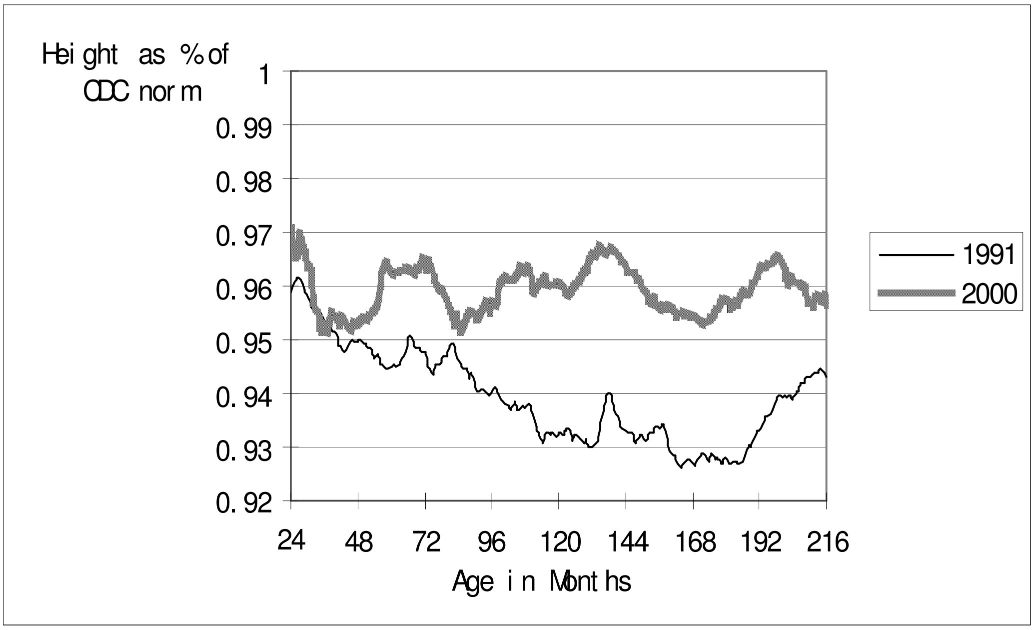
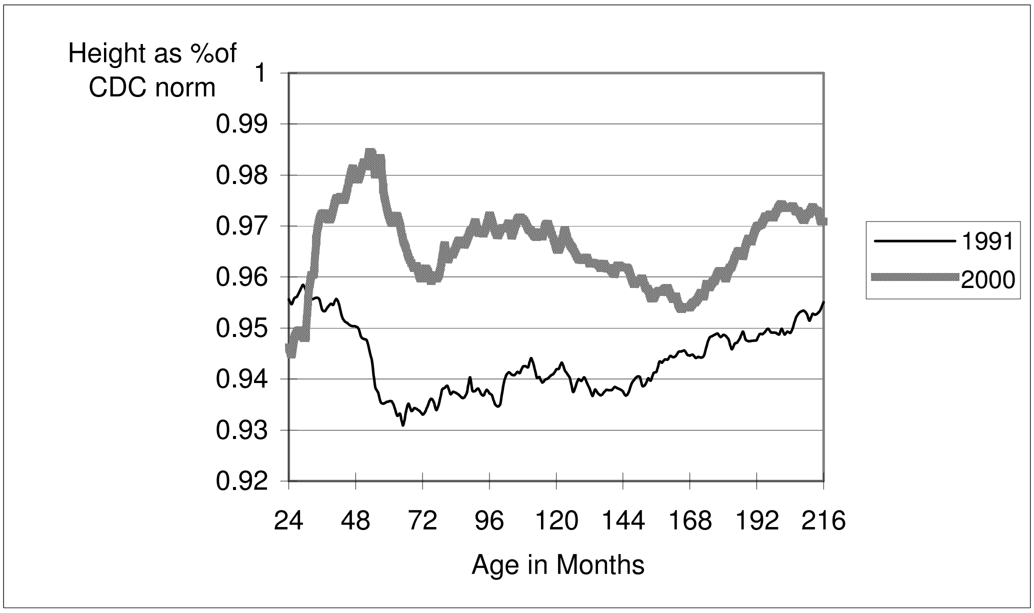
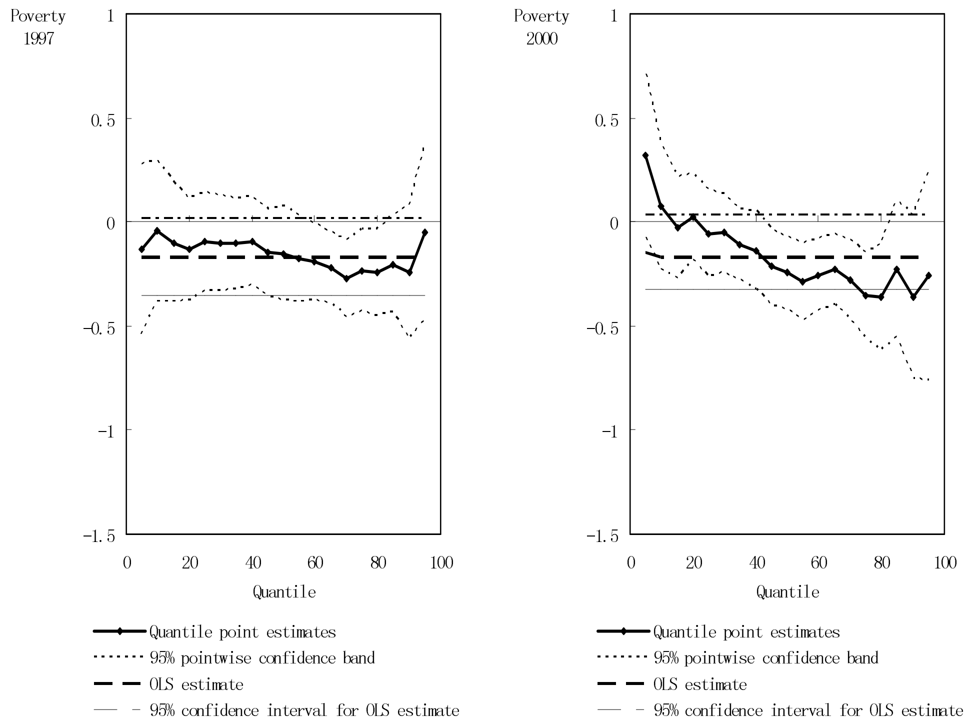



FIGURE 1B
HEIGHT AS PER CENT OF CDC NORM FOR FEMALES AGE 2 TO 18
(24-month moving average)




Note: Based on computations by authors.

FIGURE 2
QUANTILE ESTIMATES OF THE IMPACT OF POVERTY IN 1997 AND 2000




Note: Based on computations by authors.

TABLE 1
AVERAGE HEIGHT-FOR-AGE Z-SCORE (HAZ) BY DECILE FROM 1991 TO 2000 (AGE 2-13)

| Decile | Average HAZ 1991 | Average HAZ 2000 | Absolute change | Change as percentage of 10th decile height increase |
|---|---|---|---|---|
| 1 | -3.375 | -3.184 | 0.191 | 38.12 |
| 2 | -2.472 | -2.069 | 0.403 | 80.44 |
| 3 | -2.085 | -1.581 | 0.504 | 100.60 |
| 4 | -1.771 | -1.252 | 0.519 | 103.59 |
| 5 | -1.464 | -0.948 | 0.516 | 102.99 |
| 6 | -1.154 | -0.623 | 0.531 | 105.99 |
| 7 | -0.845 | -0.337 | 0.508 | 101.40 |
| 8 | -0.506 | 0.012 | 0.518 | 103.39 |
| 9 | -0.114 | 0.454 | 0.568 | 113.37 |
| 10 | 0.803 | 1.304 | 0.501 | 100.00 |
| No. of observations | 2462 | 1569 | | |

Note: Computations by authors.

TABLE 2
VALUE OF FOOD COUPONS, 1991

| Item | Households (HH)[1] % of HH | % of urban HH | % of rural HH | Average annual amount[2] | Average market value per coupon (Y) | Total coupon value (Y) |
|---|---|---|---|---|---|---|
| Rice | 41.04 | 68.66 | 28.10 | 690.32 | 0.43 | 296.84 |
| Wheat flour | 33.89 | 63.81 | 19.85 | 512.5 | 0.32 | 164 |
| Other cereal grains | 12.91 | 28.83 | 5.44 | 334.9 | 0.24 | 80.38 |
| Cooking oil | 38.53 | 70.13 | 23.71 | 32.36 | 2.53 | 81.87 |
| Eggs | 1.27 | 3.20 | 0.37 | 25.98 | 1.63 | 42.35 |
| Pork (or other meat) | 4.56 | 8.66 | 2.64 | 67.04 | 2.93 | 196.43 |
| Chicken | 0.14 | 0.26 | 0.08 | 20.0 | n/a | n/a |
| Sugar | 1.71 | 3.98 | 0.65 | 29.34 | 1.83 | 53.69 |
| No. of observations | 3618 | 1155 | 2463 | | | |

Note: Computations by authors.

1. The percentage indicates % of households who received coupons;

2. Each coupon represents 500 grams of the corresponding item;

TABLE 3
BASIC FOOD ITEMS PURCHASED

| | Coupon usage and quantity of food purchased during the previous month | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Poor* | | | | Non-poor* | | | | Lowest transaction price (¥/KG)[3] |
| | Rural | | Urban | | Rural | | Urban | | |
| | %[1] | KG[2] | % | KG | % | KG | % | KG | |
| | Rice | | | | | | | | |
| 1991 | 11.80 | 8.59 | 50.55 | 8.52 | 32.39 | 7.43 | 72.13 | 6.59 | 0.35 |
| | | (8.59) | | (8.52) | | (7.43) | | (6.59) | (0.14) |
| 1993 | 1.42 | 8.31 | 0.43 | 7.53 | 2.86 | 8.38 | 0.13 | 7.35 | 0.63 |
| | | (6.85) | | (5.92) | | (6.26) | | (6.07) | (0.13) |
| 1997 | 1.00 | 7.42 | 3.78 | 6.99 | 2.50 | 7.19 | 6.38 | 6.44 | 1.33 |
| | | (6.60) | | (5.86) | | (5.74) | | (4.28) | (1.21) |
| | Wheat flour | | | | | | | | |
| 1991 | 9.89 | 4.90 | 48.72 | 4.78 | 27.04 | 3.94 | 67.94 | 3.61 | 0.38 |
| | | (4.90) | | (4.78) | | (3.94) | | (3.61) | (0.13) |
| 1993 | 1.42 | 4.29 | 1.73 | 3.66 | 2.68 | 3.40 | 1.08 | 2.27 | 0.63 |
| | | (6.52) | | (5.75) | | (5.83) | | (3.24) | (0.17) |
| 1997 | 1.00 | 4.62 | 5.41 | 4.33 | 4.87 | 3.49 | 13.36 | 2.27 | 1.30 |
| | | (6.79) | | (7.12) | | (4.60) | | (3.18) | (0.83) |

Notes: * Poverty line: $2 a day PPP per capita. Computations by authors.

1 The percentage indicates % of households who received coupons.

2 Quantity of food purchased is measured by per capita kilograms. Standard deviations are in parentheses.

3 Different prices existed in the market for each food item, including state store coupon price, state store negotiated price, and free market price. For each price system, we take the average and present here the lowest average price in 1990 Chinese yuan per kilogram.

TABLE 4
AVERAGE EQUIVALENT INCOME BY DECILE FROM 1991 TO 2000 IN 1990 CHINESE YUAN

| | Average equivalent income | | | Change as percentage of |
|---|---|---|---|---|
| | | | Absolute | 10th decile income |
| Decile | 1991 | 2000 | change | increase |
| 1 | 82.78 | 382.73 | 299.95 | 3.99 |
| 2 | 251.04 | 853.44 | 602.40 | 8.00 |
| 3 | 453.42 | 1238.72 | 785.30 | 10.43 |
| 4 | 658.31 | 1687.85 | 1029.54 | 13.68 |
| 5 | 884.25 | 2169.20 | 1284.95 | 17.07 |
| 6 | 1138.41 | 2758.99 | 1620.58 | 21.53 |
| 7 | 1420.99 | 3334.08 | 1913.09 | 25.42 |
| 8 | 1688.84 | 4193.71 | 2504.87 | 33.28 |
| 9 | 2135.64 | 5660.05 | 3524.41 | 46.83 |
| 10 | 4294.34 | 11820.61 | 7526.27 | 100.00 |
| No. of observations | 2462 | 1569 | | |

Note: Computations by authors. The LIS equivalence scale calculates the equivalent income of each household member as: $y_i = \frac{y_f}{n_f^{0.5}}$ where $y_f$ is total household income and $n_f$ is the number of persons in the household.

TABLE 5
THE GROWTH OF CHINESE CHILDREN AGED 2-13, ESTIMATED COEFFICIENTS FROM OLS

Dependent variable = Z-score for height-for-age (HAZ) at final year

| Variables | 1991-93 | 1993-97 | 1997-2000 |
|---|---|---|---|
| HAZ initial year | 0.711*** | 0.545*** | 0.533*** |
| | (0.045) | (0.057) | (0.041) |
| Dummy=1 if child is female | -0.053 | 0.047 | 0.083 |
| | (0.041) | (0.066) | (0.057) |
| Dummy=1 if residence in urban area | 0.043 | 0.107 | 0.167** |
| | (0.068) | (0.091) | (0.073) |
| Father's BMI initial year | 0.000 | 0.054*** | 0.044*** |
| | (0.010) | (0.014) | (0.013) |
| Father's height (cm) initial year | 0.010** | 0.016* | 0.016** |
| | (0.005) | (0.007) | (0.006) |
| Father's age at child's birth | 0.009 | -0.010 | 0.000 |
| | (0.010) | (0.012) | (0.013) |
| Father's no. of years formal education initial year | 0.011 | 0.020 | -0.005 |
| | (0.010) | (0.013) | (0.013) |
| Mother's BMI initial year | 0.014 | 0.045*** | 0.017 |
| | (0.009) | (0.015) | (0.010) |
| Mother's height (cm) initial year | 0.007 | 0.029*** | 0.025*** |
| | (0.006) | (0.008) | (0.007) |
| Mother's age at child's birth | 0.012 | 0.024 | 0.105** |
| | (0.040) | (0.043) | (0.049) |
| Mother's age at child's birth squared | -0.000 | -0.000 | -0.002** |
| | (0.001) | (0.001) | (0.001) |
| Mother's no. of years formal education initial year | -0.006 | 0.008 | 0.017* |
| | (0.008) | (0.011) | (0.010) |
| Change of number of household members | 0.027 | 0.093*** | -0.030* |
| | (0.048) | (0.030) | (0.017) |
| Log of equivalent income | -0.011 | -0.169* | -0.074 |
| | (0.048) | (0.071) | (0.071) |
| Dummy=1 if income <$2 / day initial year | -0.081 | -0.061 | -0.169* |
| | (0.070) | (0.087) | (0.093) |
| Dummy=1 if income <$2 / day final year | 0.038 | -0.143 | -0.146 |
| | (0.081) | (0.123) | (0.090) |
| Dummy=1 if use food coupon initial year | 0.088 | -1.054*** | -0.107 |
| | (0.070) | (0.306) | (0.132) |
| Dummy=1 if use food coupon final year | 0.333* | 0.341* | |
| | (0.184) | (0.133) | |
| Dummy=1 if household using tap water initial year | 0.061 | -0.052 | 0.109 |
| | (0.084) | (0.113) | (0.099) |

Table con't

TABLE 5 (CON'T)
THE GROWTH OF CHINESE CHILDREN AGED 2-13, ESTIMATED COEFFICIENTS FROM OLS

Dependent variable = Z-score for height-for-age (HAZ) at final year

| Variables | 1991-93 | 1993-97 | 1997-2000 |
|---|---|---|---|
| Dummy=1 if household using tap water final year | -0.003 | 0.212** | -0.060 |
| | (0.077) | (0.105) | (0.099) |
| Dummy=1 if residence in Liaoning | 0.197* | | |
| | (0.109) | | |
| Dummy=1 if residence in Heilongjiang | | | 0.361*** |
| | | | (0.117) |
| Dummy=1 if residence inJiangsu | 0.045 | 0.046 | 0.382*** |
| | (0.096) | (0.138) | (0.120) |
| Dummy=1 if residence in Shandong | 0.230* | 0.206 | 0.101 |
| | (0.134) | (0.173) | (0.210) |
| Dummy=1 if residence in Henan | 0.057 | 0.494*** | 0.102 |
| | (0.089) | (0.130) | (0.125) |
| Dummy=1 if residence in Hubei | 0.113 | 0.049 | 0.232** |
| | (0.092) | (0.133) | (0.118) |
| Dummy=1 if residence in Hunan | 0.060 | 0.382*** | 0.250 |
| | (0.103) | (0.133) | (0.167) |
| Dummy=1 if residence in Guangxi | 0.274*** | 0.349*** | 0.191* |
| | (0.092) | (0.122) | (0.107) |
| Intercept | -3.714* | -9.011*** | -9.095*** |
| | (1.527) | (2.250) | (1.799) |
| Adjusted $R^2$ | 0.595 | 0.541 | 0.604 |
| No. of observations | 1230 | 638 | 583 |

Note: Computations by authors.
*** Significant at 1%; ** significant at 5%; * significant at 10%;
Equivalent income and poverty line are converted in to 1990 Chinese yuan value;
Newey-West robust standard errors are reported in parentheses.

TABLE 6
THE GROWTH OF CHINESE CHILDREN AGED 2-13,
ESTIMATED COEFFICIENTS FROM PANEL QUANTILE REGRESSION 1997-2000

Dependent variable=Z-score for height-for-age (HAZ) at final year

| Variables | 20% | 40% | 60% | 80% |
|---|---|---|---|---|
| HAZ initial year | 0.594*** | 0.684*** | 0.623*** | 0.573*** |
| | (0.083) | (0.056) | (0.045) | (0.050) |
| Dummy=1 if child is female | -0.006 | 0.0252 | 0.038 | 0.030 |
| | (0.094) | (0.0650) | (0.059) | (0.076) |
| Dummy=1 if residence in urban area | 0.154 | 0.0724 | 0.128* | 0.050 |
| | (0.103) | (0.092) | (0.071) | (0.097) |
| Father's BMI initial year | 0.043** | 0.015 | 0.042*** | 0.030** |
| | (0.021) | (0.015) | (0.012) | (0.015) |
| Father's height (cm) initial year | 0.018* | 0.014** | 0.009 | 0.008 |
| | (0.010) | (0.006) | (0.007) | (0.009) |
| Father's age at child's birth | 0.001 | 0.004 | -0.003 | -0.005 |
| | (0.020) | (0.014) | (0.014) | (0.016) |
| Father's no. of years formal education initial | -0.010 | -0.009 | -0.006 | -0.010 |
| year | (0.024) | (0.014) | (0.012) | (0.014) |
| Mother's BMI initial year | -0.004 | 0.028** | 0.024** | 0.019 |
| | (0.020) | (0.013) | (0.011) | (0.013) |
| Mother's height (cm) initial year | 0.015 | 0.012* | 0.023*** | 0.032*** |
| | (0.010) | (0.007) | (0.007) | (0.009) |
| Mother's no. of years formal education initial | 0.016 | 0.017 | 0.006 | 0.007 |
| year | (0.018) | (0.014) | (0.009) | (0.015) |
| Mother's age at child's birth | 0.115 | 0.073 | 0.090 | 0.094 |
| | (0.072) | (0.061) | (0.057) | (0.071) |
| Mother's age at child's birth squared | -0.002 | -0.001 | -0.002* | -0.002 |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Change of number of household members | -0.001 | -0.027 | -0.022 | -0.011 |
| | (0.059) | (0.034) | (0.032) | (0.048) |
| Log of equivalent income | -0.057 | -0.020 | -0.092 | -0.137 |
| | (0.095) | (0.076) | (0.067) | (0.087) |
| Dummy=1 if income <$2 / day initial year | -0.134 | -0.091 | -0.193** | -0.242** |
| | (0.129) | (0.111) | (0.090) | (0.108) |
| Dummy=1 if income <$2 / day final year | -0.025 | -0.136 | -0.255*** | -0.364*** |
| | (0.125) | (0.095) | (0.092) | (0.125) |

Table con't

TABLE 6 (CON'T)
THE GROWTH OF CHINESE CHILDREN AGED 2-13,
ESTIMATED COEFFICIENTS FROM PANEL QUANTILE REGRESSION 1997-2000

Dependent variable=Z-score for height-for-age (HAZ) at final year

| Variables | 20% | 40% | 60% | 80% |
|---|---|---|---|---|
| Dummy=1 if use food coupon at 1997 | -0.240 | -0.063 | -0.087 | 0.034 |
| | (0.212) | (0.123) | (0.090) | (0.139) |
| Dummy=1 if household using tap water initial year | 0.109 | 0.081 | 0.136 | 0.154 |
| | (0.130) | (0.099) | (0.086) | (0.130) |
| Dummy=1 if household using tap water final year | -0.085 | -0.049 | 0.004 | 0.044 |
| | (0.134) | (0.109) | (0.087) | (0.123) |
| Dummy=1 if residence in Heilongjiang | 0.397** | 0.254* | 0.302** | 0.265* |
| | (0.178) | (0.146) | (0.132) | (0.202) |
| Dummy=1 if residence in Jiangsu | 0.524*** | 0.318** | 0.293** | 0.110 |
| | (0.201) | (0.139) | (0.130) | (0.186) |
| Dummy=1 if residence in Shandong | -0.281 | -0.096 | 0.280 | 0.495** |
| | (0.360) | (0.250) | (0.263) | (0.246) |
| Dummy=1 if residence in Henan | -0.170 | 0.202 | 0.274* | 0.262 |
| | (0.251) | (0.159) | (0.153) | (0.200) |
| Dummy=1 if residence in Hubei | 0.217 | 0.210* | 0.231* | 0.189 |
| | (0.179) | (0.124) | (0.121) | (0.190) |
| Dummy=1 if residence in Hunan | 0.112 | 0.245* | 0.273* | 0.352 |
| | (0.231) | (0.144) | (0.166) | (0.227) |
| Dummy=1 if residence in Guangxi | 0.234 | 0.132 | 0.192 | 0.208 |
| | (0.178) | (0.120) | (0.118) | (0.147) |
| Intercept | -8.403*** | -6.459*** | -6.984*** | -7.275*** |
| | (3.099) | (1.874) | (2.041) | (2.574) |
| No. of observations | 583 | | | |

Note: Computations by authors.

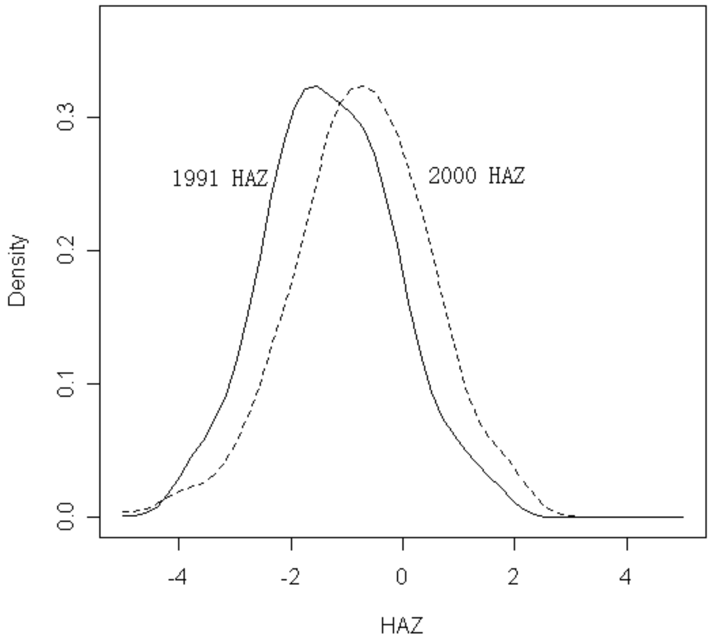
*** Significant at 1%, ** significant at 5%, * significant at 10%;

Equivalent income and poverty line are converted in to 1990 Chinese yuan value;

Bootstrapping standard errors are reported in parentheses. See Koenker (2005) for details.

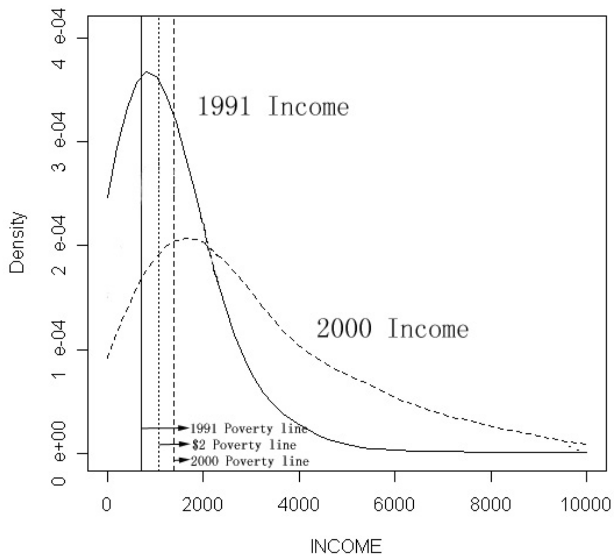
## APPENDIX A: THE DISTRIBUTIONS OF INCOME AND HEIGHT-FOR-AGE

APPENDIX FIGURE A1
HAZ DISTRIBUTION COMPARISON




Note: Based on computations by authors.

APPENDIX FIGURE A2
OVERALL INCOME DISTRIBUTION COMPARISON
[EQUIVALENT INDIVIDUAL INCOME, 1990 YUAN]




Note: Based on computations by authors.

## APPENDIX B

APPENDIX TABLE B1
MEAN AND PROPORTION – PANEL SAMPLES

| Variable | Mean/proportion 1991-93 | 1993-97 | 1997-2000 |
|---|---|---|---|
| Child's characteristics | | | |
| HAZ initial year | -1.30 | -1.30 | -1.04 |
| Last year | -1.15 | -1.20 | -0.84 |
| Dummy=1 if child is female | 46.18% | 46.71% | 43.22% |
| Parents' characteristics | | | |
| Father's BMI initial year | 21.48 | 21.52 | 22.30 |
| Father's height (cm) initial year | 165.94 | 165.61 | 166.25 |
| Father's age at child's birth | 28.21 | 28.15 | 27.33 |
| Father's no. of years formal education initial year | 8.13 | 8.26 | 8.53 |
| Mother's BMI initial year | 21.54 | 21.43 | 22.12 |
| Mother's height (cm) initial year | 155.46 | 154.46 | 155.64 |
| Mother's age at child's birth | 26.46 | 26.30 | 25.82 |
| Mother's age at child's birth squared | 720.32 | 713.51 | 687.17 |
| Mother's no. of years formal education initial year | 6.51 | 6.51 | 7.21 |
| Household characteristics | | | |
| Dummy=1 if residence in urban area | 29.11% | 26.18% | 32.76% |
| Change of number of household members | -0.03 | -0.15 | -0.07 |
| Log of total equivalent income in the period | 7.65 | 7.90 | 8.35 |
| Dummy=1 if income <$2 / day 1991 | 51.63% | | |
| Dummy=1 if income <$2 / day 1993 | 47.24% | 51.72% | |
| Dummy=1 if income <$2 / day 1997 | | 34.64% | 31.39% |
| Dummy=1 if income <$2 / day 2000 | | | 23.33% |
| Dummy=1 if use food coupon 1991 | 36.67% | | |
| Dummy=1 if use food coupon 1993 | 3.33% | 2.66% | |
| Dummy=1 if use food coupon 1997 | | 11.29% | 12.35% |
| Community characteristics | | | |
| Dummy=1 if household using tap water 1991 | 34.72% | | |
| Dummy=1 if household using tap water 1993 | 35.93% | 33.86% | |

Table con't

APPENDIX TABLE B1 (CON'T)
MEAN AND PROPORTION – PANEL SAMPLES

| Variable | Mean/proportion | | |
|---|---|---|---|
| | 1991-93 | 1993-97 | 1997-2000 |
| Dummy=1 if household using tap water 1997 | | 46.55% | 41.85% |
| Dummy=1 if household using tap water 2000 | | | 39.79% |
| Dummy=1 if residence in Liaoning | 11.87% | | |
| Dummy=1 if residence in Heilongjiang | | | 18.87% |
| Dummy=1 if residence in Jiangsu | 8.94% | 12.23% | 12.18% |
| Dummy=1 if residence in Shandong | 11.71% | 9.56% | 6.86% |
| Dummy=1 if residence in Henan | 6.83% | 10.50% | 11.66% |
| Dummy=1 if residence in Hubei | 17.15% | 19.75% | 12.18% |
| Dummy=1 if residence in Hunan | 12.76% | 10.97% | 7.55% |
| Dummy=1 if residence in Guangxi | 15.53% | 21.32% | 12.86% |
| Residence in Guizhou (baseline case) | 15.21% | 15.67% | 17.84% |
| | | | |
| No. of observations | 1230 | 638 | 583 |

Note: Computations by authors.

APPENDIX TABLE B2
MEANS AND PROPORTIONS – CROSS-SECTIONAL SAMPLES

| Variable | Mean/proportion | |
|---|---|---|
| | 1991 | 2000 |
| Child's characteristics | | |
| Height (cm) | 117.36 | 127.48 |
| Z-score for height-for-age (HAZ) | -1.30 | -0.75 |
| Age in months | 92.84 | 107.49 |
| Dummy=1 if child is female | 47.62% | 45.14% |
| Dummy=1 if child has health insurance | 21.71% | 19% |
| Parents' characteristics | | |
| Father's weight (kg) | 59.47 | 63.43 |
| Father's height (cm) | 165.89 | 166.83 |
| Father's age at child's birth | 28.16 | 27.37 |
| Father's no. of years formal education | 7.87 | 8.96 |
| Dummy=1 if father smokes cigarettes | 77.43% | 69.99% |
| Dummy=1 if father drinks alcohol | 72.85% | 68.76% |
| Dummy=1 if father has health insurance | 28.32% | 18.94% |
| Mother's weight (kg) | 52.33 | 54.90 |
| Mother's height (cm) | 155.31 | 156.08 |
| Mother's age at child's birth | 26.51 | 25.87 |
| Mother's no. of years formal education | 6.20 | 7.92 |
| Dummy=1 if mother smokes cigarettes | 1.79% | 1.35% |
| Dummy=1 if mother drinks alcohol | 13.30% | 8.98% |
| Dummy=1 if mother has health insurance | 22.20% | 15.74% |
| Household characteristics | | |
| Number of household members | 4.58 | 4.31 |
| Equivalent income 1990 yuan | 1267.56 | 3511.29 |
| Dummy=1 if income <$2 poverty line | 53.68% | 19.19% |
| Dummy=1 if girl and income <$2 | 25.05% | 8.00% |
| Total value of assets in yuan | 2501.37 | 5094.73 |
| Community characteristics | | |
| Dummy=1 if residence in urban area | 25.11% | 25.34% |
| Dummy=1 if household using tap water | 32.59% | 41.70% |
| Dummy=1 if household has flush toilet | 15.34% | 32.47% |
| Dummy=1 if residence in Liaoning | 12.99% | 12.79% |
| Dummy=1 if residence in Heilongjiang | n/a | 15.74% |
| Dummy=1 if residence in Jiangsu | 9.89% | 11.56% |

Table con't

APPENDIX TABLE B2 (CON'T)
MEANS AND PROPORTIONS – CROSS-SECTIONAL SAMPLES

| Variable | Mean/proportion | |
|---|---|---|
| | 1991 | 2000 |
| Dummy=1 if residence in Shandong | 13.05% | 5.66% |
| Dummy=1 if residence in Henan | 6.62% | 7.13% |
| Dummy=1 if residence in Hubei | 13.17% | 11.07% |
| Dummy=1 if residence in Hunan | 12.62% | 6.27% |
| Dummy=1 if residence in Guangxi | 16.82% | 13.04% |
| Dummy=1 if residence in Guizhou | 14.84% | 16.74% |
| No. of observations | 1617 | 813 |

Note: Computations by authors.