The Impact of Income Growth and Provision of Health-Care Services on Child Nutrition in Vietnam

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Abstract

Vietnam enjoyed rapid economic growth and a sharp reduction in child stunting in the 1990s. Economic growth can increase children's nutritional status in two ways. First, by raising household incomes, which can be used it to purchase more food, medicine and medical services. Second, by raising government revenue, which can be used to improve publicly provided medical services. This paper estimates the impact of household per capita expenditures on children's nutritional status. All the estimation methods used indicate that household income growth explains at best only part of the decrease in child stunting. The paper also examines what aspects of public and private medical services improveme child health.

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I. Introduction

Child malnutrition is pervasive in almost every low-income country. Among all developing countries, about 30 percent of all children under age 5 are underweight (low weight for age; see UNDP 1998). For the least-developed countries this figure rises to 39 percent. Most economists would agree that economic growth in these countries reduces child malnutrition. However, the size of this impact is uncertain and probably varies across countries. If the impact is small, policymakers may need to look for health policies that significantly increase children's nutritional status.

Vietnam is one of the world's poorest countries, with an annual per capita gross national product (GNP) of about $370 in 1999. It has a very high level of child malnutrition; in 1993 50 percent of Vietnamese children under age 5 were stunted (low height for age), although the situation has been improving. The role of economic growth in improving children's nutritional status is particularly relevant for Vietnam because it enjoyed rapid economic growth in the 1990s. Its annual rate of real economic growth since 1988 has been about 8 percent, or about 6 percent in per capita terms, yet it remains a very poor country with high rates of child malnutrition.

This paper has two objectives. The first is to estimate the impact of household income growth on child nutrition in Vietnam, using recent household survey data. An earlier study of child nutrition in Vietnam found only a weak relationship between household income and child nutrition (Ponce, Gertler, and Glewwe 1998). This suggests that Vietnam's recent economic growth has had little impact on children's nutritional status, yet the household survey data show that the incidence of stunting for children under 5 declined from 50 percent in 1992–93 to 34 percent in 1997–98. Given this apparent contradictory evidence, this paper seeks to clarify the role of economic growth.

These findings suggest other factors, such as new public health policies, improved child nutrition in the 1990s. Thus the second objective of this paper is to examine the impact of various health programs in Vietnam on child nutrition.

This paper is organized as follows. Section II presents some basic information about child nutrition and economic growth in Vietnam in the 1990s. The data used and the analytical framework are discussed in Section III. Estimates of the impact of household income on child nutrition are given in Section IV, and estimates of the impact of health programs and health prices are presented in Section V. Section VI provides a brief summary of the results and several concluding comments.

II. Child Nutrition and Economic Growth in Vietnam in the 1990s

This section presents data on Vietnam's economic performance and the nutritional status of Vietnamese children in the 1990s. Before examining the data it is useful to discuss methods for measuring children's nutritional status.

A. Measurement of Children's Nutritional Status

Children's nutritional status can be assessed using data on their age, sex, height, and weight. In particular, such data can be used to calculate three indicators of children's nutritional status: (a) stunting (low height for age), (b) wasting (low weight for height), and (c) underweight (low weight for age). Each indicator describes different aspects of malnutrition.

Stunting is defined as growth in a child's height that is low compared with the average growth of a healthy child. Slow growth in height over long periods of time causes children to fall further and further behind the height of healthy children. Thus stunting is a *cumulative* indicator of slow physical growth. In developing countries stunting is caused primarily by repeated episodes of diarrhea and other childhood diseases, and by insufficient dietary intake.

In contrast, wasting indicates very recent malnutrition, which leads to weight loss. Thus it indicates *current* nutritional problems, such as diarrhea, other childhood diseases, and insufficient dietary intake. While stunting usually cannot be reversed—children who become stunted typically remain so throughout their lives—the weight loss associated with wasting can be restored quickly under favorable conditions.

The third indicator, underweight, reflects both stunting and wasting. Thus it cannot distinguish between long-term and short-term malnutrition.

All three measures are commonly expressed as Z-scores, which compare a child's weight and height with the weight and height of a similar child from a reference healthy population. More precisely, the Z-score for stunting (low height for age) of a child i is the difference between the height of that child, H_i, and the median height of a group of healthy children of the same age and sex from the reference population, H_r, divided by the standard deviation of the height of those same children (same age and sex) from the reference population, SD_r:

$$Z-score=\frac{H_i-H_r}{SD_r}$$

Relatively short children have negative height for age Z-scores, and stunting is commonly defined as having a Z-scores of –2 or lower.

Z-scores for underweight children are calculated similarly, using the weight of the child (instead of height) and the median weight (and standard deviation) of children of the same age and sex from the healthy reference population. Finally, Z-scores for wasting are obtained by comparing the weight of the child with the median weight (and standard deviation) of children from the reference population who have the same height as that child. The reference population was selected by the U.S. National Center for Health Statistics, in accordance with World Health Organization (WHO) recommendations (WHO 1983).

The two preferred anthropometric indices for measuring children's nutritional status are stunting and wasting, since they distinguish between long-run and short-run physiological processes (WHO 1986). The wasting index has another advantage: It can be calculated without knowing the child's age. It is particularly useful in describing a child's current health status and in evaluating the benefits of intervention programs since it responds more quickly to changes in nutritional status than does stunting. Stunting measures long-run social conditions because it reflects past nutritional status. Thus the WHO recommends it as a reliable measure of overall social deprivation (WHO 1986).

B. Children's Nutritional Status in Vietnam

Young children that receive sufficient breastmilk and other food grow quickly and attain their potential weight and height, unless diarrhea or other illnesses intervene. In developing countries, children that fail to attain their potential growth typically suffer from inadequate dietary intake, illness, or both. During the first few years of life the single most important illness is diarrhea. Children who are exclusively breastfed are much less likely to be exposed to pathogens that lead to diarrhea and other gastrointestinal diseases; they also receive immunitive agents from breastmilk. Yet when weaning foods are introduced, typically in the first three to six months of life, infants are exposed to many pathogens that often lead to diarrhea and other diseases. This pattern is found in the 1992-93 Vietnam Living Standards Survey (VLSS) data. Figure 1 shows that the incidence of diarrhea (in the four weeks preceding the interview) in the first 18 months of life steadily rises to about 6 percent before declining to less than 1 percent among children 3 years and older.

Diarrhea interferes with human growth, leading to low weight gain. This is seen in the data on wasting in figure 1. The incidence of wasting (weight for height Z-score below –2) is only about 2 percent among children age 0–5 months, who are still primarily breastfed. Yet wasting increases steadily during the first two years of life, peaking at about 11 percent for children age 18–23 months. For children 2 years and older wasting fluctuates around 5 percent; by this age wasting is primarily caused by inadequate food intake since diarrhea is relatively rare.

The long-run consequence of diarrhea, other illnesses, and inadequate food intake is stunting. Figure 1 shows that stunting (height for age Z-score below –2) rises dramatically during the first two years of life, from about 14 percent for children age 0–5 months to 65 percent for children age 18–23 months, and then declines to about 55 percent for older children. Thus Vietnamese children follow the typical pattern; their worst bouts of malnutrition occur during the first two years of life, and as a consequence slightly more than one-half are stunted by age 2 and remain so for the rest of their lives.

The previous paragraphs describe the situation in the early 1990s. The situation in the late 1990s shows substantial improvements, at least in terms of stunting. Figure 2 shows the same general pattern; wasting and diarrhea peak in the second year of life, while stunting steadily increases during the first two years of life and then remains high. However, stunting in 1997–98 was lower than in 1992–93 for all age categories.

Figures 1 and 2 contain two anomalies. First, diarrhea appears to have increased over time for almost all age groups. This apparent increase is spurious because the question was asked differently in the two surveys. In the 1992-93 VLSS each person was asked (or, for small children, parents were asked) whether they had been sick in the last four weeks and, if so, from what illness they suffered. This underestimates the incidence of diarrhea for two reasons. First, some people may think of diarrhea as normal and so would answer that they had not been sick during the past four weeks. Second, persons suffering from multiple illnesses in the past four weeks were allowed to report only one. Thus if a child had diarrhea and another illness the other illness may have been reported instead of diarrhea. In the 1997-98 VLSS all individuals were asked directly whether or not they had had diarrhea in the past four weeks, which resulted in a much higher reported incidence of diarrhea.

The second anomaly is that wasting has increased, which is inconsistent with the dramatic decline in stunting. More specifically, the data show that, for each age category, average weight and height increased substantially between 1992–93 and 1997–98, indicating a great improvement in the nutritional status of Vietnamese children. However, height increases were larger than weight increases, and the consequent reduction in weight for height indicates increased wasting. This suggests that changes in weight for height over time may provide a misleading picture of changes in children’s nutritional status when overall nutritional status increases rapidly. Similar contradictory results over time have been found in Sub-Saharan Africa (Sahn, Stifel, and Younger 1999).

More information about malnutrition in Vietnam (as measured by stunting and wasting) is provided in table 1. Columns 1-3 present data from the 1992-93 VLSS. At that time the incidence of stunting for children aged 0–60 months was about 50 percent, while the incidence of wasting was about 6 percent. Stunting was higher in rural areas, affecting 53 percent of children, while only one-third of urban children (33 percent) were stunted. This is unsurprising since real per capita expenditures in urban areas (1,899,000 dong) were almost double those of rural areas (990,000 dong), as seen in column 3. The figures on wasting, somewhat surprisingly, are almost the same for urban and rural children (5.7 percent and 5.9 percent, respectively).

Variation in stunting and wasting across Vietnam's seven regions is also instructive. Table 1 shows that the Northern Uplands and the North Central Coast had the highest rates of stunting in 1992–93. Unsurprisingly, these two regions also had the lowest average per capita expenditures. Stunting was least common in the South East region, which includes the largest city in Vietnam (Ho Chi Minh City, formerly Saigon) and has the highest per capita expenditures. This strong correlation of stunting and per capita expenditures is missing in the data on wasting. Wasting is highest in the Mekong Delta (7.7 percent) even though it had the second highest per capita expenditures. The North Central Coast had the lowest incidence (4.1 percent) despite having the second lowest per capita expenditures. Overall, there is no clear correlation between wasting and per capita expenditures, casting doubt on it as an indicator of nutritional status.

Columns 4–6 of table 1 present information from the 1997-98 VLSS. Incomes increased in real terms in all regions (although deflated numbers are not presented) and stunting declined by almost one-third, from 50 percent to 35 percent. This decline is in both urban and rural areas, and in all seven regions. The region with the largest percentage increase in per capita expenditures—the Red River Delta, which moved from fourth highest to second highest—had the largest decline in stunting, from 54 percent to 27 percent.

In contrast, the wasting data are puzzling. Wasting increased in urban and rural areas and in all seven regions. It shows no clear relationship with income or with changes in income. Given that other indicators of child health show improvement over this time period—for example, the infant mortality rate dropped from 44 to 39 (World Bank 2001a)— this paper will focus on the stunting data.

C. Vietnam's Economic Performance in the 1990s

In the 1980s Vietnam was one of the poorest countries in the world. A rough estimate of its GNP per capita in 1984, in 1984 U.S. dollars, is $117. By 1999 Vietnam's GNP per capita had more than tripled (in nominal dollars) to $370. This rapid improvement in Vietnam's economic performance began in 1986, when a series of decrees transformed Vietnam from a planned to a market-oriented economy. The government dissolved state farms and divided agricultural land equally among rural households, removed price controls, legalized buying and selling of almost all products by private individuals, stabilized the rate of inflation, and opened up the economy to foreign trade and investment. In the 1990s Vietnam was one of the 10 fastest-growing economies in the world.

This rapid economic growth led to a dramatic decline in the poverty rate, from 58 percent in 1992–93 to 37 percent in 1997–98 (World Bank 1999). Table 1 suggests that economic growth led to large decreases in stunting among Vietnamese children. Are these dramatic increases in the incomes of Vietnamese households the main cause of the decline in stunting among young children? Table 2 provides a first glance at the evidence. It divides all households into five groups of equal size on the basis of per capita expenditures. The first group, quintile 1, is the poorest 20 percent of the population. In 1992–93 about 59 percent of the children in that group were stunted. The second poorest group, quintile 2, had a similar rate. Quintiles 3, 4, and 5 had steadily lower rates of 45 percent, 44 percent and 29 percent, respectively. The same pattern is seen in the 1997-98 VLSS; the incidence of stunting among the poorest quintile is 41 percent and steadily drops to 14 percent for the wealthiest quintile. This pattern, from cross-sectional data, suggests that higher incomes reduce child malnutrition.

The stunting rates in table 2 decline over time within each quintile. This suggests that something other than income growth also reduced malnutrition in Vietnam in the 1990s. Yet these quintiles are not strictly comparable, because the poorest 20 percent of the population in 1997–98 had higher average expenditures than the poorest 20 percent in 1992–93. The last column in table 2 adjusts for this difference, classifying households in the 1997-98 VLSS according to the quintile categories used in the 1992-93 VLSS. After this adjustment is made there are still dramatic declines in stunting for households in the same expenditure group. This suggests that increased household income is not the only factor that improved the nutritional status of Vietnamese children. The rest of this paper will examine this phenomenon more formally.

III. Data and Analytical Framework

This paper uses the 1992-93 and 1997-98 Vietnam Living Standards Surveys (VLSS). The 1992-93 VLSS covered 4,800 households, while the 1998 VLSS covered 6,000 households. Both surveys are nationally representative. About 4,300 households were interviewed in both surveys and thus constitute a large, nationally representative panel dataset. In both surveys the household questionnaire covered many different topics. Health data include use of health-care facilities and anthropometric measurements of all household members. Both surveys completed community questionnaires in rural areas (where about 80 percent of Vietnamese live), and detailed price questionnaires were completed in both urban and rural areas. The 1997-98 VLSS also included a health facility questionnaire. For further information on the VLSS see World Bank (2000a).

These two surveys are well suited for examining the determinants of children's nutritional status. All household members were measured for height, weight, and arm circumference. The household information includes detailed income and expenditure data. The panel data allow for estimation that controls for unobserved household fixed effects. Finally, the 1997–98 data include the prices of many medicines and the types of medical services (and their costs) provided by local health-care facilities.

The data presented thus far show changes over time but cannot explain what caused those changes. A clear analytical framework to avoid drawing false inferences from the data. The starting point for investigating the determinants of children's nutritional status is a health production function. In general, a child's health status (H) is determined by three kinds of variables: health inputs (HI), the local health environment (E), and the child's genetic health endowment (ε). Equation (1) shows child health status as a function of these three types of variables:

$$H = f(HI, E, \varepsilon) \quad (1)$$

The child's genetic health endowment (ε) is defined as all genetically inherited traits that affect his or her health. It is exogenous but is rarely observed in any data. The local health environment (E) consists of the characteristics of the community in which the child lives that directly affect his or her health, such as the prevalence of certain diseases. It is also exogenous, except to the extent that households migrate to areas with healthier environments or take measures to improve the local health environment (this issue will be discussed further below). Finally, there are a wide variety of health inputs (HI) that households provides to their children, including prenatal care, breastmilk, all other foods, medicines, and medical care. The quality of the household's drinking water, toilet facilities, and other hygienic conditions around the home can also be treated as health inputs.

It is almost impossible to estimate a health production function because one rarely has complete data on health inputs and the local health environment, and data on the child's genetic endowment is rarer still. This incompleteness can lead to serious problems of omitted variable bias. Analysis is further complicated because this information is needed not only for the current time period but for all past time periods of the child's life. A more practical alternative is to consider what determines health inputs and substitute out that variable from equation (1). In general, children's health inputs are determined by the household's income level (Y), the education levels of both parents (MS and FS, for mother's schooling and father's schooling), their tastes for child health (η), the local health environment, and the child's genetic health endowment. Equation (2) shows this relationship:

$$\text{(2)} \qquad HI = g(Y, MS, FS, \eta, E, \varepsilon)$$

Family size and the presence of other siblings are excluded as determinants of health inputs because they are clearly endogenous. Including them can lead to biased estimates unless suitable estimation methods, such as instrumental variables, are used. Thus it is best to include in equation (2) only variables that are clearly exogenous. Of course, one could rightly claim that household income is endogenous – parents may change their hours of work in response to their children's health status – but removing income from (2) would preclude estimation of the key relationship of interest, so it is retained. The approach used to deal with possible estimation bias is discussed below.

Substituting (2) into (1) gives the basic equation estimated in this paper:

$$\text{(3)} \qquad H = g(Y, MS, FS, \eta, E, \varepsilon)$$

The child's height for age Z-score is used as the indicator of a child's health status, H. Household per capita expenditures will be used instead of per capita income to measure Y, for two reasons. First, expenditure data are likely to be more accurate than income data (Deaton 1997). Second, expenditure data are more likely to reflect a household's permanent income, which is more appropriate because Y represents the household's income stream since the child was born.

The remaining variables in (3) merit further comment. The schooling of each parent is provided in both surveys, even for children no longer living with one or both parents. However, parental tastes for child health, η, are difficult to observe and no attempt was made to find a proxy in the VLSS data. Dropping this variable altogether relegates it to the error term, which could cause the error term to be correlated with household income, leading to biased estimates of the impact of income on child health. For example, some parents may be irresponsible, which implies low tastes for child health, and low income. This would lead to overestimation of the impact of income on child health. This paper uses three approaches to deal with this problem. First, ethnic and religious dummy variables are included to approximate, albeit only partially, tastes for child health. Second, in some estimates employ instrumental variables for per capita expenditures, which should eliminate some or perhaps even all of the bias. Third, some estimates use panel data, which removes bias if parental tastes can be specified as an additive fixed effect.

The last two variables in (3) are the local health environment, E, and the child's innate healthiness, ε. Almost all of the estimates in Section IV use community fixed effects to control for all differences across communities, including differences in the local health environment. Section V uses a different approach; community data from the 1998 VLSS on medicine prices and the availability of medical services are used to explicitly measure the impact of the local health environment on child health. Finally, consider the child's genetic health endowment, ε. In the cross-sectional estimates this is partially represented by the height of each parent (which reflects both normal variation in height and the innate healthiness of each parent) and by the sex of the child (girls are typically healthier than boys). In estimates using panel data the average healthiness of each household's children is treated as a fixed effect and thus differenced out.

The last issue to address is the problem the endogeneity og household income. Households typically make decisions about their children's health simultaneously with decisions about income-earning activities, and these decisions could be related. For example, parents whose children are chronically ill may purchase costly medicines or medical services, and some household members may work more hours to pay for those medicines. If so, OLS estimates would tend to underestimate the impact of household income on child health because unobserved negative health shocks would be positively correlated with household income. Alternatively, some household members, such as the mother, may reduce hours worked during a child's illness to spend more time caring for the child. In this case OLS would overestimate the impact of household income on child health.

Another problem with both household income and expenditure data is that they are measured with error, because it is difficult for households to report this information accurately. This chapter uses household expenditures instead of income because it is likely to be more accurate, but even expenditure data may have substantial measurement error, much of which will be random. This will lead to underestimation (attenuation bias) of the true impact of household expenditures on child health.

Instrumental variable methods can, in principle, remove the bias caused by either endogeneity or measurement error. The difficulty is to find plausible instrumental variables—variables correlated with household income but uncorrelated with unobserved determinants of child health and uncorrelated with the measurement errors. Two plausible categories of instrumental variables are types of agricultural land allocated to the household and certain sources of nonlabor income. In Vietnam agricultural land is tightly controlled by the government, and markets for land simply do not exist in many rural communities (less than 3 percent of households in the 1992-93 VLSS reported buying or selling land in the previous year). Thus households' land assets are unlikely to be influenced by children's health status. Similarly, some types of nonlabor income are received regardless of children's health status. The following instrumental variables are used for households' per capita expenditures: irrigated annual cropland, unirrigated annual cropland, perennial cropland, water surface (fish ponds), income from social funds, social subsidies, dowries, inheritances, and lottery winnings. Finally, the existence of relatives (specifically, children of household members) living overseas may also indicate an additional source of income; although the amount of remittances from such relatives may respond to child illnesses, the existence of such relatives is unlikely to be affected by those illnesses. Two such variables are used: relatives in other Asian countries and relatives in Western countries.

While these instrumental variables have statistically significant predictive power they are rather weak in terms of the R^2 coefficient in the first-stage regressions. If the main problem is measurement error, as opposed to household expenditures being correlated with unobserved determinants of child health, one could use household income as an instrument for per capita expenditures. In the results presented below, two sets of instruments are used, one without household income, which should be robust to both endogeneity and measurement error, and one that adds income, which is robust to measurement error but invalid if household income is endogenous with respect to child health.

IV. Income Growth and Child Nutrition

This section presents estimates of equation (3). The dependent variable is the child's height for age Z-score, and the sample includes only children aged 0–60 months. Separate estimates are presented for urban and rural areas. Cross-sectional estimates results are given for both 1992–93 and 1997–98.

A. Cross-Sectional Estimates

Table 3 presents estimates of the determinants of child malnutrition (measured by height for age Z-scores), for urban areas of Vietnam in 1992–93. Column one presents OLS estimates, which almost certainly suffer from omitted variable bias due to unobserved community characteristics. OLS estimates may also be biased because they ignore endogeneity and measurement error in the household expenditure variable. Column two adds community fixed effects, which avoids bias due to unobserved community characteristics if those characteristics enter equation (3) in a simple additive form without interaction terms. Yet fixed effects estimates are not robust to endogeneity or measurement error in the expenditure variable. Columns three and four employ fixed effects and instrumental variables for household expenditures. Column three excludes household income as an instrument, while column four adds that variable as an instrument.

Turning to the OLS estimates in column one, as one would expect from figures 1 and 2, child age has a strong relationship to malnutrition as measured by stunting. In addition to a linear term (age in months), quadratic and cubic terms were added to allow for flexibility. Parental height is strongly and positively related to child health, which partially controls for unobserved children's health endowments but also reflects natural variation in height across a healthy population. For some parents (4 percent of mothers and 16 percent of fathers), the height variable was missing; in such cases the parent is assigned the average height and a dummy variable is added to indicate this type of observation.

Girls in urban areas appear to be slightly healthier than boys, but this difference is never statistically significant. The impact of parents' schooling is usually statistically insignificant, which is somewhat surprising, especially for mothers. One would think that better-educated mothers are more able to care for their children's illnesses. Finally, there are few differences across ethnic and religious groups in urban areas (the omitted groups are Vietnamese and "no religion"), the two exceptions are that children in Protestant households and households practicing religions other than Buddhism and Christianity were significantly less healthy. Both groups are relatively rare in urban areas, and it is not clear what to make of this result; indeed the result for Protestants is based on a single child and so should be treated with caution. Since the focus of this chapter is on the impacts of household income and health-care services, the religion variables will not be discussed further.

Turn now to the impact of (log) per capita household expenditures on child health. The OLS estimate is 0.493, which is fairly precisely estimated (standard error of 0.108). This is higher than the estimate of 0.22 found by Ponce, Gertler, and Glewwe (1998), but that study included older children (up to 9 years), so the estimates are not strictly comparable.

Even if household expenditures were exogenous and measured without error, the OLS estimate of its impact is likely to be biased due to its correlation with unobserved community characteristics. Wealthier communities may have a better health environment, for example better sanitation and health-care facilities. If these community characteristic effects are primarily additive, community fixed effects estimates will remove this bias. The second column of table 3 shows such estimates. As expected, the impact of household per capita expenditures falls, from 0.493 to 0.388. Yet it is still statistically significant, with a standard error of 0.140.

The last two specifications in table 3 attempt to correct for endogeneity and measurement error in household expenditures. Column three presents estimates that instrument household expenditures using the land and nonlabor income variables. Although these instruments have strong explanatory power in that they have a high F-statistic (41.39), they do not by themselves explain a large percentage of the variation of household expenditures (the R^2 coefficient of a regression of expenditures on the excluded instruments is only 0.08). Thus, although the coefficient on per capita expenditures is largely unchanged 0.441), it is not statistically different from zero because its standard error increased to 0.443. This imprecision prevents one from drawing inferences about the impact of household expenditures on child health.

Somewhat higher precision is possible by assuming that household expenditures are exogenous, although measured with error, which allows one to use income as an instrumental variable. In this case the coefficient rises to 0.502. Although the standard error falls to 0.306, the coefficient is still imprecisely estimated and thus not significantly different from zero (t-statistic of 1.63). The standard overidentification test (see Davidson and MacKinnon 1993) suggests that the instrumental variables are uncorrelated with the residual, although the power of the test to detect this problem may be low. Overall, it is difficult to estimate with any precision the impact of household expenditures on children's nutritional status in urban areas of Vietnam in 1992–93 once one considers the possibility that expenditures may be endogenous or measured with error.

Cross-sectional results for rural Vietnam in 1992–93 are reported in table 4. The age, sex and parental height variables show the same patterns as in urban areas. Mothers' schooling has a marginally significant negative effect in the OLS results, but this counterintuitive finding disappears in the fixed effects and two-stage least squares with fixed effects (2SLSFE) estimates. Fathers' schooling has a significantly positive effect in the fixed effects results, but not in other specifications. Most estimates regarding religious and ethnic groups are statistically insignificant, except that, again, Protestant children are more malnourished and, in some specifications, other ethnic minorities are more likely to be malnourished.

Focusing on the (log) household expenditure variable, the OLS results show a precisely estimated impact of 0.336 (standard error of 0.072). As in urban areas, this figure declines when community fixed effects are introduced, to 0.185 (standard error of 0.92).

Column 3 in table 4 specifies the expenditure variable as endogenous, using the land and nonlabor income variables as instruments. The point estimate of 0.724 is quite large, but the estimate is very imprecise because the standard error increases to 0.437. This is not surprising because regressing household expenditures on the excluded instruments alone yields an R^2 coefficient of only 0.060. When (log) per capita income is added as an instrument the coefficient drops to 0.500; although the standard error is smaller (0.306) this estimate is not quite significant at the 10 percent level (t-statistic of 1.64). Finally, note that both 2SLSFE specifications easily pass the overidentification test.

The 1998 VLSS had a larger sample size, which may provide more precision. The results for urban and rural areas are presented in tables 5 and 6, respectively. Many results for urban areas in 1997–98 are similar to those for 1992–93. The age effects and parental height impacts are similar, although somewhat weaker, the sex of the child and parental schooling show no consistently significant effects, and the impacts of the religion variables are similar. The one change is that the Chinese variable now has a positive, statistically significant (5 percent level) effect.

The OLS estimate of the impact of household expenditures in urban areas is lower in 1997–98 than in 1992–93 (0.341 and 0.493, respectively), and the same holds when fixed effects are introduced (0.146 in 1997–98 and 0.388 in 1992–93). The first set of 2SLSFE estimates shows an effect similar to that of 1992–93 (0.401 compared with 0.441), but neither is statistically significant. Adding household income as an instrument (to control for measurement error) yields a statistically significant estimate of 0.674 (standard error of 0.226). Both 2SLSFE estimates easily pass the overidentification test.

In rural areas in 1997–98 (table 6), the results for most variables are similar to those for rural areas in 1992–93. Turning to household expenditures, the OLS and fixed effects estimates are quite similar across the two years. However, the first set of 2SLSFE estimates is very different: in 1992–93 the estimated impact was 0.724 while in 1997–98 it was –0.220. Yet when one recalls that both estimates have large standard errors (0.473 in 1992–93 and 0.593 in 1997–98) it is clear that the difference between them is not statistically significant (t-statistic of 1.36). When household income is added as an instrumental variable, the result is somewhat closer to the 1992–93 estimate (0.500 in 1992–93 and 0.203 in 1997–98. Again, neither is precisely estimated (standard errors of 0.305 and 0.335, respectively), so they are not significantly different from each other.

B. Panel Data Estimates

There are two ways to use panel data to estimate the impact of household expenditures on children's nutritional status in Vietnam. First, one could examine data on the same children over time, and estimate the impact of changes in income on changes in their height for age Z-scores. However, this is problematic because, as seen in figures 1 and 2, stunting develops in the first two years of life and changes little thereafter. Thus any child covered in the 1992-93 VLSS was already at least 5 years old in the 1997-98 VLSS, so the impact of household expenditure in the latter survey should have almost no effect on the stunting of those children because it developed three or more years before the 1997-98 survey.

The other possibility, pursued here, is to compare children 5 years or younger in the first survey to children who were 5 years or younger in the second survey. This can be done for those households in the panel that had children of that age in both surveys, which occurs for 1,663 of the 4,300 panel households. For households with two or more children in this age range in either year (or both), all variables used are averages over those children.

Before examining the estimates, a discussion of their usefulness is needed. Recall that parental tastes for child health (η) and the child's genetic health endowment (ε) are unobserved and could be correlated with household income. One way to address this problem is to use instrumental variables for household income. The approach with panel data is somewhat different; one assumes that the impacts of these two variables on child health take an additive form and that these additive components do not change over time. If so, *changes* in household income will be uncorrelated with these household fixed effects, so regressing changes in height for age Z-scores on changes in household expenditures (and changes in other variables) should eliminate bias due to these two unobserved factors.

While this sounds promising, there are two problems. First, children's health endowments vary at the child level, not the household level, so although a household's *average* child health endowment differences out, variation across different children within the household does not, and this could lead to biased estimates for the same reason it would do so in cross-sectional OLS estimates. Second, regressing differences in variables on each other greatly exacerbates measurement error bias, as stressed in Deaton (1997). Thus one would like instrumental variables that predict changes in household income over time. This excludes most of the instrumental variables used above. This subsection uses only one instrumental variable: changes in household income.

Table 7 presents panel data estimates for urban and rural areas. The only variables that change over time are age, sex and (log) per capita expenditures. The sex dummy variable never has a significant impact. The age variable, which is again specified in a flexible way, has effects that are quite similar to those seen in tables 3–6.

The three urban regressions (OLS, fixed effects, and 2SLSFE) yield unexpected negative point estimates for the impact of household expenditures on child health. However, the standard errors on these coefficients are very large (0.168, 0.185, and 0.920, respectively), which reflects the small sample size. Thus the positive estimates in tables 3 and 5 are not necessarily inconsistent with these. Unfortunately, the standard errors in table 7 are so large that little can be inferred from them.

The rural area sample is much larger. The OLS and fixed effects estimates show impacts of household expenditures that are close to zero, with standard errors small enough (0.077 and 0.084) to exclude the point estimates in tables 4 and 6 from their 95% confidence intervals. Yet these differenced estimates may suffer from considerable attenuation bias due to measurement error. The final column of estimates in table 7 uses household income as an instrument to correct for measurement error in household expenditures (note that this assumes that expenditures are exogenous). The point estimate of 0.376 is much larger and comparable with estimates in tables 4 and 6. Unfortunately, this estimate also has a large standard error (0.512), so even in rural areas the panel data estimates are too imprecise to add anything to what has been learned from cross-sectional estimates.

C. Impact of Income Growth on Child Nutrition

Given the estimates in tables 3–7, what can be said about the impact of Vietnam's economic growth on child nutrition? More precisely, is the rapid increase in household incomes the main cause of Vietnam's substantial decrease in child stunting?

This question is examined in table 8, which shows changes in mean height for age Z-scores and the percent of children who are stunted from 1992–93 to 1997–98. The first three lines show the actual changes, for rural and urban areas separately, while the other lines use the estimated impacts of household expenditures from tables 3–7 to examine how much of the change reflects increased household expenditure levels.

Table 8 shows that mean height for age Z-scores in urban areas of Vietnam increased by 0.56 standard deviations, while the mean in rural areas increased by 0.49 standard deviations. These are dramatic increases over only five years; they correspond to drops of a 15 percentage points in the incidence of stunting in both urban and rural areas. The high income growth during these years suggests that this improvement in children's nutritional status is primarily due to higher household income.

The remaining lines of table 8 assess whether this conclusion is valid. For each estimator the predicted change in the mean height for age Z-score is given, which is simply the estimated coefficient of the impact of household expenditures multiplied by the change in (log) average household expenditures. For estimates based on cross-sectional data, the estimated impact is a simple average of the 1992–93 and 1998 estimates. These estimated impacts are also added to each child's Z-score in 1992–93 to see how they change the incidence of stunting, as reported in columns three and four of table 8.

The main conclusion from table 8 is that growth in household expenditures accounts for only a small proportion of the improvement of children's nutritional status in Vietnam in the 1990s. In urban areas the mean height for age Z-score increased by 0.56, but the highest predicted change among seven different specifications is only 0.28 (the 2SLS specification with income as an instrument), less than half the total amount. Similarly, stunting dropped by 15 percentage points, but the predictions from the econometric estimates are much smaller, the highest being a drop of only 9 percentage points. This conclusion holds even more forcefully for rural areas; the mean height for age Z-score dropped by 0.49 standard deviations but the largest predicted drop is only 0.09 standard deviations, and stunting dropped by 15 percentage points while the largest predicted drop is only 3.2 percentage points.

Given the imprecision of the estimated impacts, one should check the upper bound of the 95 percent confidence intervals of the estimated impacts, since it is possible that even with low point estimates the actual change may still lie within the confidence interval. The mean changes in height for age Z-scores at the upper bounds of the 95 percent confidence intervals are shown in brackets in the first two columns of table 8. In only two of fourteen cases does the actual change lie within that confidence interval. Thus one must conclude that growth in household incomes accounts for only a proportion, and probably a small proportion, of the improvement in children's nutritional status in Vietnam during the 1990s.

V. Health Programs and Child Nutrition

The above results strongly suggest that something else happened in Vietnam in the 1990s that improved children's nutritional status. One possibility is that Vietnam's health services dramatically increased in quantity, quality, or both. This section reviews changes in health services in Vietnam, and then uses the 1997-98 VLSS data to examine the impact of health services on child nutrition in rural areas.

A. Growth in Health Programs

The community and price questionnaires in the 1992-93 and 1997-98 VLSSs have some information relevant for examining changes in Vietnam's health services in the 1990s. In general, publicly provided services did not expand their coverage in the 1990s (World Bank 2001). However, economic reforms allowed private individuals to sell medicines and provide health services. Each survey collected price data on several commonly used medicines in Vietnam. The medicines covered differ in the two surveys: only ampicillin and penicillin prices were collected in both. No price data were recorded if communities did not have a given medicine, which in principle allows one to use the price data to check for changes in the availability of medicines.

In urban areas in 1992–93 all 30 sampled communes had price data for all medicines, while in rural areas only 3 of 120 communes reported no data for ampicillin prices and only 10 reported no penicillin prices. This completeness of the 1992–93 price data implies that it is not possible to use the price data to check for increased availability of these medicines. While this suggests that medicine availability did not improve, because these medicines were already available almost everywhere, this is not necessarily the case since the distance traveled to obtain medicine may have decreased. Thus, the only conclusion is that the price data from the VLSSs are uninformative about changes in medicine availability.

The other way to check the survey data concerning changes in the availability of medicines and medical services is to examine the community questionnaires in both surveys, which asked about distances to various medical facilities, including the distance to the nearest private pharmacy. This information is available for both years from 111 of the 120 rural communes covered in the 1992-93 VLSS. In 67 communes (60 percent), the distance to the nearest private pharmacy did not change, while for 18 communes (16 percent) the distance increased and for 27 (24 percent) the distance decreased. There may be some noise in these data, but overall they suggest that the distance to the nearest private pharmacy was more likely to decrease than to increase. Moreoever, among the 18 communes where the distance increased the median increase was 3 kilometers, while in the 27 that experienced a decrease the median decrease was 7 kilometers.

B. Econometric Estimates

The 1997-98 VLSS price questionnaire collected detailed price data for nine medicines in both urban and rural areas. In rural areas the community questionnaire also collected data on the distance from the communes to 14 kinds of health facilities or health service providers. It also collected information on specific illnesses common in the community and on problems with the commune health center.

Commune health centers are the first line of defense in Vietnam's health-care system. Almost every rural commune has a commune health center; of the 156 communes in the 1998 VLSS with community data, only 2 did not have a commune health center (and in both cases there was a commune health center within 5 kilometers). The 1997-98 VLSS also administered a Commune Health Center Questionnaire in 155 of the 156 rural communes covered by that survey. That questionnaire collected information on (a) the number of medical staff (doctors, nurses, etc.); (b) hours of operation; (c) number of beds; (d) the availability of 11 kinds of medical services; (e) the availability of electricity, clean water, and toilets; (f) 13 different types of medical equipment; (g) the availability and prices of nine kinds of medicines (the same ones in the price questionnaire); and (h) fees for five kinds of services, and information on whether fees are waived under certain circumstances.

In this subsection community variables that may affect child health were added to see whether they have any explanatory power for child health. Because there are so many variables, and they vary only at the community level (and there are only 156 rural communities), they are not added all at once, rather the most basic are added first, and then other sets of variables (sometimes as an index) are added to explore their explanatory power.

We begin with medicine prices. Of the nine types of medicine available, oral rehydration salts are most relevant for child nutrition. Other potentially relevant medicines are antibiotics (ampicillin and penicillin), paracetemol (to reduce fevers), iron tablets, and vitamin A tablets. Unfortunately, these price data are very noisy, as seen in table 9. Although prices should have been collected for a given number of doses for a particular brand, it appears that some observations are for a different number of doses, or perhaps a different brand. The variation in iron tablet prices is particularly egregious. To see whether these data had explanatory power, the OLS regression in table 6 (rural areas in 1997–98) was re-estimated five times, each time adding the price of one of these five medicines (iron tablet prices were deemed too noisy to use). All the point estimates were close to zero and far from any statistical significance. For example, consider the medicine most likely to have an effect, oral rehydration salts (which also were the least noisy). While the price of oral rehydration salts had the expected negative sign, its t-statistic was only 0.83.

Another "price" of medical care is the distance to nearby health facilities. The distance to commune health centers is trivial, but they are not equipped to handle the most serious medical problems; seriously ill individuals must go to a hospital in a district or provincial capital, or perhaps to some other facility. Of the thirteen other types of health facilities or providers recorded in the commune questionnaire, four had missing data for nearly one-third or one-fourth of the observations (private nurse, medicine peddler, midwife, and practitioners of eastern medicine) and thus were dropped. For the remaining nine, the same procedure as used with the medicine price data. For six types of facilities (family planning center, polyclinic, district hospital, other hospital, private doctor, and private physician's assistant) no significant relationship was found. However, for three types (provincial hospital, state pharmacy, and private pharmacy) a negative effect—significant at the 5 percent level—was found.

The first column of table 10 presents the results when all three distance variables are added. The distance to the nearest provincial hospital is negative and statistically significant at the 10 percent level. The distance to the nearest state pharmacy is statistically insignificant. Finally, the distance to the nearest private pharmacy is negative and statistically significant at the 1 percent level. Despite the statistical significance of two of the distance variables, the policy significance of the estimated impacts is not particularly large. Reducing by one-half the current mean value of the distance to the nearest provincial hospital would raise children's z-scores by 0.044, and halving the distance to the nearest private pharmacy implies an improvement of only 0.025.

Consider next the community questionnaire information on local health problems and commune health center deficiencies. Five illnesses cited seem relevant for small children: malaria; respiratory illnesses (other than tuberculosis), childhood illnesses (diphtheria, whooping cough, measles, polio, tetanus, and encephalitis), diarrhea, and child malnutrition. Using the same procedure described above, only respiratory illnesses approached statistical significance, with a point estimate of –0.130 and a t-statistic of –1.34. Statistical significance was even weaker for the local health facility variables (lack of equipment and supplies, lack of medicines, inadequate staff, inability of staff to provide services, inadequate training opportunities, and poor sanitation). None of these variables had a t-statistic greater than 1.3.

Finally, turn to the commune health center data. The numbers of different kinds of staff, divided by the commune population, never had explanatory power. The same holds for hours of operation and number of beds (divided by the commune population). Of the eleven services variables, one was offered by all sampled centers (immunizations), one was offered by all but two (prenatal care), and two appear are irrelevant for child nutrition (eye exams and dental exams). Of the remaining seven, three are closely tied to child health (obstetrics, child health exams and education on nutrition), two concern birth control (intrauterine device (IUD) insertion and abortion), and two are very general (eastern medicine and simple operations). The last four had no explanatory power when entered individually. Neither did the three most closely tied to child health. Combining all these variables into a general health services index also had no explanatory power.

The three general variables concerning facility amenities are: electricity, clean water, and sanitary toilet. Of these, lack of a sanitary toilet and lack of electricity both had significantly negative effects on child health when added separately, while clean water had no effect. A regression adding the first two variables is shown in the second column of table 10. The electricity variable becomes insignificant but the toilet variable remains significantly negative. The policy significance of lacking a sanitary toilet is much larger than that of the distance variables; taking the coefficient at face value implies that remedying this deficiency will increase the typical child's height for age z-score by 0.15.

The health center questionnaire has 13 equipment variables. There are so many that it is best to develop an index. First, four variables with almost no variation were dropped: blood pressure monitor and stethoscope (unavailable in only one commune); and thermometer and laboratory (each lacking in only three communes). Two variables were also dropped that have little relevance for child malnutrition: eye charts and family planning equipment (for abortions). Seven variables remain for the general index: refrigerator, sterilizing equipment, delivery bed, microscope, examining bed, child growth chart, and child scale.[1] The results, after adding the equipment index, are in the third column of table 10. It has the expected positive sign but is statistically insignificant (t-statistic of 1.24).

The last type of information in the commune health center questionnaire is the availability of drugs, the price of those drugs (if available), and the prices of common health services. The drug availability index ranges from 1 (not available) to 5 (always available). Only one drug was statistically significant, oral rehydration salts, which had the expected positive impact with a t-statistic of 1.74. Missing data were a

1 An exploratory exercise added each piece of equipment separately. The three that approached statistical significance were delivery beds, examining beds and child scales, with the expected positive signs and t-statistics ranging from 1.9 to 2.6. Since there are many other kinds of equipment that are not observed but may be correlated with specific equipment, it seemed best to combine all equipment into a single index.

serious problem for drug prices because those prices were not recorded for commune centers that rarely or never had the medicine. Of the four with data for almost all commune health centers, three had statistically significant effects: ampicillin, penicillin, and oral rehydration salts (the fourth, parameticol, is used to treat fevers). The prices of ampicillin and penicillin were highly correlated, and only ampicillin was retained because it had fewer missing values. An odd finding for both ampicillin and penicillin are the positive signs; higher prices improved child health. Finally, prices of three kinds of medical services were examined: general examination, birth, and injection. Only the injection price had a statistically significant impact, which was unexpectedly positive.

When all four of the statistically significant variables discussed in the preceding paragraph (prices of ampicillin and injection, and availability and price of oral rehydration salts) are added to the regression (not show in table 10), only one retains statistical significance: the availability of oral rehydration salts has the expected positive sign. Because the sample size drops considerably due to missing data in these variables, only the oral rehydration salts variable is added in the regression in the last column of table 10. The impact is statistically significant at the 5 percent level, with a parameter estimate of 0.110. Since this index ranged from 1 to 5, this estimate implies that a change from never being available to always being available raises child height for age Z-scores by 0.44 points, which is almost as large as the increase in rural areas from 1992–93 to 1997–98. Note, however, that 84 percent of the commune health centers report that they already have this medicine all the time, so the benefits of oral rehydration salts are already reaching most Vietnamese children.

VI. Summary and Conclusion

This paper has investigated the impact of household income growth, as measured by household expenditures, on child nutritional status in Vietnam in the 1990s. In that decade household incomes rose dramatically and children's nutritional status improved rapidly. While one might conclude that the former caused the latter, that hypothesis is not supported by the estimates presented here. Using several estimation methods, this paper has shown that the impact of household expenditures on children's nutritional status (measured by height for age Z-scores) may be positive, but it is not very large. None of the estimates is large enough to account for even half of the measured improvement in children's nutritional status from 1992–93 to 1997–98.

While this finding appears to cast doubt on the benefits of economic growth for children's health, such a conclusion is premature because economic growth may lead to other changes, such as improved public provision of health-care services via increases government tax revenues. The question then becomes: What kinds of health services are most effective at raising child health? A first attempt at answering this question was made in Section V. The community level data suggest that the distance to private pharmacies has a statistically significant, though not very large, negative effect on child nutrition. It also suggests that providing commune health centers with sanitary toilets and ample supplies of oral rehydration salts could have substantial positive impacts on child health in Vietnam.

These findings regarding community health services are tentative; much more research is needed in Vietnam on the impact of the impact of different kinds of health-care services and programs on children's health. A particularly crucial factor may be parents' health knowledge, especially mothers' health knowledge. A recent study of Morocco found that mothers' health knowledge was the main pathway by which mothers' education affects child health (Glewwe 1999). In Vietnam several new community programs focus on raising parents' health knowledge (see World Bank 20001). Such programs could lead to substantial improvements in children's nutritional status, but rigorous analysis is needed to test this hypothesis.

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Table 1 Stunting and Wasting by Region, Children 0–60 months old

	1992–93			1997–98		
	Stunting (*percent*)	**Wasting** (*percent*)	**Per capita expenditures** (*thousands of dong*)	**Stunting** (*percent*)	**Wasting** (*percent*)	**Per capita expenditures** (*thousands of dong*)
Northern Uplands	58.7	6.2	804	42.3	9.8	1,593
Red River Delta	54.2	5.4	1,049	26.6	11.0	2,462
North Central Coast	57.8	4.1	877	40.7	15.8	1,716
Central Coast	46.5	5.5	1,232	37.1	8.1	1,959
Central Highlands	52.7	5.5	983	43.3	6.8	1,855
South East	29.8	5.5	1,754	17.8	7.3	4,340
Mekong Delta	45.0	7.7	1,333	33.5	2.3	2,154
All urban	33.2	5.7	1,899	18.4	8.4	4,099
All rural	53.2	5.9	990	38.2	11.4	1,816
All Vietnam	50.2	5.8	1,128	34.6	10.8	2,227

Table 2 Stunting by Expenditure Quintiles (Children 0–60 months)

Quintile	Stunting(%) 1992–92	1997–98	1997–98 with 1992–93 quintile
1	58.6	41.3	45.0
2	59.1	42.1	38.6
3	45.3	32.6	41.6
4	44.4	27.5	34.0
5	29.2	14.2	18.5

Table 3 Determinants of Child Malnutrition in Urban Areas, 1992–93

	OLS	Community fixed effects	2SLSFE [a]	2SLSFE [b]	Means
Constant	–19.245***	—	—	—	1.00
	(2.62)				
Age (months)	–0.223***	–0.221***	–0.220***	–0.219***	31.5
	(0.34)	(0.038)	(0.039)	(0.037)	
Age^2	0.007***	0.007***	0.007***	0.007***	—
	(0.001)	(0.001)	(0.002)	(0.001)	
Age^3	–0.00007***	–0.00007***	–0.00007***	–0.00006***	—
	(0.00001)	(0.00002)	(0.00002)	(0.00002)	
Mother's height (centimeters)	0.051***	0.046***	0.046***	0.046***	153.0
	(0.010)	(0.012)	(0.012)	(0.012)	
Mother's height missing	0.905***	0.652**	0.666	0.721**	0.04
	(0.266)	(0.285)	(0.407)	(0.362)	
Father's height (centimeters)	0.051***	0.052***	0.052***	0.052***	162.4
	(0.012)	(0.013)	(0.013)	(0.013)	
Father's height missing	–0.252*	–0.257*	–0.257*	–0.251*	0.16
	(0.144)	(0.153)	(0.148)	(0.152)	
Female child	0.073	0.100	0.100	0.101	0.48
	(0.112)	(0.109)	(0.109)	(0.109)	
Log mother's years schooling	0.126	0.185*	0.180	0.162	1.95
	(0.098)	(0.105)	(0.132)	(0.128)	
Log father's years schooling	–0.114	–0.203**	–0.207*	–0.224*	2.09
	(0.100)	(0.92)	(0.118)	(0.122)	
Log per capita expenditures	0.493***	0.388***	0.441	0.502	7.34
	(0.108)	(0.140)	(0.443)	(0.308)	
Buddhist	–0.018	–0.207	–0.207	–0.204	0.30
	(0.129)	(0.158)	(0.164)	(0.162)	
Catholic	0.129	–0.114	–0.115	–0.121	0.14
	(0.215)	(0.327)	(0.331)	(0.337)	
Protestant	–1.992***	–2.356***	–2.346***	–2.306***	0.002
	(0.223)	(0.174)	(0.256)	(0.241)	
Other religion	–0.966***	–1.226	–1.221	–1.202	0.02
	(0.347)	(0.898)	(0.891)	(0.874)	
Chinese	–0.161	–0.612	–0.616	–0.631	0.11
	(0.218)	(0.401)	(0.405)	(0.405)	
Ethnic minority	0.386	0.251	0.267	0.325	0.02
	(0.642)	(0.657)	(0.736)	(0.681)	

R^2	0.283	0.351	0.351	0.350	
Overidentification test (p-value)	—	—	0.284	0.364	.
F-test on excluded instruments	—	—	41.39	36.29	.
Observations	415	415	415	415	

2SLSFE = Two-stage least squares with community fixed effects.

Note:

a. Standard errors (adjusted for sample design) in parentheses.

b. Statistical significance at 10, 5, and 1 percent levels indicated by *, **, and ***, respectively.

c Instrumental variables for (a) of 2SLSFE are: irrigated annual cropland, unirrigated annual cropland, perennial cropland, and water surface; income from social funds, social subsidies, dowries, inheritances and lottery winnings; and the existence of relatives in other Asian countries and in non-Asian countries. The estimates in (b) add per capita household income as an instrument. The estimates in (b) add per capita household income as an instrument.

Table 4 Determinants of Child Malnutrition in Rural Areas, 1992–93

	OLS	Fixed effects	2SLSFE [a]	2SLSFE [b]	Means
Constant	–12.909***	—	—	—	1.00
	(1.283)				
Age (months)	–0.207***	–0.205***	–0.209***	–0.208***	30.9
	(0.021)	(0.022)	(0.023)	(0.022)	
Age^2	0.006***	0.006***	0.006***	0.006***	—
	(0.001)	(0.001)	(0.001)	(0.001)	
Age^3	–0.00005***	–0.00005***	–0.00005***	–0.00005***	—
	(0.00001)	(0.00001)	(0.00001)	(0.00001)	
Mother's height (centimeters)	0.042***	0.040***	0.038***	0.039***	151.7
	(0.006)	(0.006)	(0.006)	(0.006)	
Mother's height missing	–0.013	0.018	0.002	0.009	0.03
	(0.114)	(0.219)	(0.215)	(0.215)	
Father's height (centimeters)	0.028***	0.023***	0.019**	0.021***	161.9
	(0.007)	(0.007)	(0.008)	(0.008)	
Father's height missing	–0.026	–0.007	0.004	–0.000	0.11
	(0.114)	(0.120)	(0.121)	(0.119)	
Female child	–0.084	–0.083	–0.079	–0.081	0.49
	(0.061)	(0.059)	(0.061)	(0.060)	
Log mother's years schooling	–0.086*	0.060	–0.029	0.008	1.63
	(0.050)	(0.055)	(0.086)	(0.073)	
Log father's years schooling	0.067	0.119**	0.034	0.069	1.82
	(0.058)	(0.060)	(0.090)	(0.076)	
Log per capita expenditures	0.336**	0.185**	0.724*	0.500	6.77
	(0.072)	(0.092)	(0.437)	(0.305)	
Buddhist	0.042	–0.050	0.006	–0.017	0.23
	(0.080)	(0.117)	(0.137)	(0.126)	
Catholic	–0.111	–0.220	–0.206	–0.212	0.09
	(0.125)	(0.136)	(0.139)	(0.140)	
Protestant	–0.248	–0.556***	–0.510***	–0.529***	0.01
	(0.157)	(0.058)	(0.091)	(0.078)	
Other religion	0.203	0.130	0.068	0.094	0.02
	(0.336)	(0.355)	(0.389)	(0.375)	
Chinese	0.076	0.297	0.144	0.208	0.01
	(0.250)	(0.343)	(0.384)	(0.370)	
Ethnic minority	–0.322***	–0.238**	–0.170	–0.198*	0.19

	(0.093)	(0.114)	(0.129)	(0.119)	
R^2	0.196	0.257	0.242	0.252	
Overidentification test (p-value)	—	—	0.559	0.591	
F-test on excluded instruments	—	—	10.84	16.59	.
Observations	2,372	2,372	2,372	2,372	.

2SLSFE = Two-stage least squares with community fixed effects.

Note:

[a.] Standard errors (adjusted for sample design) in parentheses.

[b.] Statistical significance at 10, 5, and 1 percent levels indicated by *, **, and ***, respectively.

[c] Instrumental variables for (a) of 2SLSFE are: irrigated annual cropland, unirrigated annual cropland, perennial cropland, and water surface; income from social funds, social subsidies, dowries, inheritances and lottery winnings; and the existence of relatives in other Asian countries and in non-Asian countries. The estimates in (b) add per capita household income as an instrument.

Table 5 Determinants of Child Malnutrition in Urban Areas, 1997–98

	OLS	Fixed effects	2SLSFE [a]	2SLSFE [b]	Means
Constant	–15.028***	—	—	—	1.00
	(2.306)				
Age (months)	–0.140***	–0.115***	–0.121**	–0.127***	31.6
	(0.034)	(0.039)	(0.047)	(0.041)	
Age^2	0.004***	0.003**	0.003*	0.003**	—
	(0.001)	(0.001)	(0.002)	(0.001)	
Age^3	–0.00003***	–0.00002*	–0.00003	–0.00003**	—
	(0.00001)	(0.00001)	(0.00002)	(0.00001)	
Mother’s height (centimeters)	0.038***	0.036***	0.034**	0.033**	152.5
	(0.013)	(0.013)	(0.015)	(0.013)	
Mother’s height missing	–0.064	–0.080	–0.033	0.018	0.02
	(0.417)	(0.361)	(0.406)	(0.373)	
Father’s height (centimeters)	0.041***	0.036***	0.034***	0.032***	162.5
	(0.010)	(0.011)	(0.012)	(0.011)	
Father’s height missing	–0.140	–0.225	–0.206	–0.185	0.12
	(0.181)	(0.186)	(0.203)	(0.200)	
Female child	0.073	0.092	0.082	0.070	0.49
	(0.126)	(0.137)	(0.146)	(0.144)	
Log mother’s years schooling	0.181**	0.138	0.059	–0.026	1.99
	(0.090)	(0.102)	(0.305)	(0.140)	
Log father’s years schooling	–0.063	–0.139	–0.196	–0.256*	2.08
	(0.134)	(0.148)	(0.214)	(0.150)	
Log per capita expenditures	0.341***	0.146	0.401	0.674***	8.13
	(0.110)	(0.120)	(0.865)	(0.226)	
Buddhist	–0.145	–0.120	–0.121	–0.122	0.25
	(0.116)	(0.150)	(0.146)	(0.143)	
Catholic	–0.061	0.070	0.078	0.087	0.07
	(0.185)	(0.172)	(0.170)	(0.169)	
Protestant	–0.641***	–0.806***	–0.842***	–0.881***	0.01
	(0.211)	(0.202)	(0.174)	(0.132)	
Other religion	–0.574*	–0.696**	–0.648	–0.597	0.01
	(0.301)	(0.338)	(0.452)	(0.492)	
Chinese	0.857***	0.966***	0.990***	1.016***	0.06
	(0.306)	(0.313)	(0.325)	(0.328)	
Ethnic minority	0.862	1.134	1.132	1.129	0.01

	(0.721)	(0.773)	(0.777)	(0.787)
R^2	0.260	0.386	0.379	0.357
Overidentification test (p-value)	—	—	0.499	0.608
F-tests on excluded instruments	—	—	14.25	26.05
Observations	469	469	469	469

2SLSFE = Two-stage least squares with community fixed effects; = not applicable.

Note:

[a.] Standard errors (adjusted for sample design) in parentheses.

[b.] Statistical significance at 10, 5, and 1 percent levels indicated by *, **, and ***, respectively.

[c] Instrumental variables for (a) of 2SLSFE are: irrigated annual cropland, unirrigated annual cropland, perennial cropland, and water surface; income from social funds, social subsidies, dowries, inheritances and lottery winnings; and the existence of relatives in other Asian countries and in non-Asian countries. The estimates in (b) add per capita household income as an instrument.

Table 6 Determinants of Child Malnutrition in Rural Areas, 1997–98

	OLS	Fixed effects	2SLSFE [a]	2SLSFE [b]	Means
Constant	–12.715***	—	—	—	1.00
	(1.862)				
Age (months)	–0.205***	–0.202***	–0.202***	–0.203***	32.3
	(0.022)	(0.022)	(0.023)	(0.022)	
Age^2	0.006***	0.006***	0.006***	0.006***	—
	(0.001)	(0.001)	(0.001)	(0.001)	
Age^3	–0.00005***	–0.00005***	–0.00005***	–0.00005***	—
	(0.00001)	(0.00001)	(0.00001)	(0.00001)	
Mother's height (centimeters)	0.037***	0.039***	0.041***	0.083***	151.9
	(0.008)	(0.007)	(0.008)	(0.007)	
Mother's height missing	0.242	0.130	0.104	0.135	0.02
	(0.189)	(0.173)	(0.165)	(0.174)	
Father's height (centimeters)	0.035***	0.027***	0.029***	0.027***	161.8
	(0.009)	(0.009)	(0.009)	(0.010)	
Father's height missing	0.123	0.126	0.111	0.128	0.10
	(0.103)	(0.103)	(0.106)	(0.107)	
Female child	0.018	–0.003	–0.014	–0.001	0.49
	(0.068)	(0.067)	(0.071)	(0.070)	
Log mother's years schooling	–0.116	–0.104	–0.063	–0.122	1.61
	(0.073)	(0.073)	(0.093)	(0.071)	
Log father's years schooling	0.035	–0.006	0.042	–0.016	1.78
	(0.082)	(0.082)	(0.115)	(0.105)	
Log per capita expenditures	0.298***	0.134	–0.220	0.203	7.42
	(0.068)	(0.095)	(0.539)	(0.335)	
Buddhist	0.080	0.175	0.186*	0.173	0.15
	(0.093)	(0.108)	(0.111)	(0.108)	
Catholic	–0.170*	–0.223*	–0.196	–0.228*	0.12
	(0.098)	(0.129)	(0.131)	(0.124)	
Protestant	–0.269	–0.206	–0.184	–0.210	0.03
	(0.257)	(0.277)	(0.280)	(0.279)	
Other religion	–0.148	0.041	0.033	0.043	0.03
	(0.242)	(0.235)	(0.242)	(0.234)	
Chinese	–0.170	–0.096	0.055	–0.126	0.002
	(0.339)	(0.598)	(0.663)	(0.595)	
Ethnic minority	–0.086	–0.078	–0.149	–0.064	0.22

	(0.127)	(0.158)	(0.193)	(0.179)
R^2	0.215	0.326	0.320	0.326
Overidentification test (p-value)	—	—	0.561	0.506
F-tests on excluded instruments	—	—	13.54	14.54
Observations	1,672	1,672	1,672	1,672

2SLSFE = Two-stage least squares with community fixed effects; = not applicable

Note:

a. Standard errors (adjusted for sample design) in parentheses.

b. Statistical significance at 10, 5, and 1 percent levels indicated by *, **, and ***, respectively.

c Instrumental variables for (a) of 2SLSFE are: irrigated annual cropland, unirrigated annual cropland, perennial cropland, and water surface; income from social funds, social subsidies, dowries, inheritances and lottery winnings; and the existence of relatives in other Asian countries and in non-Asian countries. The estimates in (b) add per capita household income as an instrument.

Table 7 Determinants of Child Malnutrition: Panel Data Estimates

	Urban			Rural		
	OLS	**Fixed effects**	**2SLSFE**	**OLS**	**Fixed effects**	**2SLSFE**
Sex	0.033	0.032	–0.037	0.017	–0.003	0.004
	(0.329)	(0.345)	(0.395)	(0.157)	(0.147)	(0.147)
Age (months)	–0.059**	–0.067***	–0.054*	–0.083***	–0.086***	–0.087***
	(0.022)	(0.022)	(0.029)	(0.009)	(0.009)	(0.009)
Age^2	0.0009**	0.0010	0.0008	0.0011***	0.0011***	0.0011***
	(0.0004)	(0.0004)	(0.0005)	(0.0002)	(0.0002)	(0.0002)
Age^3	–0.000004*	–0.000004*	–0.000004	–0.000005***	–0.000005***	–0.000005***
	(0.000002)	(0.000002)	(0.000003)	(0.000001)	(0.000001)	(0.000001)
Log per capita expenditures	–0.016	–0.106	–0.939	0.004	–0.046	0.376
	(0.168)	(0.185)	(0.920)	(0.077)	(0.084)	(0.512)
R^2	0.068	0.239	0.178	0.138	0.240	0.226
Sample size	237	237	237	1,426	1,426	1,426

2SLSFE = Two-stage least squares with community fixed effects.

Note:

[a.] Standard errors (adjusted for sample design) in parentheses.

[b.] Statistical significance at 10, 5, and 1 percent levels indicated by *, **, and ***, respectively.

[c] All variables were differenced for estimation.

[d] Sample includes all panel households who had at least one child age 0–60 months in both surveys.

Table 8 Role of Economic Growth in Reducing Child Malnutrition

	Mean height for age Z-score		Percent stunted	
Actual figures:	**Urban**	**Rural**	**Urban**	**Rural**
1992–93	–1.455	–2.009	33.2	53.2
1997–98	–0.895	–1.524	18.4	38.2
Change (over 5 years)	+0.560	+0.485	–14.8	–15.0
Estimates of change due to economic growth:				
OLS	0.199	0.083	–5.7	–3.0
	[0.344]	[0.133]		
FE	0.128	0.042	–3.3	–1.5
	[0.300]	[0.109]		
2SLSFE[a]	0.201	0.066	–6.6	–2.4
	[1.112]	[0.421]		
2SLSFE[b]	0.281	0.092	–9.0	–3.2
	[0.639]	[0.324]		
OLS (panel)	–0.008	0.001	+0.2	–0.0
	[0.156]	[0.041]		
FE (panel)	–0.051	–0.013	+2.3	+0.6
	[0.130]	[0.031]		
2SLS (panel)	–0.449	0.098	+15.0	–3.2
	[0.451]	[0.363]		

FE = Community fixed effects.

2SLSFE = Two-stage least squares with community fixed effects.

Note:

[a] Cross-sectional estimates are based on the mean of the 1992–93 and 1997–98 estimates.

[b] Increase in real expenditures per capita was 29.8 percent in rural areas and 61.3 percent in urban areas (GSO 1999). This implies that the changes in log per capita expenditures were +0.261 in rural areas and +0.478 in urban areas. Numbers in brackets are upper bounds of 95 percent confidence intervals.

Table 9 Descriptive Statistics of Selected Community Variables, 1997–98

Variable	Communities with observants	Mean	Standard dev.	Min.	Max.
Price of oral rehydration salts	146	1,288	385	450	2,500
Price of ampicillin	152	4,143	1,112	700	8,000
Price of penicillin	151	2,591	948	1,000	8,000
Price of iron tablets	119	3,409	5,541	0	37,250
Price of Vitamin A	126	692	865	0	4,750
Price of paracetemol	151	1,121	1,101	0	9,000
Distance to provincial hospital (kilometers)	154	38.6	33.4	0	180
Distance to state pharmacy (kilometers)	144	6.1	12.1	0	100
Distance to priv. pharmacy (kilometers)	146	3.1	7.8	0	50
Diarrhea is local health problem	156	0.46	—	—	—
Characteristics of community health center:					
Lack of electricity	155	0.13	—	—	—
Lack of clean water	155	0.26	—	—	—
Lack sanitary toilet	155	0.34	—	—	—
Total equipment index	152	9.29	1.11	7	14
Price of ampicillin	135	4.07	5.40	0	50
Injection price	153	0.28	0.56	0	5
Oral rehydration salts price	150	1.41	1.12	1	5

Table 10 Impact of Community Health Services on Child Malnutrition in Rural Areas, 1997–98

	Base model	Electricity and toilet	Equipment index	Oral rehydration salts
Age (months)	–0.211***	–0.209***	–0.208***	–0.207***
	(0.024)	(0.024)	(0.025)	(0.025)
Age^2	0.006***	0.006***	0.006***	0.006***
	(0.001)	(0.001)	(0.001)	(0.001)
Age^3	–0.00005***	–0.00005***	–0.00005***	–0.00005
	(0.00001)	(0.00001)	(0.00001)	(0.00001)
Mother's height (cm)	0.035***	0.035***	0.035***	0.0036***
	(0.008)	(0.008)	(0.008)	(0.008)
Mother's height missing	0.150	0.127	0.110	0.160
	(0.219)	(0.219)	(0.108)	(0.208)
Father's height (cm)	0.032***	0.032***	0.031***	0.031***
	(0.010)	(0.010)	(0.010)	(0.010)
Father's height missing	0.094	0.099	0.110	0.092
	(0.107)	(0.107)	(0.108)	(0.109)
Female child	–0.030	–0.031	–0.023	–0.033
	(0.068)	(0.068)	(0.069)	(0.071)
Log mother's years schooling	–0.202***	–0.185***	–0.178**	–0.181**
	(0.069)	(0.070)	(0.0070)	(0.075)
Log father's years schooling	–0.002	0.000	–0.001	–0.002
	(0.085)	(0.084)	(0.083)	(0.088)
Log per capita expenditures	0.0259***	0.240***	0.232***	0.219***
	(0.074)	(0.078)	(0.080)	(0.083)
Buddhist	0.047	0.029	0.028	0.053
	(0.098)	(0.097)	(0.097)	(0.103)
Catholic	–0.233*	–0.213*	–0.269**	–0.288***
	(0.124)	(0.116)	(0.108)	(0.109)
Protestant	–0.357*	–0.278	–0.343	–0.346
	(0.195)	(0.204)	(0.221)	(0.217)
Other religion	–0.330	–0.364	–0.387	–0.178
	(0.227)	(0.231)	(0.247)	(0.184)
Chinese	–0.946***	–0.971***	–0.894***	–0.959***
	(0.112)	(0.110)	(0.106)	(0.113)

Ethnic minority	–0.066	–0.036	–0.007	–0.016
	(0.134)	(0.135)	(0.132)	(0.136)
Distance provincial hospital (inkilometers)	–0.0023*	–0.0016	–0.0022	–0.0018
	(0.0012)	(0.0015)	(0.0016)	(0.0017)
Distance state pharmacy (in kilometers)	–0.0022	–0.0020	–0.0018	–0.0024
	(0.0019)	(0.0020)	(0.0021)	(0.0021)
Distance private pharmacy (in kilometers)	–0.0158***	–0.0136**	–0.0138**	–0.0133**
	(0.0053)	(0.0062)	(0.0062)	(0.0063)
Commune health center variable				
(a) Lacks electricity	—	–0.104	–0.028	–0.052
	—	(0.165)	(0.173)	(0.166)
(b) Unsanitary toilets	—	–0.151*	–0.142	–0.192**
		(0.087)	(0.089)	(0.091)
(c) Equipment index	—	—	0.051	0.052
			(0.041)	(0.038)
(d) Availability of oral rehydration salts	—	—	—	0.110**
				(0.048)
Sample	1,446	1,443	1,411	1,342
R^2	0.247	0.250	0.252	0.261