Child Nutrition and Economic Growth in Vietnam in the 1990s

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I. Introduction

Child malnutrition is pervasive in almost every low income country. Among all developing countries, about 30% of all children under age 5 have abnormally low weight given their age (UNDP, 1998). For the least developed countries, this figure rises to 39%. Most economists would agree that economic growth can lead to better nutrition among children in these countries. However, the size of this impact is uncertain and will probably vary across countries. If the impact is small, policymakers in developing countries may wish to implement health policies that have a larger impact on children's nutritional status.

These issues are of crucial importance for Vietnam. It is one of the poorest countries in the world, with an estimated annual per capita GNP of about $370 in 1999. It has a very high incidence of child malnutrition; in 1993 50% of Vietnamese children under age 5 were stunted (abnormally low height given their age), although the situation has improved since that time. The role of economic growth in improving children's nutritional status is of particular interest in Vietnam because it enjoyed very rapid economic growth in the 1990s. Its annual rate of real economic growth since 1988 has been about 8%, or about 6% in per capita terms, yet at the same time 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 economic growth on child nutrition in Vietnam. It does so using data from two household surveys recently completed in Vietnam, the 1992-93 and the 1997-98 Vietnam Living Standards Surveys (VNLSS). A recent study of child nutrition in Vietnam, based on the 1992-93 data, found only a weak relationship between household income and child nutrition (Ponce, Gertler and

Glewwe, 1998). This suggests that Vietnam's rapid economic growth in the 1990s resulted in little improvement in children's nutritional status, yet the 1997-98 data show that the incidence of stunting (low height for age) for children under 5 declined from 50% in 1992-93 to 34% in 1997-98. Given this apparent contradictory evidence, this paper seeks to clarify the role of economic growth.

One way to reconcile these findings is to investigate whether other factors, such as new public health policies, could have improved child nutrition in the 1990s. This leads to the second objective of this paper, which is to examine the impact of various health programs on child nutrition. A very rich analysis is possible because the 1997-98 household survey contains data on health infrastructure that were not collected in the 1992-93 survey.

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 employed 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 provides a broad overview of the nutritional status of Vietnamese children in the 1990s, along with some information on Vietnam's economic performance during that time period. Before examining the data, it is useful to discuss briefly how children's nutritional status can be measured.

A. Measurement of Children's Nutritional Status. The nutritional status of children 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: 1) stunting (low height-for-age), 2) wasting (low weight-for-height) and 3) 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 to the growth in height of a reference healthy population. Slow growth in height over long periods of time causes children to fall further and further behind the height of the reference population. Thus stunting is a *cumulative* indicator of deficient physical growth. In developing countries stunting is caused primarily by repeated episodes of diarrhea, other childhood diseases, and insufficient dietary intake.

In contrast to stunting, wasting is an indicator for current malnutrition, which leads to loss of weight. Thus it indicates *current* nutritional problems, such as diarrhea, other childhood diseases, and insufficient dietary intake. While stunting is usually not reversed – children who become stunted remain so throughout their lives, as opposed to "catching up" – the low weight associated with wasting can be restored quickly under favorable conditions.

The third indicator, underweight, can reflect stunting, wasting, or both. Thus it does not distinguish between long-term and short-term malnutrition.

All three measures are commonly expressed in the form of 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 stunting Z-score 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 group of children (same age and sex) from the reference population, SD_r:

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

Relatively short children have negative height for age Z-scores, and thus stunted children are commonly defined as those that have Z-scores of –2 or lower.

Z-scores for low weight for age (underweight) are calculated in the same way, 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 a healthy reference population. Finally, Z-scores for wasting (low weight for height) 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 National Center for Health Statistics (NCHS), in accordance with the WHO recommendations (WHO, 1983).

The two preferred anthropometric indices for the measurement of nutritional status of children are stunting and wasting, since they distinguish between long-run and short-run physiological processes (WHO, 1986). The wasting (low weight for height) index has the advantage that it can be calculated without knowing the child's age. It is particularly useful in describing the current health status of a population and in evaluating the benefits of intervention programs since it responds more quickly to changes in nutritional status than does stunting. A disadvantage of this index, however, is that it classifies children with poor growth in height as normal (Gibson, 1990). Stunting measures long-run social conditions because it reflects past nutritional status. This is why 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, infant foods and "adult" foods grow quickly and attain their potential weight and height, unless disease 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 years of life, the single most important factor is the incidence of diarrhea. Children who are exclusively breastfed are much less likely to be exposed to pathogens that lead to diarrhea and other gastrointestinal diseases, and they also receive immunitive agents from breastmilk. Yet when weaning foods are introduced, typically in the first 3-6 months of life, infants are exposed to many pathogens that often lead to diarrhea and other diseases. This typical pattern is found in the 1992-93 survey data from Vietnam. The first column of Table 1 shows that less than 1% of children age 3 and older are reported to have had diarrhea in the past 4 weeks, while the incidences in the first, second, third and fourth six-month periods of life are 2.6%, 4.5%, 5.8% and 4.3%, respectively.

Repeated bouts of diarrhea interfere with human growth, leading to low weight gain. This is seen in the second column of Table 1, which shows that wasting (defined as a weight for height Z-score below -2) is relatively rare among very young children, who are still primarily breastfed. Specifically, only 1.7% of children age 0-5 months are wasted, but this figure increases to 6.1% for children age 6-11 months, then 7.9% for children 12-17 months, and finally peaks at 10.9% for children age 18-23 months. For children 2 years and older wasting fluctuates between 4% and 7%, but this is more likely caused by inadequate food intake since diarrhea is relatively rare by that age.

The long-run consequence of diarrhea, other illnesses and inadequate food intake is stunting (low height for age). As seen in the last column of Table 1, stunting (defined as a height for age Z-score below –2) rises dramatically during the first two years of life, from 13.6% for children age 0-5 months to 65.3% for children age 18-23 months, and then "settles down" to about 55% for children aged two to nine years. In other words, Vietnamese children follow the typical pattern in that their worse bouts of malnutrition occur during the first two years of life, and as a consequence slightly more than half of them become stunted during these years and remain so for the rest of their childhood.

The previous paragraphs described the situation in the early 1990s. The situation in the late 1990s shows substantial improvments, at least in terms of stunting. As seen in Table 2, stunting in 1997-98 was less common for all age categories, relative to 1992-93. At the same time, one sees the same general pattern that wasting (low weight for height) peaks in the second year of life, as does the incidence of diarrhea, so that stunting again typically develops during the first two years of life, after which it remains relatively high.

While Tables 1 and 2 demonstrate typical patterns of malnutrition and show that stunting declined during the 1990s, two anomalies stand out. The first is that the incidence of diarrhea seems to have increased dramatically for almost all age groups. This apparent increase is spurious because the way the question was asked changed between the two surveys. In the 1992-93 survey each person was asked (or, for small children, parents were asked) whether they had been sick in the last 4 weeks and, if so, what illness they suffered from. 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 4 weeks. Second, persons suffering from more than one illness in the past 4 weeks were allowed to report only one illness. Thus if a child had diarrhea and another illness, the other illness may have been reported instead of diarrhea. In the 1997-98 survey all individuals were asked directly whether or not they had had diarrhea in the past 4 weeks, which resulted in a much higher reported incidence of diarrhea.

The second anomaly in Tables 1 and 2 is that wasting (low weight for height) appears to have 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, both of which indicate that the nutritional status of Vietnamese children greatly improved in the 1990s (add weight for age data in Tables 1 and 2?). However, height increases were larger than weight increases, so that weight for height indicates a worsening condition (wasting). This suggests that examining changes in weight for height over time may provide a misleading picture of changes in children’s nutritional status when household incomes are rising. Similar contradictory results over time have been found in sub-Saharan Africa (Sahn, et al. 1999).

More information about the nature of malnutrition (as measured by stunting and wasting) is provided in Table 3. The first three columns present data from the 1992-93 survey. At that time the overall incidence of stunting for children age 0-9 years was about 53%, while the incidence of wasting was about 6%. Stunting was most prevalent in rural areas, affecting about 56% of the population, while only about one third of urban children (35%) were stunted. This is not surprising since real per capita expenditures in urban areas were almost double those of rural areas (1,897,000 vs. 1,012,000 Dong), as seen in the third column. The figures on wasting are somewhat surprising in that it was slightly more common among urban children than among rural children (6.8% vs. 5.7%).

Regional rates of stunting and wasting are also instructive. Vietnam can be divided into seven regions. The two regions with the highest incidence of stunting in 1992-93 were the Northern Uplands and the North Central region. As one would expect, these two regions also had the lowest average per capita expenditures. Stunting was least common in the Southeast region, which includes the largest city in Vietnam (Ho Chi Minh City, formerly known as Saigon) and by far the highest per capita expenditures. This strong correlation of stunting and per capita expenditures is not found in the data on wasting. The Mekong Delta had the highest incidence of wasting (7.0%) even though it had the second highest per capita expenditures. The Central Highlands had the lowest incidence of wasting (3.2%) even though it had the third lowest per capita expenditures. Overall, there is no clear correlation between wasting and per capita expenditures, which casts doubt on its use as an indicator of nutritional status.

Columns 4-6 of Table 3 present information from the 1997-98 survey. Incomes have increased in all regions (although deflated numbers are not presented) and the incidence of stunting has declined by almost one third, from 53% to 37%. This decline is found in both urban and rural areas and in all seven regions. Indeed, the region with the largest percentage increase in per capita expeditures – the Red River Delta, which moved from 4th highest to 2nd highest per capita expenditures – had the largest decline in stunting, from 56% to 32%.

In contrast, the wasting data are rather puzzling. The incidence of wasting increased in urban and rural areas of Vietnam and in all seven regions. Wasting shows no clear relationship with income or with changes in income. Given that other indicators of child health also show improvement over this time period, for example the infant mortality rate dropped from 44 to 39 (World Bank, 1999a), the rest of this paper will focus on the stunting data.

C. Vietnam's Economic Performance in the 1990s. In the 1980's 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. This would place it as the second poorest country in the world, barely ahead of Ethiopia and just behind Bangladesh (the poorest and second poorest countries in the world as reported in World Bank, 1986). By 1999, Vietnam's GNP per capita had increased to $370 (1998 U.S. dollars), so that instead of being second to last it ranked 167 out of 206 countries (World Bank, 2000).

This rapid improvement in Vietnam's economic performance dates back to 1986, when a series of decrees transformed Vietnam from a planned to a market-oriented economy. In particular, the government dissolved state farms and divided agricultural land equally among rural households, removed prices 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. In the 1990s Vietnam was one of the ten fastest growing economics in the world, with an average real GDP growth of 8.4% per annum from 1992 to 1998.

This rapid economic growth has led to a dramatic decline in the rate of poverty, from 58% in 1992-93 to 37% in 1997-98 (World Bank, 1999b). As seen in Table 3, it also appears to have led to large decreases in the rate of stunting among Vietnamese children. Are these dramatic increases in the incomes of Vietnamese households the main cause of the large decreases in stunting among young children? Table 4 provides a first glance of the evidence. For each survey, households were divided into five groups of equal size on the basis of their per capita expenditures. The first group, quintile 1, is the poorest. In 1992-93 about 63% of the children in that group were stunted. The second poorest group, quintile 2, had a somewhat lower rate of about 59%. Quintiles 3, 4 and 5 had steadily lower rates of 50%, 46% and 32%, respectively. The same pattern is seen in the 1997-98 survey; the incidence of stunting among the poorest quintile is 48% and steadily drops to 15% for the wealthiest quintile. This pattern, based on cross-sectional data, strongly suggests that higher incomes reduce child malnutrition. In contrast, the data on wasting (low weight for height) show no such pattern, raising further doubts about the informational content of this nutritional indicator, at least in the Vietnam context.

Returning to the stunting data in Table 4, note that stunting rates decline over time within each quintile. This suggests that something else in addition to income growth was leading to reduced malnutrition in Vietnam in the 1990s. Yet these quintiles are not strictly comparable because the poorest 20% of the population in 1997-98 had a higher income than the poorest 20% in 1992-93. The last column in Table 4 adjusts for this difference, classifying households in the 1997-98 survey according to the quintile categories used in the 1992-93 survey. Even after this adjustment is made there are still dramatic declines in stunting for households in the same income group. This suggests that increased household income is not the only factor that brought about the improved nutritional status of Vietnamese children. The rest of this paper will examine this phenomenon more formally.

III. Data and Analytical Framework

A. Data. All of the analysis done in this paper uses the 1992-93 and 1997-98 Vietnam Living Standards Surveys. The 1992-93 survey covered 4800 households, while the 1997-98 survey covered 6000 households. Both surveys are nationally representative. About 4300 households were interviewed in both surveys and thus constitute a large, nationally representative panel data set. In both surveys, the household questionnaire covered a wide variety of topics, including education, health (use of health care facilities and anthropometric measurements of all household members), employment, migration, housing, fertility, agricultural activities, small household businesses, income and expenditures, and credit and savings. In each year, community questionnaires were completed in rural areas (where about 80% of Vietnamese households live) and detailed price questionnaires were completed in both urban and rural areas. In the 1997-98 survey, health facility and school questionnaires were also administered.

These two household surveys are particularly useful for examining the determinants of children's nutritional status. All household members, both children and adults, were measured for height, weight and arm circumference. The vast amount of information on the households surveyed, including detailed income and expenditure data, reduces problems of omitted variable bias. The panel data allow for estimation that controls for unobserved household fixed effects. Finally, the 1997-98 data include a substantial amount of information on local prices of medicines and the types of medical services (and their costs) provided by the local health care clinic.

B. Analytical Framework. The data presented in Section II show changes over time but they do not attempt to explain what caused those changes, or more generally what determines children's nutritional status. Such causal analysis is much more difficult and requires a clear analytical framework to avoid drawing false inferences from the data.

The starting point for thinking about the determinants of a child's nutritional status is a health production function, since nutritional status is a major component of child health. 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):

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

The child's health endowment (ε) is defined as all genetically inherited traits that affect his or her health. It is exogenous (cannot be altered by the child or anyone else), 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 have a direct effect on his or her health, such as the prevalence of certain diseases and the extent of environmental pollution. It is also exogenous, although one could argue that it is endogenous 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 are provided by the household to the child, including prenatal care, breastmilk, infant formula, all other foods, medicines and medical care. In addition, the quality of the household's drinking water, toilet facilities and other hygienic conditions around the home can be treated as health inputs.

While researchers would often like to estimate a health production function, it is almost impossible to do so 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 may well lead to serious problems of omitted variable bias. This problem is further complicated by the need to have this information 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, the health inputs that households choose for their children are determined by the household 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:

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

Note that family size and the presence of other siblings are not included as determinants of health inputs. This is done because those variables are clearly endogenous, and including endogenous variables will often lead to biased estimates unless suitable estimation methods, such as instrumental variables, are used. Thus it is best to include in equation (2) only those variables that are clearly exogenous. Of course, one could rightly claim that household income is endogenous; for example, parents may change their hours of work in response to the health status of their children. However, removing this variable from (2) would preclude estimation of the key relationship of interest in this paper, so it is retained.

The approach used to deal with possible estimation biases from retaining this variable is discussed below.

Substituting (2) into (1) gives the basic equation that this paper will attempt to estimate:

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

This paper will use each child's height for age Z-score as the indicator of child health, H. As mentioned above, both surveys have data on household income and expenditures. Household per capita expenditures will be used instead of household 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 households "permanent income", which is more appropriate in this case because Y represents the household's income stream since the child was born, not just current income.

The remaining variables in equation (3) merit further comment. The schooling of each parent is provided in both surveys, even for children who are no longer living with one or both parents (8% of the children in the sample are not living with their father, and 3% are not living with their mother). However, parental tastes for child health, η, are difficult to ascertain in any survey and no attempt was made to do so in the Vietnamese surveys used here. Dropping this variable from the estimation altogether is risky; doing so would relegate it to the error term and many scenarios suggest that it could be correlated with household income (in which case it would lead to biased estimates of the impact of household 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, dummy variables representing different ethnic and religious groups are included to approximate, albeit only partially, tastes for child health. Second, in some estimates instrumental variables are used for household per capita expenditures, which should eliminate some or perhaps even all of the bias due to correlation between income and unobserved tastes for child health. Third, some estimates presented below are based on panel data, and for those parental tastes can be thought of as a fixed effect that differences out of the estimation.

The last two variables in (3) are the local health environment, E, and the child's innate healthiness, ε. The estimates presented in Section IV use community fixed effects are used to control for all differences across communities, one of which is differences in the local health environment. In Section V, a different approach is used; data from the 1997-98 survey on local health conditions, 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 that is not associated with health status and the innate healthiness of each parent) and by the sex of the child (since girls are typically healthier than boys, but note that this masks any sex discrimination taking place). In estimates using panel data, the average healthiness of each household's children is treated as a fixed effect and thus is differenced out.

The last issue to address is the problem that household income is endogenous, which raises the possibility of simultaneity bias. In general, households make decisions about their children's health at the same time that they make decisions about income earning activities, and these two decisions could be related. For example, parents whose children are chronically ill may decide to purchase costly medicines or medical services, and to do this they may increase some household members' work hours in order to pay for those medicines. In this scenario simple ordinary least squares (OLS) estimates would tend to underestimate the impact of household income (expenditures) on child health because unobserved negative shocks to child health would be positively correlated with household income. Alternatively, households may decide to reduce hours worked in response to a child's illness, for example the mother may work fewer hours in order to spend more time caring for the child. In this case OLS estimates would overestimate the impact of household income (expenditures) on child health.

Another problem with both household income and expenditure data is that they are often measured with random error, simply because it is difficult for households to provide accurate answers to detailed questions about their incomes and expenditures. As explained above, this paper will use household expenditures instead of household income because it is likely to be more accurate. However, even household expenditures are likely to suffer from a significant amount of measurement error, much of which will be rather random. Such random measurement error will lead to underestimation (attenuation bias) of the true impact of household expenditures on child health.

Of course, instrumental variable methods can, in principle, remove the bias caused by either endogeneity or measurement error in the household expenditures variable. The task is to find plausible instrumental variables, that is variables that are correlated with household income but are not correlated with unobserved determinants of child health and are not correlated with the measurement error in the household expenditure variable. Two plausible categories of instrumental variables are types of agricultural land allocated to the household and certain sources of non-labor income. In Vietnam, agricultural land is tightly controlled by the government, and markets for land simply do not exist in most rural communities (less than 3% of households in the 1992-93 survey reported that they had bought or sold land in the previous year). Thus households' land assets are unlikely to be influenced by children's health status. Similarly, some types of non-labor income are received regardless of children's health status. Thus the following instrumental variables are used for households' per capita expenditures: irrigated annual cropland, unirrigated annual cropland, perennial cropland, water surface, income from social funds, social subsidies, dowries, inheritances and lottery winnings. Finally, the existence of relatives (more specifically, children of household members) living overseas may also indicate an additional source of income; although the amount of remittances sent by 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, overseas relatives in other Asian countries and overseas relatives in Western countries.

As will be seen in the next section, 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, then one could use household income as an instrumental variable for household per capita expenditures. In the regression results presented below, two sets of instruments are used, one without household income, which should be robust to both endogeneity and measurement error in the income variable, and another set that adds income, which is robust to measurement error but is invalid if household income is endogenous with respect to child health.

IV. Income Growth and Child Nutrition

This section presents regressions that estimate equation (3). In all regressions the dependent variable is the child's height for age Z-score. Separate estimates are presented for urban and rural areas. For cross-sectional regressions separate estimates are given for 1992-93 and 1997-98. The cross-sectional estimates are presented first, followed by estimates based on panel data.

A. Cross-Sectional Estimates. Table 5 presents estimates of equation (3), the determinants of child malnutrition (as measured by height for age Z-scores), for urban areas of Vietnam in 1992-93. The first column presents OLS estimates, which are likely to suffer from omitted variable bias due to unobserved characteristics of local communities (such as the local health environment). OLS estimates may also be biased because they do not account for endogeneity or measurement error in the household expenditure variable. The second column of estimates includes community fixed effects, which avoids bias due to unobserved community characteristics as long as those variables enter equation (3) in a simple additive form without interaction terms with household or child level variables. Yet these fixed effects estimates are not robust to endogeneity or measurement error in the expenditure variable. The third and fourth columns employ both fixed effects and instrumental variables for household expenditures. The third column does not use household income as an instrument, so it should be robust to both measurement error and endogeneity, while the fourth adds household income as an instrument and thus controls only for measurement error.

Although the OLS estimates in the first column are likely to be biased, it is useful to begin with them because the results for many variables change only slightly when other estimation methods are used. As one would expect given the results of Tables 1 and 2, the age of the child 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 in this relationship. Mother's and father's height are both strongly and positively related to child health, which partially controls for unobserved children's health endowment but also reflects natural variation in height across a healthy population. For some mothers and fathers (3% of mothers and 16% of fathers), the height variable was missing. In this case the parent is assigned the average height and a dummy variable is added to indicate this type of observation. These dummy variables are never significant and thus indicate little difference between parents whose heights were and were not measured.

In all the regressions in Table 5, girls in urban areas appear to be slightly healthier than boys, but this apparent advantage is never statistically significant. The impact of mothers' and fathers' schooling is also never statistically significant, which is somewhat surprising, especially for mothers. One would think that better educated mothers are more able to care for their children's illnesses, ceteris paribus. Perhaps better educated women are also more likely to work outside the home, which could have negative consequences for their children's health, so that the net effect of mother's education is zero. Finally, there are few differences across ethnic and religious groups in urban areas (the omitted ethnic groups are Vietnamese and "no religion"), the two exceptions are that Protestants and households practicing religions other than Buddhism and Christianity had children who 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 paper is on the impact of household income and health care services, these apparent impacts of religion on child health will not be discussed further.

Turn finally to the impact of per capita household expenditures (expressed in natural logarithm) on child health. The OLS estimate is 0.302, which is fairly precisely estimated (the standard error of 0.068 yields a t-statistic is 4.47). This is a somewhat higher than the estimate of 0.22 found by Ponce, Gertler and Glewwe (1998), which may reflect small differences in sample size and specification.

Even if household expenditures were exogenous and measured without error, the OLS estimate of the corresponding coefficient is likely to be biased due to correlation between household income and unobserved community differences. The basic problem is that wealthier communities may have a better health environment, for example better sanitation and health care facilities. If these community characteristics have effects that are primarily additive, community fixed effects estimates will remove this bias. Such estimates are shown in the second column of Table 5. As expected, the impact of household per capita expenditures is much smaller, falling from 0.302 to 0.193. Yet the impact of household expenditures on child health is still statistically significant (the standard error is

0.084, yielding a t-statistic of 2.31). This result is very similar to the coefficient of 0.20 found by Ponce, et al.

The last two estimations in Table 5 attempt to correct for endogeneity and measurement error in the household expenditures variable. The third column of Table 5 presents estimates that predict household expenditures using the land assets and non-labor income variables. Although these instrumental variables have strong explanatory power in the sense that they have high F-statistics, they do not by themselves explain a large percentage of the variation of per capita household expenditures (the R^2 coefficient of a regression of the expenditure variable on the excluded instruments is only 0.08). Thus, although the coefficient on per capita expenditures appears to have increased tremendously, from 0.193 to 0.878, it is not statistically different from zero because the standard error has increased from 0.084 to 0.582. This imprecision means that one can say almost nothing about the impact of household expenditures on child health in urban areas of Vietnam in 1992-93.

Somewhat higher precision can be obtained if one assumes that the only problem with household expenditures is measurement error, i.e. if one assumes that it is exogenous. This allows one to use per capita income as an instrumental variable, which greatly increases the precision of the estimates. When this is done the coefficient falls to 0.233. Although the standard error falls from 0.582 to 0.267 the coefficient is still quite imprecisely estimated and thus not significantly different from zero. To make matters worse, the standard overidentification test (see Davidson and MacKinnon, 1993) indicates that one or more of the instrumental variables is correlated with the residual (this could well be per capita income, since the estimates in the third column easily pass this test), although this is only significant at the 10% level. 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 accounts for the possibility that the expenditure variable may be endogenous and may be measured with a significant amount of error.

Turn now to the cross-sectional results for rural areas of Vietnam in 1992-93, which are reported in Table 6. The age and parental height variables show the same patterns as in urban areas. As in urban areas, girls are somewhat healthier than boys, and this time this difference is significant at the 5% level. Mother's schooling has a significantly negative effect in the OLS results, but this counterintuitive finding is not found in the fixed effects or 2SLS estimates. Father's schooling occasionally has a significantly positive effect, but this result is not very robust. No estimates regarding religious and ethnic groups are consistently statistically significant except that again Protestant children appear to be more malnourished, though the magnitude of the impact is much smaller than in urban areas (perhaps because it is based on a larger number of such children).

Focusing on the (log) household expenditure variable, the OLS results show a precisely estimated impact of 0.365 (the standard error is 0.053). As in urban areas, this figure declines when community fixed effects are introduced, to 0.227 (with a standard error of 0.62). This is similar to the fixed effects result of 0.25 in rural areas found in the Ponce, et al. study.

The third column in Table 6 specifies the expenditure variable as endogenous, using the land and non-labor income variables as instruments. The point estimate is quite large, at 0.467, but the precision of the estimate is quite low because the standard error increases to 0.318. This imprecision is not surprising because a regression of 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 0.281; although the standard error is smaller (0.206) this estimate is still not significantly different from zero. A final point to notice is that both 2SLS specifications easily pass the overidentification test, which suggests that it may well be legitimate to use household income as an instrumental variable (that is, the expenditure variable can be treated as exogenous, although measured with error).

The 1997-98 survey had a larger sample size, which may add more precision to the estimates. The results for urban areas are presented in Table 7 while those for urban areas are presented in Table 8. Many of the results for the urban areas in 1997-98 are very similar to those for 1992-93. The age effects and parental height impacts are similar, the sex of the child and parental schooling again have no significant effects, and the impacts of the religion variables are similar. The one change is that the Chinese and ethnic minority variables now have positive effects that are statistically significant at the 5% level, but this is of little interest for the purposes of this paper.

The OLS estimate of the impact of household expenditures is somewhat higher in 1997-98 than in 1992-93 (0.431 and 0.302, respectively), but this difference is not so large after fixed effects are introduced (0.260 in 1997-98 vs. 0.193 in 1992-93). The first set of 2SLS estimates shows an effect of almost zero (0.024), which is quite different from the comparable 2SLS estimate of 0.878 in 1992-93. However, in both cases the standard errors of the estimates are huge (0.582 for 1992-93 and 0.590 for 1997-98), so these differences are not statistically significant. If one assumes that household expenditures are exogenous, then household income as a valid instrumental variable (for purposes of controlling for measurement error), one obtains a much more precise and indeed a statistically significant estimate of 0.413 (standard error of 0.163). Unlike the estimate from the 1992-93 data, this easily passes the overidentification test, although one should bear in mind that the power of this test to detect invalid instrumental variables may not be very high.

In rural areas in 1997-98, again there are few differences in most variables. The only differences are that the Catholic dummy variable is significantly negative, and the Protestant variable is less negative, though still statistically significant. Turning to the variable of primary interest, household expenditures, the OLS and fixed effect estimates are very similar across the two years. However, the first set of 2SLS estimates is very different: in 1992-93 the estimated impact was 0.467 while in 1997-98 it was –0.430. Yet when one recalls that both of these estimates have very large standard errors (0.318 in 1992-93 and 0.303 in 1997-98) the difference between them is barely statistically significant at the 5% level (t-statistic of 2.04). The second set of 2SLS estimates, which adds household income as an instrumental variable, is much closer to the estimates for 1992-93, with point estimates of 0.281 in 1992-93 and 0.155 in 1997-98. Again, neither of these is very precisely estimated (with standard errors of 0.206 and 0.161, respectively), so they are not significantly different from each other.

Overall, the cross-sectional estimates settle on impacts of about 0.2 in rural areas, while the estimates for urban areas may be as high as 0.4. Before assessing the policy significance of these estimates, it is worthwhile to examine some estimates based on panel data.

B. Panel Data Estimates. In principle, there are two possible 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 rather problematic because, as seen in Tables 1 and 2, stunting develops in the first two years of life, after which there is little change. Thus any child who was covered in the 1992-93 survey was already at least 5 years old in the 1997-98 survey, and the impact of the household's expenditure levels in the latter survey should have almost no effect on the stunting of those children because their stunting developed 3 or more years prior to the time of that survey.

The alternative possibility, which is pursued in this paper, is to compare children five years or younger in the first survey to children who were five years or younger in the second survey. This can be done using panel data for those households in the panel data that had children of that age in both 1992-93 and 1997-98, which occurs for 1663 of the 4300 households in the panel data set. For households that had two or more children in this age range in either year (or both years), all variables used are averages over those children.

Before examining the estimates, a discussion of their usefulness is in order. Recall that parental tastes for child health (η) and the child's health endowment (ε) are unobserved variables that could be correlated with household income. One way to try to get around this problem is to use instrumental variables for income that are not correlated with these variables. The approach with panel data is somewhat different. Instead, one assumes that the impact of these variables on child health takes an additive form and that these additive components do not change over time. In this case, *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 other variables that may change over time) should eliminate bias due to these two types of household unobserved characteristics.

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

Table 9 presents panel data estimates for urban and rural areas. The only variables that change over time are the age and sex of the children and (log) per capita expenditures. The sex dummy variable has no significant impact in any of the regressions. The age variable is again specified in a flexible way, with linear, quadratic and cubic terms. The coefficients on these age terms are quite similar to those seen in Tables 5-8.

The three urban regressions (OLS, fixed effects and 2SLSFE) reveal a rather odd finding: negative point estimates for the impact of household expenditures on child health. However, note that 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 5 and 7 are not necessarily inconsistent with these results. On the other hand, these standard errors are so large that it is probably not possible to infer much of anything from them.

In rural areas, the sample sizes are much larger. In the OLS and fixed effects estimates, the estimated impacts of household expenditures are very close too zero, and the standard errors are small enough (0.077 and 0.084) to exclude the point estimates in Tables 6 and 8 from the associated confidence intervals. However, recall that such differenced estimates may suffer from considerable attenuation bias due to increased bias due to measurement error, The final column of estimates in Table 9 uses household income to correct for measurement error in the household expenditures variable (but recall that this assumes that expenditures can be considered exogenous). The point estimate of 0.376 is much larger and comparable with estimates in Tables 6 and 8. Unfortunately, this point estimate also has a very large standard error (0.512), so even in rural areas the panel data estimates are probably too imprecise to add anything to what has been learned from the cross-sectional estimates.

C. Impact of Income Growth on Child Nutrition. Given the estimates in Tables 5-9, what can be said about the impact of Vietnam's economic growth on child nutrition? More precisely, is the rapid increase in household incomes and expenditures the main cause of Vietnam's substantial decrease in child stunting?

This question is examined in Table 10, which shows changes in mean height for age Z-scores and in the percent of children who are stunted from 1992-93 to 1997-98. The first three lines of the table show the actual changes, for rural and urban areas separately, while the rest of the table uses the estimated impacts of household expenditures from Tables 5-9 to examine how much of the change was brought about by directly raising households' expenditure levels.

Table 10 shows that the mean height for age Z-score in urban areas of Vietnam increased by 0.49 standard deviations, while the mean in rural areas increased by 0.38 standard deviations. These increases are quite dramatic over a period of only five years; they correspond to a drop of almost 15 percentage points in the incidence of stunting in both urban and rural areas. Given the high rate of income growth over this time period, it is tempting to conclude that this large improvement in children's nutritional status is due to higher household income.

The remaining lines of Table 10 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 (the log of) average household expenditures. For estimates not based on panel data, the estimated impact used is a simple average of the 1992-93 and 1997-98 estimates. In addition, these estimated impacts are added to each child's Z-score in 1992-93 to see how they change the incidence of stunting (low height for age). Those calculations are reported in the third and fourth columns of Table 10.

The clear conclusion to draw from the results in Table 10 is that growth in household expenditures accounts for only a small proportion of the improvement of children's nutritional status in Vietnam from 1992-93 to 1997-98. In urban areas, the mean height for age Z-score increased by 0.49, but the highest predicted change among seven different specifications is only 0.22 (from the 2SLS specification without income as an instrumental variable), less than half the total amount. Similarly, the incidence of stunting dropped by

14.6 percentage points, but the predictions from the econometric estimates are much smaller, the highest one showing a drop of only 8.1 percentage points. The same conclusion holds even more forcefully for rural areas; the mean height for age Z-score dropped by 0.38 standard deviations but the largest predicted drop is only 0.10 standard deviations, and the incidence of stunting dropped by 14.8 percentage points while the largest predicted drop is only 3.5 percentage points.

Given the imprecision of the estimated impacts, it is useful to check the upper bound of the 95% confidence interval of the estimated impacts, since it is possible that even though the point estimates are low the actual change may still lie within that confidence interval. The mean changes in height for age Z-scores using the upper bounds of the 95% confidence intervals are shown in brackets in the first two columns of Table 10. In only one out 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 rather small proportion, of the improvement in children's nutritional status in Vietnam during the 1990s.

V. Health Programs and Child Nutrition

The results of Section IV strongly suggest that something else happened in Vietnam in the 1990s that reduced child nutrition. One possibility is that health services in Vietnam dramatically increased in their quantity, or quality, or both. This section reviews changes in the quantity and quality of health services in Vietnam, and then uses the 1997-98 VNLSS data to examine the impact of health services on child nutrition in rural areas.

A. Growth in Health Programs

To be written! Compare community questionnaire in 92-93 and 97-98 survey to see if there is increased evidence of privately provided health services. Also check price data on medicines to see if more communes report that medicines are available.

B. Econometric Estimates

The 1997-98 VNLSS price questionnaire collected detailed data on the prices of nine medicines in both urban and rural areas. In addition, in rural areas the community questionnaire collected data on the distance from the sampled communes to 14 different kinds of health facilities or health service providers. That questionnaire also collected information from community respondents on specific illnesses that were common to the community and on reported problems with the commune health center.

Commune health centers are the "first line of defense" in the Vietnamese health care system. Almost every rural commune has a commune health center; of the 156 communes in the 1997-98 VNLSS for which community data were collected, only two did not have their own commune health center (and in both cases there was a commune health center within five kilometers). The 1997-98 VNLSS administered a Commune Health Center Questionnaire in 155 of the 156 communes in the rural areas covered by that survey (a few of these communes are small towns, these are not used in the analysis of this subsection). That questionnaire collected information on: a) the number of medical staff (doctors, physician assistants, nurses and nurse's aides); b) hours of operation; c) number of beds; d) the availability of 11 kinds of medical services; e) the availability of electricity, "clear water" and a "sanitary toilet"; f) 13 different types of medical equipment, ranging from thermometers to laboratories; g) the availability and prices of nine kinds of medicines (the same ones collected in the price questionnaire); and h) fees for five kinds of services, and some information on how often those fees are waved for different types of people.

In this subsection we add community level variables that are relevant for child health to see whether they any have explanatory power as determinants of child health. Because there are so many variables, and they vary only at the level of the community (and there are only 156 communities in our rural sample), we do not add them all at one, but start with the most basic and then add other sets of variables (sometimes in the form of an "index") to see what explanatory power they have.

We begin with the data on medicine prices. Of the nine types of medicine available, the one most relevant for child nutrition is oral rehydration salts. Other potentially relevant medicines are the antibiotics ampicillin and penicillin, paracetemol (to reduce fevers), iron tablets and vitamin A tablets. Unfortunately, these price data are very noisy, as seen in the first six rows of Table 11. Although prices were supposed to be collected for a given number of doses for a particular brand, it is likely that some observations are for a different number of doses, or perhaps for a different brand. To see whether these data had any explanatory power, the OLS regression in Table 8 (for rural areas in 1997-98) was re-estimated six times, each time adding one of the price variables for each of these six types of medicine. In all cases, the point estimates were very close to zero and were far from any statistical significance. As an example, consider the medicine most likely to have an effect, namely oral rehydration salts (which also displayed the least amount of noise in the data). While the price of oral rehydration salts had the expected negative sign, it had a t-statistic of only 1.08 and thus was not statistically different from zero.

Another "price" of medical care is the distance to nearby health facilities. Although the distance to commune health centers is trivial, those centers are not equipped to handle the most serious medical problems, so that seriously ill individuals must go to a hospital in a district or provincial capital, or perhaps to some other kind of health facility (including private health facilities). Of the 13 other types of health facilities or health service providers considered in the commune questionnaire, four had missing data for nearly a third or a fourth of the observations (private nurse, medicine peddler, midwife and oriental/traditional doctor) and thus were not considered. For the remaining nine, the same procedure used with the medicine data was used for the distance data. For six types of facilities (family planning center, polyclinic, district hospital, other hospital, private doctor and private physicians assistant) no significant relationship was found. However, for three types of health facilities, provincial hospital, state pharmacy and private pharmacy, a significant negative effect was found.

The first column of Table 12 presents the results when all three distance variables are added simultaneously. Although the distance to the nearest provincial hospital is statistically significant when the other two variables are not present (coefficient of –0.0021 and t-statistic of -2.57) this is no longer the case when the two variables on distance to pharmacies are added. The distance to the nearest state pharmacy is still significant at the 5% level (with a coefficient of –0.0029) while the distance to the nearest private pharmacy is statistically significant at the 10% level (with a coefficient of –0.0078). However, the policy significance of these two coefficient estimates, taken at face value, is not particularly large. Reducing by one half the current mean value of the distance to the nearest state pharmacy implies an improvement in children's z-scores of about 0.009, and halving the distance to the nearest private pharmacy implies an improvement of only 0.012.

The next set of variables to consider are those from the community questionnaire on local health problems and problems with the commune health center. 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 diarrhea approached statistical significance, with a point estimate of –0.071 and a t-statistic of –1.28. Even less statistical significance was seen in the variables citing problems with local health facilities (lack of equipment and supplies, lack of medicines, inadequate staff, inability of staff to provide services, inadequate training opportunities, and lack of sanitation). None of these variables had a t-statistic greater than 1.0 when added to the regression.

Finally, turn to the data from the health facility questionnaire. The number of staff in the clinic, divided by the population of the commune, never had any explanatory power, either separately or as a group. The same is true of weekly hours of operation and number of beds (divided by the commune population). Of the 11 kinds of services offered, one was offered by all clinics in the sample (immunizations), one was offered by all but two of the communities (prenatal care), and two appear to be 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 (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 that are most closely tied to child health. In addition, putting all of the variables together into a general health services index had no explanatory power either.

Next consider the three general variables concerning amenities at the facility; electricity, “clean water” and “sanitary toilet”. Of these, lack of a sanitary toilet had a significantly negative effect on child health and is added to the list of community level regressors. Thus the variables that seem to have some explanatory power before turning to the equipment variables are the three distance variables, the incidence of diarrhea in the community and the availability of a sanitary toilet in the commune health center. A regression with all of these variables is shown in the second column of Table 12. 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 0.11 points.

The last set of variables examined (at least until the next draft!) are the 13 equipment variables. There are so many that the best thing to do is develop two indices, one general and one for equipment particularly relevant for child health. Before developing these indices we drop four variables with almost no variation: blood pressure monitor and stethoscope (only one commune did not have); and thermometer and laboratory (only three communes did not thermometers and only three had laboratories). In addition, we drop two variables that do not seem to have any relevance for child malnutrition, eye charts and “family planning equipment” (for abortions). This leaves five variables for the general index (refrigerator, sterilizing equipment, delivery bed, microscope and examining bed) and two variables for the child health index (child growth chart and child scale).

The results after adding the two equipment index variables are shown in the third column of Table 12. The general equipment has the expected positive sign but it is not at all statistically significant. In contrast, the child equipment index, which is based on the availability of growth charts and child scales, has a strong and statistically positive impact; the coefficient is 0.112 and the t-statistic is 2.42. Since this scale ranges from 0 to 2, this coefficient suggests that added this two types of equipment to a community center that does not now have them will raise the average z-scores of children by 0.22 standard deviations, which is almost half of the change from 1992-93 to 1997-98. The data from the 155 commune health centers show that about 12% due not have child scales, about 25% do not have growth charts and about 5% have neither. On the other hand, this crude index of health equipment relative to children may reflect other kinds of equipment that were not included in the commune health questionnaire, or may even reflect the priorities of the commune health center staff. Further investigation of this is needed before making sweeping policy statements.

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. Vietnam was fortunate in this decade in that both household incomes rose dramatically while children's nutritional status improved rapidly. While one may conclude that the former caused the later, the estimates presented here do not support such a conclusion. Using many different estimation methods, this paper has shown that the impact of household expenditures on children's nutritional status (as measured by height for age Z-scores) is not necessarily significantly different from zero. More specifically, the impact may well be positive, but it is not very large. In particular, 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 some observers may argue that this finding casts doubt on the benefits of economic growth for children's health status, such a conclusion would be premature. This is because economic growth may lead to other changes in society, such as improved health care services. That is, economic growth should increase government budgets through increased tax revenues, some of which can then be used to provide better health care services. The question then becomes: What kinds of health projects are most effective at raising child (and adult) health? A first attempt at answering this question was made in Section V. The community level data on health services suggest that the distance to state pharmacies has a statistically significant, though not very large, negative effect on child nutrition. It also suggests that communities with a high prevalence of diarrhea have poorer child nutrition outcomes, but this is not very precisely estimated. Finally, data from commune health centers suggests that "unsanitary toilets" (need to find definition of this) and lack of health equipment relevant for checking child growth have significantly negative impacts of considerable magnitude.

To do for next draft:

1. Do all commune fixed effects in the form of differences from commune means, which will make overidentification and other specification tests cleaner.
2. Put in formal Hausman tests of differences between OLS, FE and 2SLS estimates.
3. Put in Bound et al diagnostics for 2SLS estimates, and discuss them.
4. Maybe replace tables 1 and 2 with graphs based on nonparametric regressions
5. Density estimates of HAZ in both years to check for possible lower tail in HAZ (which would be consistent with WHZ results).
6. In tables replace t-stats with standard errors, and use asterisks to denote statistical significance.
7. Panel data estimates should be checked for possible selection bias, but maybe no big deal because household fixed effects difference out. Also, note that strictly speaking those estimates are only for children age 0-5, not kids age 0-9.
8. In Section V, try using travel time as an instrumental variable to account for measurement error in the distance variable.
9. Use data on medicine prices in commune health center questionnaire as instruments for medicine prices in the price questionnaire.
10. Check household data – for kids with diarrhea what do parents do? See a provider or just go straight to a pharmacy to buy medicine?
11. Think about limiting the sample to kids age 5 years and younger, which may get more impact from household expenditures.

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Table 1: Stunting and Wasting in Vietnam, 1992-93

Age	Percent Diarrhea During Last 4 Weeks	Percent Wasted	Percent Stunted
0-5 months	2.6	1.7	13.6
6-11 months	4.5	6.1	25.3
12-17 months	5.8	7.9	54.6
18-23 months	4.3	10.9	65.3
2 years (24-35 months)	1.7	4.4	52.8
3 years	1.0	4.7	55.4
4 years	0.8	6.7	59.2
5 years	0.5	5.7	55.3
6 years	0.7	4.5	57.5
7 years	0.5	6.1	53.4
8 years	0.4	7.0	53.4
9 years	0.3	6.5	55.7

Table 2: Stunting and Wasting in Vietnam, 1997-98

Age	Percent Diarrhea During Last 4 Weeks	Percent Wasted	Percent Stunted
0-5 months	2.3	7.1	4.4
6-11 months	14.2	11.4	7.9
12-17 months	16.3	16.1	38.1
18-23 months	10.2	13.2	49.9
2 years (24-35 months)	4.6	13.7	31.1
3 years	4.9	9.2	36.4
4 years	3.3	8.8	46.9
5 years	2.9	7.2	41.6
6 years	0.9	8.6	43.1
7 years	2.2	7.7	38.2
8 years	0.7	9.6	36.8
9 years	1.9	7.7	38.1

Table 3: Stunting and Wasting by Region, 1992-93 and 1997-98
(All children 9 years or younger)

	1992-93			1997-98		
	Stunting	**Wasting**	**Per Capita Expend.**	**Stunting**	**Wasting**	**Per Capita Expend.**
Northern Uplands	62.2%	6.4%	827	43.5%	8.2%	1629
Red River Delta	55.5	6.2	1099	32.2	8.6	2473
North Central	63.8	4.5	884	44.2	10.9	1879
Central Coast	48.7	5.0	1229	43.8	8.0	2193
Central Highlands	56.7	3.2	988	47.6	7.0	1781
Southeast	33.0	6.3	1802	19.7	9.3	4575
Mekong Delta	44.9	7.0	1277	33.5	10.9	2191
All Urban	34.9	6.8	1897	20.3	9.7	4406
All Rural	55.7	5.7	1012	40.9	9.2	1884
All Vietnam	52.5	5.9	1147	37.3	9.3	2305

Note: Per capita expenditures are given in thousands of current Dong

Table 4: Malnutrition By Expenditure Quintiles, 1992-93 and 1997-98

	Stunting		
Quintile	**1992-92**	**1997-1998**	**1997-98 with 1992-93 Quintile**
1	63.4	47.8	50.9
2	59.0	41.9	45.9
3	50.2	36.8	41.7
4	45.7	29.5	36.7
5	31.5	15.4	20.4

	Wasting		
Quintile	**1992-92**	**1997-1998**	**1997-98 with 1992-93 Quintile**
1	4.9	9.5	11.8
2	6.5	10.0	8.2
3	6.1	9.5	10.0
4	6.3	8.6	9.3
5	6.0	7.6	8.0

Table 5: Determinants of Child Malnutrition in Urban Areas, 1992-93

	OLS	Fixed Effects	2SLSFE (1)	2SLSFE (2)	Means
Constant	-18.112	-	-	-	1.00
	(-9.67)				
Age (months)	-0.080	-0.080	-0.080	-0.080	62.3
	(-4.44)	(-4.29)	(-4.19)	(-4.29)	
Age^2	0.0013	0.0013	0.0013	0.0013	-
	(3.98)	(3.90)	(3.75)	(3.89)	
Age^3	-0.000006	-0.000006	-0.000006	-0.000006	-
	(-3.69)	(-3.67)	(-3.51)	(-3.65)	
Mother's height (cm)	0.051	0.047	0.045	0.047	152.6
	(8.05)	(6.91)	(6.52)	(6.81)	
Mother's height missing	0.333	0.178	0.483	0.196	0.03
	(1.60)	(0.85)	(1.24)	(0.77)	
Father's height (cm)	0.046	0.046	0.045	0.046	1.624
	(5.53)	(5.23)	(4.39)	(5.12)	
Father's height missing	-0.129	-0.131	-0.085	-0.128	0.16
	(-1.54)	(-1.62)	(-1.02)	(-1.63)	
Female child	0.115	0.082	0.103	0.083	0.50
	(1.55)	(1.09)	(1.23)	(1.08)	
Log mother's years schooling	0.048	0.061	-0.081	0.053	1.90
	(0.58)	(0.67)	(-0.60)	(0.51)	
Log father's years schooling	0.086	0.061	-0.088	0.053	2.07
	(1.04)	(0.69)	(-0.48)	(0.45)	
Log per capita expenditures	0.302	0.193	0.878	0.233	7.35
	(4.47)	(2.31)	(1.51)	(0.87)	
Buddhist	0.017	-0.118	-0.129	-0.119	0.30
	(0.18)	(-1.04)	(-0.90)	(-1.04)	
Catholic	0.092	-0.015	-0.010	-0.015	0.14
	(0.78)	(-0.09)	(-0.05)	(-0.08)	
Protestant	-2.312	-2.524	-2.222	-2.506	0.001
	(-13.11)	(-15.17)	(-7.16)	(-11.40)	
Other religion	-0.771	-1.026	-0.896	-1.019	0.01
	(-3.48)	(-2.96)	(-2.96)	(-3.03)	
Chinese	-0.008	-0.078	-0.159	-0.083	0.10
	(-0.06)	(-0.40)	(-0.80)	(-0.42)	
Ethnic Minority	0.096	0.027	0.424	0.050	0.01
	(0.36)	(0.09)	(0.78)	(0.16)	
R^2	0.216	0.257	0.201	0.256	
Overidentification test (p-value)	-	-	0.188	0.077	
Observations	870	870	870	870	

Notes: 1. Asymptotic t-statistics in parentheses.
2. Standard errors and t-statistics adjusted for sample design.
3. Instrumental variables for (1) 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 (2) add per capita household income as an instrument.

Table 6: Determinants of Child Malnutrition in Rural Areas, 1992-93

	OLS	Fixed Effects	2SLSFE (1)	2SLSFE (2)	Means
Constant	-15.004	-	-	-	1.00
	(-14.85)				
Age (months)	-0.091	-0.090	-0.091	-0.090	60.9
	(-14.49)	(-14.21)	(-14.01)	(-14.08)	
Age^2	0.0014	0.0014	0.0014	0.0014	-
	(12.75)	(12.59)	(12.50)	(12.47)	
Age^3	-0.000006	-0.000006	-0.000006	-0.000006	-
	(-11.24)	(-11.16)	(-11.12)	(11.05)	
Mother's height (cm)	0.042	0.040	0.039	0.039	151.7
	(11.49)	(9.99)	(9.74)	(9.96)	
Mother's height missing	-0.008	-0.018	-0.025	-0.019	0.03
	(-0.07)	(-0.14)	(-0.20)	(-0.15)	
Father's height (cm)	0.035	0.031	0.029	0.030	161.9
	(7.27)	(6.39)	(5.53)	(6.02)	
Father's height missing	-0.056	-0.39	-0.034	-0.038	0.11
	(-0.69)	(-0.49)	(-0.42)	(-0.47)	
Female child	0.078	0.076	0.079	0.076	0.48
	(2.31)	(2.25)	(2.29)	(2.26)	
Log mother's years schooling	-0.072	0.005	-0.031	-0.003	1.60
	(-2.07)	(0.13)	(-0.53)	(-0.06)	
Log father's years schooling	0.038	0.085	0.049	0.077	1.81
	(1.14)	(2.32)	(0.90)	(1.77)	
Log per capita expenditures	0.365	0.227	0.467	0.281	6.80
	(6.94)	(3.67)	(1.47)	(1.37)	
Buddhist	0.049	0.053	0.074	0.057	0.25
	(0.84)	(0.73)	(0.87)	(0.75)	
Catholic	-0.168	-0.132	-0.127	-0.131	0.08
	(-1.62)	(-1.31)	(-1.25)	(-1.29)	
Protestant	-0.304	-0.512	-0.483	-0.505	0.01
	(-2.37)	(-12.61)	(-8.23)	(-10.09)	
Other religion	0.341	0.268	0.253	0.265	0.02
	(1.36)	(0.94)	(0.87)	(0.92)	
Chinese	-0.023	0.138	0.098	0.129	0.01
	(-0.18)	(1.00)	(0.66)	(0.92)	
Ethnic Minority	-0.247	-0.144	-0.112	-0.137	0.18
	(-3.37)	(-1.61)	(-1.10)	(-1.49)	
R^2	0.175	0.220	0.216	0.220	
Overidentification test (p-value)	-	-	0.507	0.485	
Observations	4787	4787	4787	4787	

Note: 1. Asymptotic t-statistics in parentheses.
2. Standard errors and t-statistics adjusted for sample design.
3. See note 3 of Table 5 for a description of the instrumental variables used.

Table 7: Determinants of Child Malnutrition in Urban Areas, 1997-98

	OLS	Fixed Effects	2SLSFE (1)	2SLSFE (2)	Means
Constant	-16.947	-	-	-	1.00
	(-12.95)				
Age (months)	-0.062	-0.064	-0.063	-0.065	64.9
	(-5.26)	(-5.31)	(-5.24)	(-5.21)	
Age^2	0.0009	0.0009	0.0009	0.0009	-
	(4.09)	(4.30)	(4.42)	(4.22)	
Age^3	-0.000004	-0.000004	-0.000004	-0.000004	-
	(-3.45)	(-3.69)	(-3.81)	(-3.61)	
Mother's height (cm)	0.044	0.045	0.046	0.044	152.7
	(6.24)	(6.07)	(6.53)	(5.84)	
Mother's height missing	-0.137	-0.096	-0.110	-0.086	0.04
	(-0.82)	(-0.62)	(-0.660)	(-0.56)	
Father's height (cm)	0.041	0.041	0.043	0.040	162.7
	(8.12)	(7.05)	(6.51)	(7.00)	
Father's height missing	0.036	-0.062	-0.064	-0.060	0.13
	(0.31)	(-0.53)	(-0.57)	(-0.51)	
Female child	0.052	0.073	0.076	0.071	0.47
	(0.69)	(0.99)	(1.04)	(0.95)	
Log mother's years schooling	0.053	0.037	0.093	0.001	1.99
	(0.96)	(0.059)	(0.58)	(0.02)	
Log father's years schooling	-0.005	-0.034	0.029	-0.074	2.10
	(-0.08)	(-0.43)	(0.18)	(-0.84)	
Log per capita expenditures	0.431	0.260	0.024	0.413	8.19
	(5.15)	(3.03)	(0.04)	(2.53)	
Buddhist	-0.148	-0.151	-0.161	-0.144	0.24
	(-1.77)	(-1.61)	(-1.67)	(-1.55)	
Catholic	-0.006	0.005	-0.015	0.019	0.08
	(-0.06)	(0.04)	(-0.10)	(0.12)	
Protestant	-0.433	-0.428	-0.396	-0.448	0.004
	(-3.42)	(-4.52)	(-2.44)	(-4.58)	
Other religion	-0.541	-0.528	-0.610	-0.475	0.01
	(-3.39)	(-2.52)	(-2.08)	(-2.04)	
Chinese	0.441	0.413	0.415	0.411	0.07
	(2.32)	(2.23)	(2.32)	(2.17)	
Ethnic Minority	0.618	0.807	0.780	0.825	0.01
	(1.75)	(2.12)	(2.05)	(2.13)	
R^2	0.244	0.322	0.315	0.319	
Overidentification test (p-value)	-	-	0.493	0.557	
Observations	1066	1066	1066	1066	

Note:
1. Asymptotic t-statistics in parentheses.
2. Standard errors and t-statistics adjusted for sample design.
3. See note 3 of Table 5 for a description of the instrumental variables used.

Table 8: Determinants of Child Malnutrition in Rural Areas, 1997-98

	OLS	Fixed Effects	2SLSFE (1)	2SLSFE (2)	Means
Constant	-15.096	-	-	-	1.00
	(-12.87)				
Age (months)	-0.095	-0.094	-0.094	-0.094	66.9
	(-14.05)	(-14.47)	(-14.31)	(-14.47)	
Age^2	0.0014	0.0014	0.0014	0.0014	-
	(11.93)	(12.17)	(12.19)	(12.19)	
Age^3	-0.000006	-0.000006	-0.000006	-0.000006	-
	(-10.47)	(-10.63)	(-10.69)	(-10.65)	
Mother's height (cm)	0.041	0.040	0.044	0.041	152.1
	(10.22)	(11.32)	(10.41)	(11.27)	
Mother's height missing	0.143	0.098	0.097	0.098	0.03
	(1.40)	(1.04)	(0.95)	(1.04)	
Father's height (cm)	0.041	0.036	0.040	0.036	161.9
	(8.02)	(7.79)	(8.24)	(7.62)	
Father's height missing	0.022	0.052	0.045	0.052	0.10
	(0.34)	(0.94)	(0.81)	(0.92)	
Female child	0.146	0.145	0.133	0.144	0.50
	(4.08)	(4.10)	(3.65)	(4.05)	
Log mother's years schooling	-0.093	-0.048	0.036	-0.041	1.62
	(-2.43)	(-1.36)	(0.68)	(-1.15)	
Log father's years schooling	0.051	0.035	0.123	0.043	1.81
	(1.00)	(0.76)	(1.92)	(0.77)	
Log per capita expenditures	0.312	0.207	-0.430	0.155	7.47
	(6.67)	(3.86)	(-1.42)	(0.96)	
Buddhist	-0.015	-0.018	-0.008	-0.017	0.15
	(-0.25)	(-0.27)	(-0.11)	(-0.26)	
Catholic	-0.240	-0.260	-0.231	-0.258	0.10
	(-3.49)	(-3.78)	(-3.30)	(-3.75)	
Protestant	-0.414	-0.385	-0.358	-0.382	0.02
	(-2.15)	(-2.38)	(-1.80)	(-2.36)	
Other religion	0.011	0.049	0.063	0.051	0.03
	(0.06)	(0.28)	(0.34)	(0.29)	
Chinese	0.299	0.394	0.517	0.404	0.004
	(0.92)	(2.38)	(1.41)	(1.27)	
Ethnic Minority	-0.091	0.019	-0.083	0.010	0.20
	(-1.19)	(0.19)	(-0.72)	(0.10)	
R^2	0.215	0.280	0.250	0.280	
Overidentification test (p-value)			0.732	0.223	
Observations	4086	4086	4086	4086	

Note:
1. Asymptotic t-statistics in parentheses.
2. Standard errors and t-statistics adjusted for sample design.
3. See note 3 of Table 5 for a description of the instrumental variables used.

Table 9: 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
	(0.10)	(0.09)	(-0.09)	(0.11)	(-0.02)	(0.03)
Age (months)	-0.059	-0.067	-0.054	-0.083	-0.086	-0.087
	(-2.68)	(-2.99)	(-1.90)	(-9.06)	(-9.07)	(-9.29)
Age^2	0.0009	0.0010	0.0008	0.0011	0.0011	0.0011
	(2.10)	(2.35)	(1.61)	(6.51)	(6.32)	(6.13)
Age^3	-0.000004	-0.000004	-0.000004	-0.000005	-0.00005	-0.000005
	(-1.71)	(-1.92)	(-1.29)	(-5.47)	(-5.29)	(-5.20)
Log per capita expenditures	-0.016	-0.106	-0.939	0.004	-0.046	0.376
	(-0.10)	(-0.57)	(-1.02)	(0.05)	(-0.55)	(0.73)
R^2	0.068	0.239	0.178	0.138	0.240	0.226
Sample Size	237	237	237	1426	1426	1426

Note:
1. Asymptotic t-statistics in parentheses.
2. All variables were differenced for estimaton
3. Sample includes all panel households who had at least one child age 0-60 months in both surveys.

Table 10: Role of Economic Growth in Reducing Child Malnutrition

	Mean HAZ		Percent Stunted	
Actual Figures:	**Urban**	**Rural**	**Urban**	**Rural**
1992-93	-1.566	-2.108	34.9	55.7
1997-98	-1.073	-1.727	20.3	40.9
Change (over 5 years)	+0.493	+0.381	-14.6	-14.8
Estimates of change due to economic growth:				
OLS	0.175	0.088	-6.6	-3.4
	[0.248]	[0.114]		
FE	0.108	0.057	-3.5	-2.2
	[0.191]	[0.086]		
2SLS (1)	0.216	0.005	-8.1	-0.0
	[0.783]	[0.165]		
2SLS (2)	0.154	0.057	-5.1	-2.2
	[0.363]	[0.152]		
OLS (panel)	-0.008	0.001	+0.4	-0.0
	[0.156]	[0.041]		
FE (panel)	-0.051	-0.013	+2.4	+0.7
	[0.130]	[0.031]		
2SLS (panel)	-0.449	0.098	+16.8	-3.5
	[0.451]	[0.363]		

1. Cross-sectional estimates are based on the mean of the 1992-93 and 1997-98 estimates.
2. Increase in real expenditures per capita was 29.8% in rural areas and 61.3% 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.
3. Numbers in brackets are upper bounds of 95% confidence intervals.

Table 11: Descriptive Statistics of Selected Community Variables

Variable	Communities with Observants	Mean	Standard Dev.	Min.	Max.
Price of oral rehydration salts	146	1288	385	450	2,500
Price of ampicillin	152	4143	1112	700	8,000
Price of penicillin	151	2591	948	1000	8,000
Price of iron tablets	119	3409	5541	0	37,250
Price of Vitamin A	126	692	865	0	4,750
Price of paracetemol	151	1121	1101	0	9,000
Distance to prov. hospital (km)	154	38.6	33.4	0	180
Distance to state pharmacy (km)	144	6.1	12.1	0	100
Distance to priv. pharmacy (km)	146	3.1	7.8	0	50
Diarrhea is local health problem	156	0.46	-	-	-
Characteristics of comm. health cen:					
Lack of electricity	155	0.13	-	-	-
Lack of clean water	155	0.26	-	-	-
Lack sanitary toilet	155	0.34	-	-	-
General equip. index	152	3.11	0.87	0	5
Child equip. index	153	1.63	0.57	0	0

Table 12: Impact of Community Health Services on Child Malnutrition in Rural Areas 1997-98

Age (months)	-0.093	-0.092	-0.093
	(12.63)	(-12.55)	(-12.12)
Age^2	0.0014	0.0013	0.0013
	(10.60)	(10.45)	(10.16)
Age^3	-0.000006	-0.00006	-0.00006
	(-9.33)	(-9.14)	(-8.94)
Mother's height (cm)	0.039	0.040	0.040
	(9.73)	(9.98)	(9.68)
Mother's height missing	0.123	0.111	0.108
	(1.13)	(1.05)	(1.01)
Father's height (cm)	0.038	0.038	0.039
	(7.11)	(7.18)	(7.07)
Father's height missing	0.015	0.013	0.023
	(0.22)	(0.19)	(0.34)
Female child	0.147	0.149	0.153
	(3.86)	(3.86)	(3.84)
Log mother's years schooling	-0.121	-0.108	-0.113
	(-3.45)	(-3.03)	(-3.26)
Log father's years schooling	0.043	0.044	0.035
	(0.91)	(0.95)	(0.73)
Log per capita expenditures	0.303	0.290	0.283
	(5.87)	(5.36)	(5.37)
Buddhist	-0.012	-0.024	-0.014
	(-0.20)	(-0.38)	(-0.22)
Catholic	-0.237	-0.231	-0.288
	(-2.78)	(-3.11)	(-4.32)
Protestant	-0.484	-0.457	-0.501
	(-2.89)	(-2.74)	(-2.54)
Other religion	-0.078	-0.115	-0.153
	(-0.43)	(-0.63)	(-0.77)
Chinese	0.312	0.327	0.380
	(0.82)	(0.86)	(1.11)
Ethnic Minority	-0.030	-0.018	-0.007
	(-0.35)	(-0.22)	(-0.09)
Distance Prov. Hosp.	-0.0010	-0.0008	-0.0009
	(-1.09)	(-0.88)	(-0.93)
Distance State Pharm.	-0.0029	-0.0028	-0.0033
	(-2.32)	(-2.23)	(-2.69)
Distance Priv. Phar.	-0.0078	-0.0075	-0.0051
	(-1.74)	(-1.76)	(-1.23)
Diarrhea cited as heath risk	-	-0.064	-0.071
		(-1.17)	(-1.34)
Commune health center variable			
(a) unsanitary toilets	-	-0.106	-0.109
		(-1.83)	(-1.89)
(b) general equipment index	-	-	0.028
			(0.082)
(c) child equipment index	-	-	0.112
			(2.42)