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Young Lives
An International Study of Childhood Poverty

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Young Lives, Department of International Development, University of Oxford, Oxford OX1 3TB, UK

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Department of International Development
University of Oxford
3 Mansfield Road
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Tel: +44 (0)1865 281751
Fax: +44 (0)1865 281801
E-mail: younglives@younglives.org.uk
Web: www.younglives.org.uk

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Abstract

While the Ethiopian national emergency and food security programmes support farmers hit by area-wide shocks such as crop failure brought about by drought, insects and pests, idiosyncratic shocks such as illness and death of household member, loss of assets and separation of family or divorce are not covered by any of the current programmes. In the absence of social assistance programmes to support vulnerable households, these idiosyncratic shocks may lead to serious malnutrition among poor children.

Using longitudinal data of children collected at the age of 1 and 5 years (Young Lives younger cohort data), we examined the existence of permanent consequences of early childhood malnutrition and recovery of children from their early childhood malnutrition plus the persistent effect of pre-natal and post-natal economic shocks on child health and nutritional achievement, as measured by z-score of height-for-age and log of height of 5-year-old children. We employed OLS, instrumental variable (IV) and generalised method of moment estimation methods controlling for community fixed effects.

Our results confirmed the existence of permanent consequences of early childhood malnutrition and also the potential for the strong recovery of children from their initial early malnutrition. We also found significant effects on z-score of height-for-age and log of height, not only for post-natal economic shock but also the pre-natal economic shocks, implying the long-term consequence of shocks on children's height.

In addition to area-wide shocks including crop failure brought about by drought, insects and pests, we found that idiosyncratic shocks such as separation of family, death of breadwinners and unavailability of food are also important determinants of malnutrition. Although area-wide economic shocks are very important and it would be good for the government to focus more on them, idiosyncratic shocks also have a considerable contribution to make to the improvement of children's z-score of height-for-age and consequently to the reduction of stunting and severe stunting in Ethiopia. Therefore, it is still worthwhile to ensure that government assistance programmes cover idiosyncratic shocks such as death and illness of household members and separation of family or divorce. Also, since rural children are more vulnerable to economic shocks than urban children, it would be beneficial for social assistance programmes to focus more on rural areas.

Keywords: economic shocks, malnutrition, Ethiopia.

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The Author

Tassew Woldehanna is an Associate Professor in Economics at the School of Economics, Addis Ababa University and Senior Research Fellow at the Ethiopian Development Research Institute, the Young Lives research partner in Ethiopia. He is a development economist mainly involved in poverty and related research. He is currently Principal Investigator for Young Lives in Ethiopia.

About Young Lives

Young Lives is an innovative longitudinal study investigating the changing nature of childhood poverty. Young Lives is tracking 12,000 children in Ethiopia, India (Andhra Pradesh), Peru and Vietnam over 15 years through a quantitative survey and participatory qualitative research, linked to policy analysis. Young Lives seeks to:

- improve understanding of the causes and consequences of childhood poverty and to examine how policies affect children's well-being
- inform the development and implementation of future policies and practices that will reduce childhood poverty.

Young Lives is a collaborative partnership between research and government institutions in the 4 study countries, the University of Oxford, the Open University, other UK universities, and Save the Children UK.

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1. Introduction

Reductions in child mortality and episodes of illness are often considered main indicators of social development. As a result, one of the targets of the United Nations Millennium Development Goals (MDGs) is reducing child and infant mortality rates by two-thirds. In the Ethiopian context, the target set by the Ethiopian national survival strategy is to cut the under-5 mortality rate from 140 to 85 per 1,000 and the infant mortality rate from 97 to 45 per 1,000 births between 2005/06 and 2009/10 (MoFED, 2006a, 2006b). Ethiopia therefore has to lower the mortality rate substantially if it is to achieve the MDGs; nutritional achievement of children is key to this. Stunting (long-term nutritional achievement) is therefore also considered an indicator of social development. In this connection, one main question that remains to be answered is ‘what are the mechanisms of reducing stunting and child mortality in Ethiopia?’

In Ethiopia households are commonly hit by area-wide shocks such as drought and crop failure and also idiosyncratic shocks such as illness and death of household members, increase in food prices, and loss of employment. However, while these shocks are common in Ethiopia, there is no clear evidence to what level the shocks have persistent effect on children’s nutritional achievements.

Therefore, determining the long-term consequences of shocks on children’s nutritional achievement at a later period requires careful analysis. Analysis of nutritional achievements and childhood mortality is also useful in identifying health programmes that are effective in reducing child mortality.

According to Ethiopia’s Health Sector Development Programme (FMoH, 2005), the major causes of child mortality are pneumonia, neonatal conditions, malaria, diarrhoea, measles, malnutrition and HIV/AIDS. In order to reduce child mortality, therefore, ways have to be found to effectively improve the sanitation, nutritional and health-seeking behaviour of children in the country. Although improvements in nutrition achievement in Ethiopia over the last 10 years have been observed, episodes of illness have increased and health service consultations have decreased over the same period (Woldehanna et al. 2008b). Reducing child mortality may therefore be problematic. Hence studying the underlying causes of episodes of illness, health-seeking behaviour, and malnutrition is crucial to understand more about the underlying causes of child mortality.

In developing countries, economic shocks or crises have been shown to negatively impact child health (Paxson and Schady 2004; Hill et al. 1993; and Pongou et al. 2005). Many of these studies have been mainly concerned with the health effects of economic downturns in the short term (Dercon and Hoddinott 2003) and at household level (Behrman and Rosenzweig 2004; Haddad et al. 2003). Obviously shocks can have short-term effects on child growth, but as long as social assistance programmes are in place and effective (Yamano, Alderman and Christiansen 2005), a one-time economic shock should not have a long-term impact on children’s nutritional achievements. In this regard, there are no studies so far conducted in Ethiopia regarding the long-term consequences of shocks.

The broad aims of this paper are, first, to examine the existence of permanent consequences of early childhood malnutrition and recovery of children from their early childhood malnutrition and, second, to assess the persistent effect of pre-natal and post-natal economic shocks on demand for child health and nutritional achievement as measured by z-score of height-for-age and log of height of 5-year-old children. Specifically the paper has the following objectives:

1. to analyse the existence of permanent consequences of early childhood malnutrition and recovery of children from their early childhood malnutrition;
2. to assess the persistent and lingering effect of pre-natal and post-natal economic shocks on demand for child health and nutritional achievement as measured by z-score of height-for-age and log of height of 5-year-old children;
3. to examine the relative importance of area-wide (covariant) and idiosyncratic economic shocks on the nutritional achievements of 5-year-old children; and
4. to draw policy implications for Ethiopia's social protection policy.

The reduced form demand model for child health and nutritional achievement is specified that can be derived from a household's utility maximisation problem subject to health and nutritional achievement production functions, income and time constraints (Becker 1965; Grossman 1972a,b; Cropper 1977; Rosenzweig and Schultz 1983)[1]. We used two rounds of Young Lives survey data of the Younger Cohort (1- and 5-year-old cohort) which follows 2,000 such children every three to four years starting from 2002. Both Round 1 data (conducted in last quarter of 2002) and Round 2 data (collected in last quarter 2006) contain information on height-for-age of the 1-year- and 5-year-old children, respectively, and on the incidence of economic shocks that hits households up to five years before the surveys. The information on economic shocks that hit a household before and after the child was born helped us to assess the short- and long-term effect of economic shocks on children's nutritional achievement and stunting. The detailed information on households' nutritional achievements, initial wealth and household composition also enabled us to find the effect of economic shocks, controlling for the initial conditions of the particular household in which the children lived.

The rest of the paper is organised as follows. Section 2 briefly reviews the literature on determinants of malnutrition and the role of shocks. Methodologies of the study and data sources are described in Section 3. Section 4 presents the results along with discussions. Concluding remarks are provided in Section 5.

2. Literature review

2.1 Impact of child malnutrition

Malnutrition is currently the single leading cause of the global burden of disease (Ezzati et al. 2002) and has been identified as the underlying factor in about 50 per cent of deaths of children under 5 years of age in developing countries (Frimpong and Pongou 2006; Black et al. 2003). Nearly a third of these children are stunted and a quarter are underweight, a situation which is expected to worsen in some parts of the world including sub-Saharan Africa (Frimpong and Pongou 2006; De Onis et al. 2000).

1 See Behrman and Deolalikar (1988, pp. 639-47) for detailed discussions on derivation of reduced form demand for health and nutritional achievement and health production function.

Malnutrition in children leads to permanent effects and to their having diminished health capital as adults (Strauss and Thomas 1998; Alderman, Hoddinott, and Kinsey 2006; Linnemayr et al. 2008). Young children are believed to be especially vulnerable to shocks that lead to growth faltering (Smith et al. 2003; Beaton 1993; Martorell et al. 1994, 1998). They are particularly susceptible to shocks in their first two to three years of life, and there are several possible reasons for this (Omitsu and Yamano 2006; Martorell 1999; Behrman, Alderman, and Hoddinott 2004). First, the growth rate is highest in infancy, thus adverse factors have a greater potential for causing retardation at this time. Second, younger children have higher nutritional requirements per unit (e.g. kilogram) of their body weight and are more susceptible to infections. Third, they are also less able to make their needs known and are therefore more vulnerable to the effects of poor care practices (Omitsu and Yamano 2006).

There is a growing literature that explores whether health shocks have permanent or transitory effects on child health status. This is especially important in light of the epidemiological evidence that stature by age 3 is strongly correlated with attained body size at adulthood (Dercon and Hoddinott 2003; Martorell 1995, 1999). Children who experience slow height growth tend to delay school enrolment; are found to perform less well in school; score poorly on tests of cognitive function; have poorer psychomotor development and fine motor skills; interact less frequently in their environment; fail to acquire skills at normal rates; and tend to have lower activity levels (Martorell 1999, Grantham-McGregor et al. 1997, 1999; Johnston et al. 1987; Lasky et al. 1981; Dercon and Hoddinott 2003).

Moreover, the detrimental effects of slow height growth during early childhood may be long lasting. Alderman et al. (2002) found that in Zimbabwe, lowered stature as a pre-schooler following exposure to the 1982-84 drought resulted in a permanent loss of stature of 2.3 cm, a delay in starting school of 3.7 months, and 0.4 grades less of completed schooling. The combined effect of these factors was estimated to reduce lifetime earnings by 7 per cent (Yamano et al. 2005). Hoddinott and Kinsey (2001) found that children aged 12 to 24 months lost 1.5-2cm of growth in the aftermath of droughts in Zimbabwe in 1994 and 1995, although they did not find a similar negative loss among older children. Yamano et al. (2005) also found a negative shock on child growth in height only among children aged 6 to 24 months, not older children (Omitsu and Yamano 2006). Using longitudinal data with information at national and sub-national levels, Pelletier and Frongillo (2003) found a significant relationship between child mortality and weight-for-age after controlling for socioeconomic factors and changes in policy.

Child height has proven to be an informative and longer-term indicator of nutritional status of children (Waterlow et al. 1977; Falkner and Tanner 1986). While height is clearly determined by the time an individual reaches adulthood (apart from shrinking later in life), there is some debate in the literature about the extent to which adult stature is completely determined by the time the child has progressed beyond early childhood (Strauss and Thomas 1998). Nevertheless, to the extent that height does affect labour outcomes, it will clearly reflect returns to human capital investments made during early childhood and, perhaps, return to strength (Strauss and Thomas 1998).

Dercon and Hoddinott (2003) found adult height to be correlated with earnings and productivity, poorer cognitive outcomes and premature mortality due to increased risk of cardiovascular and obstructive lung disease. An increasing body of evidence links adult weight or Body Mass Index (BMI) to agricultural productivity and wages (Dasgupta 1993; Dercon and Krishnan 2000; Strauss and Thomas 1998; Pitt, Rosenzweig and Hassan 1990). Low BMI is correlated with a large number of health-related indicators, including early onset of chronic conditions and increased risk of premature mortality (Waaler 1984; Higgins and

Alderman 1997). Taller women are also found to experience fewer complications during childbirth, typically have children with higher birth weights, and experience lower risks of child and maternal mortality (Strauss and Thomas 1998).

Weight varies in the short term and so provides a more current indicator of nutritional status (Strauss and Thomas 1998). Since a light person may also be small, and thus not underweight given height (and, conversely, a heavy, tall person may not be overweight), nutritionists have found it convenient to analyse weight given height.

2.2 Determinants of child malnutrition

Malnutrition in children has been shown to lead to permanent effects and to result in diminished health capital as adults. Linnemayr et al. (2008) further argued that there may also be an intergenerational cycle of malnutrition as a worse health capital stock may be passed on from adults to their children. Thomas and Frankenberg (2002) argued that there is ample evidence at the macroeconomic as well as the microeconomic level that health is positively associated with other dimensions of economic prosperity and that causality goes both directions: people with higher income invest more in their human capital and become healthy while healthier workers tend to be more productive and receive higher earnings.

Case and Paxson (2002) examined parental behaviour in both the pre-natal period and childhood in an attempt to document the ways in which parental behaviour and socioeconomic status affect children’s health. They presented evidence on the correlation of this behaviour with income and parents’ socioeconomic status, and on the ways in which parents’ actions affect children’s health. They concluded that while health insurance coverage and advances in medical treatment may be important determinants of children’s health, they cannot be the only pillars: protecting children’s health also calls for a broader set of policies that target parents’ health-related behavior.

Linnemayr et al. (2008) empirically showed that mothers’ education and access to clean drinking water are important determinants for the nutritional status of children. They found evidence of a positive impact of female education at the primary level on nutrition.

Frimpong and Pongou (2006) used data from Ghana and concluded that malnutrition could be associated with the healthcare system and maternal factors. They further argued that it is also important to note that macro-level economic growth, which may lead to improvements in household economies, may not necessarily translate into improvement in child health and nutrition. The findings from the study reiterate the importance of interventions that address characteristics associated with specific populations within communities. Policy and interventions should emphasis individual, community and governmental level approaches. Empowering parents with necessary tools and information concerning the importance of proper nutrition could potentially overcome differences in occupation, employment status and mechanisms of decision-making that negatively impact child malnutrition.

By applying the conditional or quasi-reduced nutrition demand approach to household data from three consecutive welfare monitoring surveys over the period 1996–98, Christiaensen and Alderman (2004) identified household resources, parental education and food prices as key determinants of chronic child malnutrition in Ethiopia. Though largely consistent with findings from other malnutrition studies, they claimed that their empirical results, with respect to the community sanitation, health, and communication infrastructure, are less robust, possibly because of confounding factors such as the quality of healthcare or lack of variation in the variables. Their results further indicated that it is quite plausible that maternal nutritional knowledge, as measured by the community’s diagnostic capability of growth faltering, also plays an important role in the determination of child malnutrition. For example, increasing the community's ability to rightly diagnose stunted and non-stunted children, respectively, as stunted and non-stunted by 25 percentage points has similar effects to providing at least one female adult per household with primary education. When community-based programmes to enhance knowledge are implemented in addition to the more general development interventions, such as income growth and increased primary schooling, the authors anticipated that chronic child malnutrition in Ethiopia could be reduced by up to 31 per cent.

Using quintile regressions, Aturupane, Deolalikar, and Gunewardena (2006) explored the effects of variables such as a child's age, sex and birth order; household expenditure per capita; parental schooling; and infrastructure on child weight and height at different points of the conditional distributions of weight and height. They found that OLS estimates of the determinants of child weight and height, which effectively estimate the effects of intervention variables at the mean, can be misleading. The results of their quintile regressions indicated that the belief that increases in income are associated with strong nutritional improvements is generally true only at the upper end of the conditional weight and height distributions. Over much of the lower end, household expenditure per capita is not a significant determinant of child weight or height. What this means is that income-generating interventions, while very important for a number of other social outcomes, are unlikely to be effective in raising the nutritional levels of those at the greatest risk of malnutrition. They also found evidence asserting discrimination against girls at the lower end of the weight and height distribution, suggesting that even though on average girls are not nutritionally disadvantaged relative to boys, among children at the highest risk of malnutrition, girls are disadvantaged relative to boys. Policy interventions to address child malnutrition need to be sensitive to this reality, and need especially to target girls at high risk of under-nutrition.

The quintile regressions further show that most of the explanatory variables of child malnutrition considered in their study (such as parental education, electricity access, and even availability of piped water) tend to have larger and more significant effects on child weight and height at the higher quintiles than at the lower quintiles. The implication for policy is that since these general interventions are not as effective in raising the nutritional status of children in the lower tail of the conditional weight and height distributions, it may be important to target direct nutritional interventions, such as food supplementation programmes to at-risk children (Aturupane, Deolalikar, and Gunewardena 2006).

2.3 Shocks and child malnutrition

The available empirical evidence to date on the effect of income shocks on child growth suggests pervasive growth retardation (Martorell 1999; Hoddinott and Kinsey 2001). As such temporary income shocks may cause permanent damage to children's future welfare and cognitive abilities (Yamano et al. 2005). Using three nationally representative surveys conducted during 1995-96, Yamano et al. (2005) found that income shocks, measured by crop damage, reduce child growth substantially, especially among children aged 6 to 24 months. Children in this age group may lose 1cm growth over a six-month interval when half of their crop area is damaged. As early child growth faltering may cause permanent damage, appropriate insurance mechanisms to help households protect their consumption from income shocks are crucial. This holds especially true in Ethiopia, where stunting among pre-school children has persisted at alarming levels over the past decades and where droughts are a recurrent phenomenon.

The common feature across both child and adult studies is that temporary shocks can have permanent effects (Dercon and Hoddinott 2003). As such, conventional studies that focus on the short-term welfare losses associated with reduced consumption following shocks that are not fully insured against may understate the full consequences of these shocks. Dercon and Hoddinott (2003) explored the impact of shocks on health status, making particular use of evidence from Ethiopia and Zimbabwe on the impact of droughts and other serious shocks. They found that health status, as measured by height and body mass, is affected by these shocks, suggesting that they are imperfectly insured against. Livestock and other assets play a role in mitigating these shocks. The evidence also suggests that poor people are using their body as a store of energy, in ways consistent with poorly functioning asset and food markets. This implies welfare losses and puts them at risk of further ill-being. The authors further revealed that the impact of shocks is not uniform within the household. Younger pre-schoolers are more adversely affected than older pre-schoolers. Adult women are more often adversely affected than adult men. Among adult women, daughters of the household head are more vulnerable than other women. Shocks can have long-term consequences, reducing final attained stature and schooling outcomes, which affect adversely the employment prospects and productivity of these young people. Further, taller (and better-educated) women have, on average, taller (and healthier) children, and so the impact of these transitory shocks may be felt for several generations.

Economic shocks at birth have lasting impacts on children's health several years after the shock. Akresh, Verwimp, and Bundervoet (2007) calculated height-for-age z-scores for children under age 5 using data from a Rwandan nationally representative household survey conducted in 1992. They exploit district and time variation in crop failure and civil conflict to measure the impact of exogenous shocks experienced by children at birth on their height several years later with the use of a two-by-two difference-in-differences table. They found that boys and girls born after the shock in regions experiencing civil conflict are both negatively impacted with height-for-age z-scores 0.30 and 0.72 standard deviations lower, respectively. Conversely, only girls are negatively impacted by crop failure, with these girls exhibiting 0.41 standard deviation lower height-for-age z-scores and the impact worsening for girls in poor households.

Similarly, using two nationally representative surveys from Nicaragua conducted during 1998 and 2001, Omitsu and Yamano (2006) found that children who experienced a shock (Hurricane Mitch) when they were younger than 2.5 years old have 0.35 points lower height-for-age z-scores and have 6.6 per cent higher probability of stunting than expected in 2001, more than two years after experiencing the shock. The authors used pooled cross-section models to identify the impacts of the Hurricane Mitch. Dividing the children under 5 into two groups (younger and older than 2.5 years old in the two surveys) and estimating determinants of height-for-age z-score and stunting in the pooled cross-section models, they found results that are consistent with earlier studies which indicate that children aged 2 to 3 years old are vulnerable to economic shocks.

Using household panel data that include directly solicited information on economic shocks and employing household fixed-effects estimation, Carter and Maluccio (2003) explored how well households cope with shocks by examining the effects of shocks on child nutritional status. Unlike in the idealised village community, some households appeared unable to insure against risk, particularly when others in their communities simultaneously suffered large losses. Households in communities with more social capital, however, seemed better able to cope with weather shocks.

2.4 The Ethiopian case

Several surveys were conducted to monitor the evolution of child malnutrition in Ethiopia (Woldehanna et al. 2008b for details of the results). The first striking observation is the sheer magnitude of child malnutrition in Ethiopia; the incidence of underweight children has been consistently about 45 per cent, much larger than the average incidence of 33 per cent underweight children in sub-Saharan Africa in the 1990s (Christiaensen and Alderman 2004). Similarly, surveys in Ethiopia have found more than half the children under 5 years old to be stunted, with stunting rates most often reaching more than 60 per cent, while the average prevalence of children stunted for 19 sub-Saharan African countries in the mid-1990s was 39 per cent (Christiaensen and Alderman 2004).

There are several possible explanations for the high rate of child malnutrition in Ethiopia. Household resources, parental education and food prices are identified as key determinants of chronic child malnutrition in Ethiopia while maternal nutritional knowledge, and the community's diagnostic capability of growth faltering, also play an important role (Christiaensen and Alderman 2004).

Shocks are also found to negatively affect health status in Ethiopia. Making particular use of evidence from Ethiopia on the impact of droughts and other serious shocks, Dercon and Hoddinott (2003) found that health status, as measured by height and body mass, is affected by these shocks. Similarly Yamano et al. (2005) showed that income shocks, measured by crop damage, reduce child growth substantially, especially among children aged 6 to 24 months and suggested that the average value of food aid received in a community has indeed a large positive effect on early child growth.

Gilligan and Hoddinott (2007) studied the impact of food aid programmes on household food security and welfare and nutrition. They found that food aid programmes such as general food distribution or food-for-work have at most a small impact on food consumption or nutrition and often only a short-term effect on aggregate consumption, while EGS (Employment Generation Scheme) programmes and receiving free food raises growth in food consumption but negatively impacts food security; they therefore suggest that food aid results in accumulated and persistent effects.

The studies cited hitherto unambiguously suggested that shocks can have a detrimental effect on child growth, but as long as there is some kind of social protection programme effectively in place, the long-term effects of shocks can be deterred. There is, however, a significant gap in the literature with regard to studies conducted in Ethiopia that relate children's nutritional achievements, the impact of economic shocks and the role played by social protection programmes. This particular study intends to bridge this gap by investigating the persistent effect of pre-natal and post-natal economic shocks on nutritional achievement of children amid social assistance programmes that existed more than a decade ago.

3. Method

3.1. Econometric model

As an indicator of demand for child health, the nutritional achievements of 5-year-olds are analysed using an econometric model that can be derived from a household's of utility maximisation subject to income and biological health production constraints (Grossman 1972a,b; Cropper 1977; Rosenzweig and Schultz 1983; Behrman and Deolalikar 1998)[2]. The dependent variables are z-score of height-for-age and log of height in centimetre as well as stunting and severe stunting measured at around the age of 5 years. In order to have a clear picture of the effect of shocks on recovery of children from their stunting, we have also analysed the changes in child's height-for-age or changes in z-score of height-for-age or change in log height between the age of 1 and 5 years.

In addition to the pre-natal and post-natal economic shocks (that is, shocks that hit families before and after the birth of the child), various other independent variables are also used as controlling factors including initial nutritional achievements, household wealth, household composition in Round 1. The lagged demand for child health (for example, z-score height-for-age, log of height in Round 1) is expected to help to capture lagged effects of health inputs and nutritional achievement, which could be endogenous because of the possible correlation with the error terms. The other initial conditions and economic shocks are clearly exogenous variable in our setting as the dependent variable is nutritional achievement of 5-year-old children who have not yet started to supply labour for the household that could influence household income. The pre-natal and post-natal economic shocks are included as explanatory variables because they are expected to affect health and nutrition inputs and household income. Two reduced form econometric models of demand for child health were specified to enable us to examine the existence of permanent consequences of early childhood malnutrition and recovery of children from their early childhood malnutrition as well as the persistent effect of pre-natal and post-natal economic shocks on demand for child health and nutritional achievement.

Specifically, the following equations were specified:

$$\left(Z\ score\ of\ \frac{H}{A}\right)_t = \beta_1 + \beta_2\left(Z\ score\ of\ \frac{H}{A}\right)_{t-1} + \beta_3 X_{t-1} + \beta_4 S_{t-1} + \beta_5 S_{t-2} + \varepsilon_{2t} \tag{3.1}$$

$$\ln H_t = \beta_1 + \beta_2 \ln H_{t-1} + \beta_3 X_{t-1} + \beta_4 S_{t-1} + \beta_5 S_{t-2} + \varepsilon_{2t} \tag{3.2}$$

Where *t* stands for time, Δ stands for change, H/A is height-for-age, $\left(Z\ score\ of\ \frac{H}{A}\right)_t$

$\left(Z\ score\ of\ \frac{H}{A}\right)_{t-1}$ is z-score of height-for-age at time *t* and *t–1*, respectively;

$\ln H_t$ is natural logarithm of height in centimetre, $\ln H_{t-1}$ is natural logarithm of height in centimetre at time t-1, H is height of the child in centimetres, H_{t-1} is lagged height of the child in centimetres; A stands for the age of the child in months; X_{t-1} lagged values of covariates other than those included in the regression; S_{t-1} is a vector of post-natal economic shocks

2 See Behrman and Deolalikar (1988, pp. 639-47) for detailed discussions on derivation of reduced form demand for health and nutritional achievement and health production function.

and S_{t-2} is a vector pre-natal economic shocks (at most eight years before Round 2 survey); β are parameters to be estimated, *t* is time, and ε is the error term.

The error terms can have three components: household or home environment effect (ε_{2h}), child specific effect (ε_{2c}), and random component (ε_{2r}). The pre-natal and post-natal economic shock variables (i.e., S_{t-2} and S_{t-1}) included in the model are drought, crop failure, breadwinners' illness, death of household members, theft, divorce, lose of employment, decline in output prices and increase in input prices, while covariates (X_{t-1}) include household socio-economic characteristics such as household composition, household wealth and education. In the regressions where the dependent variables are standardised (such as z-score of height-for-age or stunting), we did not include age of the child as explanatory variable because the children considered in this paper are around the same age (1 year in Round 1 and 5 years in Round 2) and hence there is little variation in age among the children. Moreover using the same set of independent variables, we run a probit model of probability of a child being stunted and severely stunted.

There is potentially a problem of endogeniety in these set-ups because human capital formation process is a multistage process (Cunha et al. 2006), and at least two stage in our set-up (Glewwe, Jacoby and King 2001; Alderman, Hoddinott and Kinsey 2006). Considering equation 3.1 and 3.2 as stage two of the human capital formation process, the first stage to equation 3.1 and 3.2 can be specified, respectively as:

$$\left(Z\ score\ of\ \frac{H}{A}\right)_{t-1} = \alpha_1 + \alpha_z Z_{t-2} + \alpha_x X_{t-1} + \alpha_{s1} S_{t-1} + \alpha_{s2} S_{t-2} + \varepsilon_{1t}$$

$$\ln H_{t-1} = \alpha_1 + \alpha_2 Z_{t-2} + \alpha_3 X_{t-1} + \alpha_4 S_{t-1} + 1_5 S_{t-2} + \varepsilon_{2t}$$

where Z_{t-2} is a vector of variables that affect the initial height-for-age which are not included in X_{t-1}, S_{t-2} , and S_{t-1}. Hence (z-score of H/A)$_{t-1}$ is potentially correlated with ε_{2t} because of the possible correlation between the error terms ε_{1t} and ε_{2t}.

To elaborate further, both of the error terms ε_{1t} and ε_{2t}.have three components: ε_h, representing aspects of the home environment which influence nutrition and are common to all children in the household (this would capture, for example, parents' knowledge regarding good child care practices); ε_c captures child specific effects such as innate healthiness; and ε_r is a white noise disturbance term. The basic difficulty with a least squares regression of equation 3.1 is the likelihood that height-for-age in period t-1 [(Z-score of H/A)$_{t-1}$] is correlated with ε_{2t} because of possible correlation between (Z-score of H/A)$_{t-1}$ and ε_H or between (Z-score of H/A)$_{t-1}$ and ε_c mediated through either the correlation of household effects or individual effects or both.

Such correlations could arise for several reasons. For example, a child with high genetic growth potential will be, relative to her peers, taller in both Round 1 and 2. Conversely, children with innately poor health may be more likely to die between Round 1 and 2 and even remain unborn due to abortion, miscarriage or still-birth, leaving a selected sample of individuals with, on average, better genetic growth potential. Parents observing outcomes in period 1 may respond in a variety of ways. For example, faced with a short child in period 1, parents might subsequently allocate more food and other health resources to that child. In any of these cases, estimates of β_2 using ordinary least squares could be biased. The possible solutions to this problem is to use an instrumental variables regression with the variables affecting child health at a very early stage in life (at time t-1) acting as instruments for the lagged measure of anthropometric status, but not correlated directly with outcome at time t (Round 2).

3.2. Data source and description of datasets

We used longitudinal survey data of Young Lives collected in 2002 (Round 1) and 2006 (Round 2) from the younger cohort when sample children were at the age of 1 and 5 years, respectively. The pre-natal economic shocks are collected during Round 1 survey while the post-natal economic shocks are obtained from the Round 2 survey. For the outcome variable, we used z-score of height-for-age and natural logarithm of height to see the long-term effect of shocks. As a robustness check, we also ran two versions of probit models in which the dependent variables are stunting and severe stunting. Moreover, in order to see the recovery of children from their malnutrition, we regressed changes in height-for-age and changes on z-score of height-for-age on pre-natal and post-natal economic shocks, with and without initial wealth status of the caregivers.

3.3. Description of variables

Wealth and asset indices. Table 3.1 presents levels and percentage changes of asset and wealth indices between the two survey rounds. Wealth and asset indices were constructed using various assets and services that the households have access to. While the wealth index is constructed from final wealth excluding assets used as inputs into production such as land, livestock and farm implements, the asset index includes final wealth plus those assets used as inputs in production and other equipments used for non-farm activities. The two indices are constructed in such a way to lie between 0 and 1 (see Woldehanna 2009 for the detail of the construction of the wealth and asset index).

Both the wealth and asset indices have increased in Round 2 compared to that of Round 1. The increments are statistically significant for both indices at less than 1 per cent level although the magnitude of the change was higher for the wealth index than the asset index. A comparison of the wealth and asset indices for urban and rural areas shows that there was a statistically significant increase in these indices in Round 2 compared with Round 1. Similar comparisons by region show that asset ownership as reflected by the asset index has increased in Round 2 compared with Round 1, but the result is not statistically significant for the SNNP region in the older cohort sample. While a comparison of wealth index by region between the two rounds indicates a statistically significant increase for four of the five regions covered by the survey, a statistically significant decrease is observed for Tigray (Woldehanna et al. 2008a), mainly due to a reduction in access in sanitation facilities and safe water, perhaps due to the lack of maintenance of the services.

Table 3.1 *Wealth and asset index by urban/rural and region*

	Rural			Urban			Total		
	R1	R2	% change	R 1	R2	% change	R1	R2	% change
Wealth index	0.08	0.13	60.39***	0.33	0.37	12.84***	0.18	0.23	25.42***
Asset index	0.21	0.26	21.34***	0.12	0.16	26.93***	0.18	0.21	21.02***

R1 = Round 1; R2 = Round 2; % change refers to (R2-R1)/R1 times 100

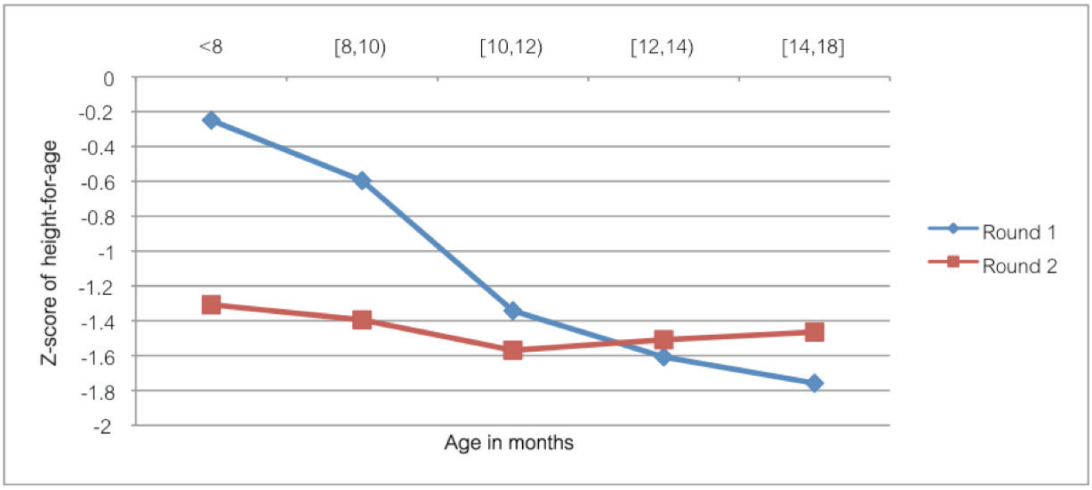
Source: Woldehanna et al. (2008a)

In our definition, a household with less than 0.2 wealth index is considered as extremely poor. In the Younger Cohort, the percentage of children living in households with a wealth index below 0.2 decreased from 42.0 to 32.4 which represents an improvement over time by about 23 per cent. This difference is statistically significant at less than 1 per cent level. The differences are similar for the percentage of children living in households with an asset index less than 0.2, with the change over time being slightly larger (about 29 per cent) but still statistically significant at the 1 per cent level (Table 3.1). A comparison of the percentage of children living in households below a wealth index of 0.2 by region also shows similar results except for Tigray where the difference was not statistically significant. The improvement is the largest for Addis Ababa (92.31 per cent) compared with other regions and it is larger for urban areas (44.29 per cent) compared with rural areas (16.21 per cent). A similar comparison of asset index by location shows, however, that there was no statistically significant change for urban areas. Moreover, the percentage of children living in households with asset index below 0.2 has decreased for four of the five regions, the exception being SNNP for which the difference was not statistically significant (see Woldehanna et al. 2008a for details).

Malnutrition. We calculated the main statistics that is used in the literature to measure malnutrition among children, namely, height-for-age and stunting for the younger cohort (1- and 5-year-old children). In order to measure nutritional achievements such as stunting, severe wasting and z-scores of nutritional achievements of the 1- and 5-year-old children, we used the table developed by WHO made public in 2006 (WHO 2007; WHO Multicentre Growth Reference Study Group, 2006) based on Brazil, Ghana, India, Norway, Oman and USA as a reference population. We categorised children's' nutritional achievements into three based on the z-score values: children with a z-score greater than or equal to -2 are considered as normal children, that is, children not stunted; while children with a z-score less than -2 reflect stunted; and those with a z-score of less than -3 reflect severely stunted.

As can be seen in Table 3.2, stunting declined significantly, both in terms of magnitude and in the statistical sense as indicated by the student t-tests. According to the statistics, the severe form of height-for-age has declined substantially. This is an impressive accomplishment given the time elapsing between the two data collection periods, which can be attributed to improvement in the wealth level of households and increased access to health services. One should, however, take note of the fact that these measures were quite high in Round 1. Thus what we observe could easily be one of recovery of child nutrition status. Tables 3.2a and 3.2b as well as Figure 1 also show that of the children who were not stunted at aged 1, 85 per cent remain not stunted and 15 per cent became stunted at the age of 5 years. On the other hand, of the children who were stunted at age 1, 41 per cent of them recovered from their stunting, while the rest, 59 per cent, remain stunted. Of those severely stunted, 75 per cent recovered. These figures indicate that the rate of recovery is higher than the rate of deterioration for both stunting and severe stunting.

Figure 1 *Mean z-score of height-for-age by age of child*



When we consider the split in terms of rural-urban location, we see relatively larger percentage points of improvement for children living in rural areas. However, caution should be taken in interpreting this result as well, since children living in rural areas started with a relatively higher incidence of malnutrition in Round 1. Moreover, the percentages for incidence of malnutrition are still higher in rural areas.

Table 3.2 *Malnutrition among 1- and 5-year-old children*

	Total			Rural			Urban		
	R1	R2	% change	R1	R2	% change	R1	R2	% change
Stunted	34.84	31.33	-10.0**	41.34	36.41	-11.92**	25.03	23.65	-5.51
Severely stunted	15.46	8.22	-46.80***	19.2	10.63	-44.64***	9.83	4.6	-53.19***

R1 = Round 1; R2 = Round 2; % change= ((R1-R1)/R1))*100; *significant at 10%, ** significant at 5%, and *** significant at 1%

Source: Woldehanna et al. (2008a)

Table 3.2a *A matrix of recovery of children from stunting between 2002 and 2006*

	Not stunted 2006 (%)	Stunted 2006 (%)	Total 2006 (%)	Total N
Not stunted 2002	85	15	100	960
Stunted 2002	41	59	100	508
Total	70	30	100	1468

N = number of observations

Source: own computation; we excluded observation whose z-score growth are below -2 and above 2

Table 3.2b *A matrix of recovery of children from severe stunting between 2002 and 2006*

	Not severely stunted 2006 (%)	Severely stunted 2006 (%)	Total (%)	Total N
Not severely stunted 2002	95	5	100	1,295
Severely stunted 2002	75	25	100	173
Total	93	7	100	1,468

N = number of observations

Source: own computation; we excluded observation whose z-score growth are below -2 and above 2

Apart from female stunting (height-for-age z-score less than -2), malnutrition of children showed a decline between rounds for both genders that was more or less equal in magnitude (Table 3.3). The changes between the two rounds have also been statistically significant. Thus, the improvements in the nutritional status of children, whenever they occurred, were not gender biased.

Table 3.3 *Younger Cohort: Changes in the proportion of children malnourished by gender*

	Male			Female		
	R1	R2	% change	R1	R2	% change
Stunted	0.39	0.33	-16.4***	0.3	0.29	-0.6
Severely stunted	0.18	0.08	-54.4***	0.12	0.08	-33.7***

R1 = Round 1; R2 = Round 2; *significant at 10%, ** significant at 5%, and *** significant at 1%; N=Number of observations

Source: own computation

Table 3.4 reports the results for malnutrition outcomes by wealth index quartile among the younger cohort of the Young Lives data. Change in stunting showed insignificant changes between the two rounds. For the other outcome variables, the poorest 50 per cent of the sample have attained improvements in the children's malnutrition status as indicated by the reductions in the percentages of children below the cut-off point of -2 and -3 z-scores. It is also important to note that in every case except stunting, the percentage in the difference is larger for the poorest two quartiles (the poorest 50 per cent).

Changes in malnutrition indicators between the two rounds for younger cohort children categorised by education level of household head are provided in Table 3.5. It may seem surprising to see that there is little, if any, change for these indicators where the household head has post-secondary education. On the other hand, children that were under the severe malnutrition category have shown statistically significant improvements for all household heads with lower than post-secondary education, including the illiterate ones. One should, however, take into account the fact that for households with heads having post-secondary education, the incidence of severe malnutrition was relatively smaller than the others in Round 1. Moreover, the proportion of this category in the whole sample was also small. All the forms of malnutrition (except for female stunting – height-for-age z-score less than -2) showed an improvement for both genders that are more or less equal in magnitude (Woldehanna et al. 2008a). The changes between the two rounds have also been statistically significant. Thus, the improvements in the nutritional status of children, whenever they occurred, were not gender biased.

Table 3.4 *Changes in the proportion of stunted children between Round 1 and Round 2 by Round 1 wealth quartile*

	Quartile	R1	R2	% change
Height-for-age z-score < than – 2: (stunted)	1	0.43	0.43	0
	2	0.44	0.36	-18.2***
	3	0.32	0.29	-9.4
	4	0.2	0.17	-15
Height-for-age z-score < than -3: (severely stunted)	1	0.21	0.16	-23.8**
	2	0.2	0.09	-55***
	3	0.13	0.06	-53.8***

R1 = Round 1; R2 = Round 2

Source: own computation

Economic shocks. Various economic shocks that affect household well-being were observed during both Round 1 and Round 2. Those in the Round 1 survey are shocks that affected households in the five years before the Round 1 survey and hence these shocks are pre-natal shocks in the sense that they occurred before the index child was born. Shocks in the Round 2 survey are those that occurred after the child was born, but before the Round 2 survey.

Table 3.5 presents the incidence of shocks affecting households before and after the child was born, respectively. The highest incidence of shock observed before the child was born was for decrease in food availability followed by crop failure and, for urban areas, job loss. Among the shocks that occurred after the child was born are drought, crop failure, pests and diseases.

Table 3.5 *Descriptive statistics (mean values) of variables used in the regression*

	Rural	Urban	Total
Dummy for male child (1 if male and 0 otherwise)	0.53	0.53	0.53
Age of children in months in R1	12.4	12.3	12.4
Age of children in months in R2	62.3	62.5	62.3
Round 2 outcomes			
Change in height-for-age between R2 and R1	-4.57	-4.63	-4.59
Change in z-score of height-for-age between R2 and R1	-0.16	-0.24	-0.19
Z-score of height-for-age in R2	-1.63	-1.19	-1.45
Z-score of height-for-age in R1	-1.46	-0.95	-1.26
Height in centimetre in R2	102.99	105.19	103.87
Height in centimetre in R1	70.46	71.74	70.97
Natural logarithm of height in R1	4.25	4.27	4.26
Natural logarithm of height in R2	4.63	4.65	4.64
Height-for-age (age in months) for R2 data	1.66	1.69	1.67
Dummy for stunted child (r2_zhfa<-2)	0.36	0.24	0.31
Dummy for severely stunted child (r2_zhfa<-3)	0.11	0.05	0.08
Initial conditions (Round 1)			
Dummy for stunted child (r1_zhfa<-2)	0.41	0.25	0.35
Dummy for severely stunted child (r1_zhfa<-3)	0.19	0.1	0.16
Height-for-age (age in months) for R1 data	6.23	6.32	6.27
Wealth index for 1-year-olds in R1	0.08	0.33	0.18
Square of wealth index in R1	0.01	0.13	0.06
Number of children below 7 and above 65 years old	1.7	1.52	1.63
Number of children between 7 and 17 years old	1.33	1.3	1.32
Number of male family members > 17 and less than 65 years	1.03	1.16	1.09
Number of female family members > 17 and less than 65 years	1.1	1.41	1.22
Shocks after the child was born			
Dummy for illness	0.37	0.35	0.36
Dummy for death	0.08	0.14	0.11
Dummy for theft	0.17	0.09	0.14
Dummy for increased input prices	0.37	0.19	0.3
Dummy for decreased output prices	0.09	0.01	0.06
Dummy for death of livestock	0.38	0.07	0.26
Dummy for drought, crop failure, pests and diseases	0.39	0.05	0.25
Dummy for natural disaster including drought	0.63	0.07	0.41
Dummy for divorce or separation of family	0.04	0.06	0.05
Shocks before the child was born			
Dummy for decrease in food availability	0.54	0.34	0.46
Dummy for livestock death	0.3	0.05	0.2
Dummy for crops failure	0.61	0.08	0.4
Dummy for death/reduction in household members	0.07	0.06	0.07
Dummy for job loss/source of income/family enterprise	0.09	0.18	0.12
Dummy for divorce or separation	0.04	0.06	0.05

R1 = Round 1; R2 = Round 2

Source: own computation

In general, the most serious pre-natal economic shocks reported by the respondents are: (1) decrease in food availability; (2) crops failure; (3) death of livestock death, (4) job loss/source of income/family enterprise; (5) death of household members. Although they have very little perceived impact on child welfare, other reported shocks that occurred before the index child was born are crime, divorce or separation of family members, paying for child's education, and migration of family members were

The shocks that occurred after the index child was born (post-natal economic shocks) are: (1) illness and death of household members, (2) drought, (3) crop failure, (4) pests and diseases, (5) place employment shutdown or job loss, (6) natural disaster such as drought and flooding (7) divorce or separation of family, (8) death of livestock, (9) increased input prices, (10) decreased output prices, (11) theft and robbery.

Table 3.5 presents descriptive statistics of household composition and other variables used in the regressions for Round 1 and Round 2 surveys. The family size was 5.2 in 2002 during the Round 1 survey. After four years the family size increased to 6.7.

4. Results and discussion

We have estimated several versions of equations (3.1) and (3.2) to examine the existence of permanent consequences of early childhood malnutrition and recovery of children from their early childhood malnutrition as well as to assess the persistent effect of pre-natal and post-natal economic shocks on children's z-score of height-for-age and log of height in centimetres. In the estimation of the models, we used data of 1,860 children of 4.5 to 5.5 years old of which 1,119 live in rural areas and 741 in urban areas. First, we ran an instrumental variables estimation and generalised method of moments (GMM) estimation methods (*using ivreg2 command in Stata version 11*). We conducted various tests including under-identification, weak identification, over-identification and relevance tests[3]. The instrument variables used are dummy variable whether the child had a long-term illness and dummy variable for the household head was severely ill before the child was born. We found that these instruments are relevant and pass the under-identification and week identification tests as well as over-identification problems. Specifically, we found these instrument variables are not correlated with initial z-score of height-for-age. We also conducted a test of endogenity of the z-score height-for-age in Round 1 specified in equation 3.1, and we failed to reject that the z-score of height-for-age in Round 1 is exogenous. However, in the estimation of equation 3.2, we found that log of height-for-age at time t-1 is endogenous. We also used OLS estimation method; the results from both IV and OLS have similar signs, but the magnitude of the coefficients from IV estimation is slightly higher than that of OLS estimation. The summary of the OLS and IV estimation results are provided in Table 4.1 and 4.2 (see Appendix A for details of the estimation and testing results). To check the robustness of our result, we estimated two versions of probit model of stunting and severe stunting on the same set of explanatory variables.

For equations (3.1) and (3.2) as well as probit regressions, we estimated three versions: version one is the full model, version two is without X_{t-1}, and version three is without both X_{t-1} and lagged dependent variable, where variables included under X_{t-1} are initial household level wealth index and initial household compositions (number of male and female household members separately for less than 7 and above 65 years old, between 7 and 17 years old, between 17 and 65 years old, members). We used both OLS and IV estimation method controlling for community fixed effects. Estimated results of equations 3.1 and 3.2 as well as probit regressions of stunting and severe stunting used for interpretation are presented in Table A4.1 to A4.10.

3 These tests are available in statistical software called *stata* and they can be run under ivreg2 and GMM commands.

As a further robustness check and to confirm the recovery of children from their malnutrition, the dependent variables are specified as change in height-for-age, changes in z-score of height-for-age and changes in log of height in centimetre. We regressed these dependent variables on the pre-natal and post-natal economic shocks, initial malnutrition, but with and without initial wealth status of caregivers (See details of the results in Table A4.11 to 4.16).

The specific type of pre-natal economic shocks included in the regression are: (1) decrease in food availability; (2) crops failure; (3) death of livestock; (4) job loss/source of income/family enterprise; (5) birth of new household member, (6) death of household members; and (7) divorce or separation of family members. Shocks that have very little perceived impact on household welfare such as crime, paying for child's education, and migration of family members were not included in the regressions.

The type of post-natal economic shocks included are: (1) illness and death of household members; (2) drought; (3) crop failure; (4) pests and diseases; (5) place employment shutdown or job loss; (6) natural disaster such as drought and flooding; (7) divorce or separation of family; (8) death of livestock; (9) increased input prices; (10) decreased output prices; and (11) theft and robbery.

We also included interaction of these shocks with the initial wealth index, however, none of the interactions were found to have significant influence on the child nutritional achievements. The interaction variables increased the level of multicollinearity among the regressors measured by condition index (Belsely et al. 1980) and variable inflating factor (VIF) following Gujarati (2003). Initially, we also included mother and father's education as well as boys' dummy (to account for the gender of the child) as explanatory variables, but we dropped the education variables from the estimation because none of these coefficients were different from zero at any reasonable level of significance in any of the regression equations we estimated. Coefficient for boy's dummy is negative and found to be statistically significant only when urban areas.

Since the types of shocks that affect households are potentially different for rural and urban areas, we did not intend to run the same model for both areas. However, estimating separate equations for rural and urban areas will be inefficient if the pooled regression works well. Hence we had to conduct a statistical test known as the Chow test before we estimate separately for rural and urban areas. According to the Chow test, we reject the null hypothesis that coefficient for rural and urban area the same at 1 per cent level of significance, suggesting that we have to estimated the models separately for rural and urban areas[4].

Details of estimates of equations 3.1 and 3.2 are provided in Table A4.1 to A4.8 separately for rural and urban areas. For both rural and urban areas, the data fits quite well in the all OLS and probit regressions. About 23 per cent of the variations z-score of height-for-age are explained by the explanatory variables in the model specified in equation 3.1. For equation 3.2, about 26 per cent of the variation is explained by the model. In the probit regressions, the Psedu R^2 is 11 per cent and 15 per cent for rural and urban areas, respectively. We have checked for multicollinearity and heteroscedasticity. After we tested for multicollinearity, we decided to drop the interaction variables because it makes the condition index to be above 30 and the coefficients to be highly insignificant. After we dropped the interaction variables, we found the condition index was 15 which is tolerable according to Greene (2003).

4 For example, for equation 3.1, the test statistics χ^2 is given by 67.2 which is greater than the critical value with 29 degree of freedom at 1 per cent level. This indicates rejection of the null hypothesis that the coefficients for rural and urban area are not the same.

The variable inflation factor was 4.5 when interaction of shocks and wealth index variables are included in the regression. When we exclude these interaction variables, the variable inflation factor reduced to 2.2. In order to account for hereosacedasticty, we estimated robust standard errors using site dummies as cluster variables. As we can see in Tables A4.1 to A4.8, for all models, we estimated three versions where version one includes all explanatory variables including post-natal and pre-natal economic shocks and initial z-score of height-for-age and X_{t-1} variables; version two includes post-natal and pre-natal economic shocks but excluding X_{t-1} variables such as initial household wealth and household compositions; and version three includes only post-natal and pre-natal economic shocks, but without both initial z-score of height-for-age and X_{t-1} variables. Versions two and three helps to see if the inclusion of initial z-score of height-for-age and X_{t-1} variables weakens the effect of pre-natal economic shocks on z-score child height age.

The effect of early malnutrition on z-score of height-for-age and log of height of 5-year-old is summarised in Table 4.1. As expected, z-score of height-for-age at the age of 1 year (initial nutritional achievement) has positive and statistically significant effect on height-for-age at the age of 5 years, but is very low in magnitude, implying a very high potential for recovery of children between the age of 1 and 5 years. This also indicates the rejection of no permanent consequences from stunting at the age of 1 year. The same pattern was observed when we estimated equation 3.2 (where the dependent variable is log of height in centimetre). These results also holds when we control for community fixed effects, but fails to show permanent effect of initial height when we use IV estimation method for rural areas. Relatively speaking, we see more permanent effect and less recovery for urban areas than for rural areas. When we compared our results with the study made by Alderman et al. (2006) on 17-year-old Zimbabwean children, our results shows more recovery and less permanent effect of very early malnutrition, perhaps because of the smaller age group we considered.

Table 4.1 *Effect of initial z-score of height-for-age or ln of height in centimetres*

Method of estimation	**Dependent variable = z-score of height-for-age**		**Dependent variable = log of height in cm**	
	Rural	**Urban**	**Rural**	**Urban**
OLS	0.223***	0.252***	0.280***	0.347***
Community fixed effect OLS	0.250***	0.280***	0.353***	0.385***
IV estimation	0.046	0.514***	0	0.366***
Community fixed effect IV	0.29	0.590***	0.437**	0.338***
	Dependent variable = changes in z-score of height-for-age of 5-year-old		**Dependent variable = Changes in ln of height of 5-year-old**	
	Rural	**Urban**	**Rural**	**Urban**
OLS	-0.777***	-0.748***	-0.688***	-0.656***
IV estimation	-1.122***	-0.936***	-1.000***	-0.634***

See details of the estimated results in Appendix A. *** p<0.01, ** p<0.05, * p<0.1; p stands for the lowest level of probability at which the parameter is different from zero

Source: own computation

Using our alternative specification where the dependent variable is change in z-score of height-for-age, we estimated negative and significant effect of initial z-score of height-for-age on the changes in z-score of height-for-age between Round 1 and Round 2 (Table 4.1). The magnitude of the coefficient in absolute value confirming the same result to equations 3.1 and 3.2 in that the recovery of children in their stunting is very high implying very little permanent consequence of early childhood malnutrition (see Table A4.11 to A4.13). The positive results of the effect of height-for-age at the age of 1 year on nutritional achievement of 5-year-old children are supported by the result obtained from the stunting and severe stunting regressions. Stunting and severe stunting at the age of 1 year has positive and statistically significant effect on the stunting and severe stunting of children at the age of 5 years (Table A4.9 and A4.10 in Appendix A). These effects are substantial in magnitude and are consistent and similar for rural and urban children. In general, the results imply that efforts to achieve better nutritional status of children should start at an early stage of child development, perhaps at pregnancy and birth.

The other factor found to affect nutritional achievements at the age of 5 years is initial household wealth (measured by wealth index). Consistent with many findings and previous Young Lives results (Alemu et al. 2005), for both rural and urban children, we found the initial household wealth index to have a statistically significant and positive effect on height-for-age and change in height-for-age at the age of 5 years (Table 4.2). The squared wealth index is found to have statistically significant negative effect on height-for-age and change in height-for-age at the age of 5 years, indicating the effect of household wealth on nutritional achievement of children is non-linear. Wealth index also affects stunting and severe stunting at the age of 5 years for both rural and urban children negatively. The effect is statistically significant at 1 per cent level for all children living in both rural and urban areas. However, the square of wealth index was not found to be statistically significant for both stunting and severe stunting and for both rural and urban children indicating that the effect of household wealth on stunting and severe stunting of children is not non-linear. To check the robustness of the result, we replaced wealth index by asset index; the result is the same in that household asset index in Round 1 positively affects z-score of height-for-age and log of height and negatively affects stunting and severe stunting at the age of 5 years, while the effect of squared asset index has the opposite sign, but is statistically not significant.

Table 4.2 *The effect of wealth index and household composition and sex of the child on z-score of height-for-age in R2*

	OLS		IV	
	Rural v1	**Urban v1**	**Rural v1**	**Urban v1**
Length/height-for-age z-score in Round 1	0.223***	0.252***	0.046	0.514***
	-14.27	-10.887	-0.3	-3.161
Wealth index for 1-year-olds in Round 1	4.055***	2.082**	4.662***	0.799
	-3.915	-2.379	-3.887	-0.652
Square of wealth index in Round 1	-7.237*	-1.325	-7.872**	-0.06
	(-1.960)	(-1.104)	(-2.020)	(-0.039)
Dummy for male	0.022	-0.195***	-0.082*	0.008
	-0.367	(-2.638)	(-1.926)	-0.137
Number of children below 7 and above 65 years old	-0.073*	0.002	0.048*	-0.007
	(-1.821)	-0.043	-1.735	(-0.227)
Number of children between 7 and 17 years old	0.032	0.012	-0.075	-0.061
	-1.412	-0.419	(-1.036)	(-0.990)
Number of male family members > 17 and less than 65 years	-0.04	-0.016	-0.047	0.110**
	(-0.636)	(-0.344)	(-0.594)	-2.231
Number of female family members > 17 and less than 65 years	-0.025	0.112**		
	(-0.341)	-2.422		
Other outputs omitted				

See Table A4.1 and A4.3 for details of the results; *** p<0.01, ** p<0.05, * p<0.1; p stands for the lowest level of probability at which the parameter is different from zero

Source: own computation

We have included four kinds of household composition variables, namely: (1) number of people below the age of 7 and above the age 65; (2) number of people between 7 and 17 years old; (3) number of male members between 17 and 65 years old; and (4) number of female members between 17 and 65 years old. Among these four kinds of household composition variables, we found the number of people between 7 and 17 years old has a statistically significant and negative effect on z-score of height-for-age, log of height and stunting of children, but only for rural children. This signifies the fact that households with more number of dependents in the household will face significant resource constraints to feed and improve the health of children. We did not find this variable to have statistically significant effect in urban areas although the sign of the effect is negative. The number of female family members between 17 and 65 years old are found to have positive and significant effect on height-for-age and change in height-for-age of the 5-year-old children in urban areas only. In rural areas this variable does not have significant and positive effects. The rest of the household composition variables were not found to have statistical significant effect on both z-score of heights-for-age and log of heights. Especially in severe stunting regression, none of the household composition variables are found to have any significant effect.

Economic shocks and child height-for-age

Controlling for early (initial) nutritional achievements of children and initial household wealth and compositions, we found that z-score of height-for-age and log of height are affected negatively (and stunting and severe stunting affected positively) by the pre-natal and post-natal economic shocks affecting a household. The effects of pre-natal and post-natal economic shocks on children's z-score of height-for-age and log height are still statistically significant when we drop initial wealth only and both initial wealth and malnutrition, but the magnitude of the effects of pre-natal economic shocks got slightly higher, indicating that the shocks have affected the wealth and initial z-score of height-for-age and log of height (see details of the result in Tables A4.1 to A4.8).

Post-natal economic shocks. When we look at rural children, among those shocks that occurred after the child was born, natural disaster including drought, crop failure and pest and diseases has a significant and negative effect on the z-score of height-for-age and log of height and a positive effect on stunting of the 5-year-old children (Table 4.3). These negative effects became lower in magnitude when lagged wealth and dependent variables are included, indicating very strong lingering and persistent effects of post-natal economic shocks. The effects of these shocks on stunting and severe stunting are also statistically significant and have positive signs as expected. Unexpectedly, decrease in output price affected nutritional achievements of children positively, and stunting and severe stunting negatively, which are all statistically significant. Given many of the rural households in Young Lives sites are poor and are perhaps net buyers of food, a decrease in output price may be a positive shock to many households instead of being a negative economic shock and as a result had affected children's nutritional achievement positively. Illnesses of household members also affects both z-score of height-for-age and log of height negatively as well as stunting and severe stunting positively, but are only statistically significant when initial wealth is excluded from the models, indicating that illness effect on children's height is via initial wealth of the household. Such effects of post-natal economic shocks are still significant when we use the instrumental variables estimation method (Tables 4.3 and 4.4) and account for community fixed effect (see Table A4.1 to A4.4).

In urban areas, we found economic shocks – namely, dummy for divorce or separation of family and natural disaster including drought, crop failure and pest and diseases - to have negative effects on z-score of height-for-age and log of height of 5-year-old children only when initial conditions are excluded in the model, indicating a very weak lingering effect. However, theft is found to have stronger negative effect on z-score of height-for-age and log of height even when lagged dependent variable and wealth are included, indicating a very strong lingering effect. When we see stunting of the 5-year-old children, it is affected by dummy for death of livestock, while severe stunting of the 5-year-old children is not affected by any of the economic shocks that affect the household after the birth of the child.

Table 4.3 *The effect of post-natal economic shocks on height of 5-year-old children*

	OLS Rural v1	IV Rural v1	OLS Urban v1	IV Urban v1
On z-score of height-for-age of 5-year-old				
Dummy for illness	-0.039	0.037	0.032	0.03
	(-0.594)	-0.392	-0.407	-0.361
Dummy for death	-0.073	-0.048	0.05	0.094
	(-0.680)	(-0.419)	-0.473	-0.785
Dummy for theft	0.048	0.049	-0.249**	-0.279**
	-0.588	-0.574	(-1.973)	(-2.024)
Dummy for increased input prices	0.005	0.037	0.108	0.094
	-0.079	-0.49	-1.109	-0.901
Dummy for decreased output prices	0.317***	0.353***	-0.534	-0.333
	-2.832	-2.934	(-1.301)	(-0.740)
Dummy for death of livestock	-0.096	-0.087	0.169	0.119
	(-1.478)	(-1.274)	-1.114	-0.724
Dummy for drought, crop failure, pests and diseases	-0.104	-0.076	0.092	0.286
	(-1.586)	(-1.044)	-0.494	-1.219
Dummy for natural disaster including drought	-0.189***	-0.200***	-0.265	-0.363*
	(-2.754)	(-2.759)	(-1.640)	(-1.933)
Dummy for divorce or separation of family	0.042	0.066	-0.187	-0.119
	-0.264	-0.393	(-1.150)	(-0.672)
Dummy for place employment shutdown or job loss	-0.208	-0.17	-0.134	-0.154
	(-1.600)	(-1.220)	(-1.384)	(-1.474)
On ln of height in centimetres at the age of 5 years				
Dummy for illness	-0.003	0.002	0.002	0.002
	(-0.827)	-0.587	-0.636	-0.541
Dummy for death	-0.004	-0.002	0.003	0.002
	(-0.754)	(-0.359)	-0.54	-0.478
Dummy for theft	0.003	0.003	-0.011*	-0.011**
	-0.846	-0.699	(-1.892)	(-2.256)
Dummy for increased input prices	0	0.002	0.003	0.002
	(-0.050)	-0.606	-0.7	-0.551
Dummy for decreased output prices	0.012**	0.017***	-0.027	-0.026***
	-2.346	-2.873	(-1.470)	(-3.171)
Dummy for death of livestock	-0.004	-0.004	0.009	0.009
	(-1.422)	(-1.200)	-1.338	-1.577
Dummy for drought, crop failure, pests and diseases	-0.006*	-0.003	0.001	0.002
	(-1.910)	(-1.057)	-0.161	-0.27
Dummy for natural disaster including drought	-0.008**	-0.009***	-0.009	-0.009
	(-2.549)	(-2.663)	(-1.269)	(-1.536)
Dummy for divorce or separation of family	0.003	0.003	-0.01	-0.01
	-0.471	-0.451	(-1.424)	(-1.391)
Dummy for place employment shutdown or job loss	-0.011*	-0.007	-0.006	-0.005
	(-1.842)	(-1.178)	(-1.279)	(-1.105)

Note: Figures in parenthesis are t-ratio; *** p<0.01, ** p<0.05, * p<0.1; p stands for the lowest level of probability at which the parameter is different from zero; V1 are full model, V2 is restricted model without x(t-1) variables ,and v3 is restricted model where both x(t-1) and initial z-score of height-for-age are dropped. Endogenous variable is Height-for-age (age in months) in Round 1; excluded the instruments: dummy variables for the child had long-term health problem and dummy variable for the household had severe illness or injury.

Source: own computation

Pre-natal economic shocks. Relatively speaking, shocks that hit the household before the child was born were found to be more damaging to children than shocks that affected the household after the child was born in both rural and urban areas. In rural areas, controlling for initial wealth and malnutrition, decrease in food availability, death of household members, divorce or separation of family affected z-score of height-for-age and log of height negatively which are also statistically significant (Table 4.4). The magnitude of these negative effects increased slightly when lagged wealth and dependent variables are dropped, indicating a very strong lingering and persistent effect of pre-natal economic shocks. For stunting, we found only a decrease in food availability and divorce or separation of family that affected household before the child was born to have a negative and significant effect on the probability of a 5-year-old being stunted, while the only shock that hit households before the birth of a 5-year-old child that has a significant and negative effect on severe stunting of a 5-year-old is divorce or separation of family. These results also hold true when we used the instrumental variables (IV) estimation method (Table 4.3 and 4.4) and, accounting for community fixed effect, indicate the robustness of the results (see Table A4.1 to A4.4 for details).

These results in general imply that the idiosyncratic shocks have long-term consequences on child welfare due to the fact that such shocks are not covered by any of the government and non-government social assistance programmes. If the idiosyncratic shocks are not going to be covered by social assistance programmes, current crises such as unemployment and inflation will have consequence on the nutritional achievements and hence the mental development of our children and future generations. Therefore, it would be advisable for government and donors to consider revising their assistance programmes to include idiosyncratic shocks.

Table 4.4 *Effect of pre-natal economic shocks on height of 5-year-old children*

	OLS	**IV**	**OLS**	**IV**
	Rural v1	**Rural v1**	**Urban v1**	**Urban v1**
On z-score of height-for-age of 5-year-old				
Dummy for decrease in food availability	-0.159**	-0.161**	0.113	0.171*
	(-2.268)	(-2.195)	-1.317	-1.703
Dummy for livestock death	0.107	0.096	0.08	0.085
	-1.543	-1.322	-0.438	-0.438
Dummy for crops failure	-0.01	0.047	-0.253	-0.315*
	(-0.140)	-0.519	(-1.575)	(-1.777)
Dummy for death/reduction in household members	-0.288**	-0.321***	-0.176	-0.223
	(-2.500)	(-2.601)	(-1.068)	(-1.254)
Dummy for job loss/source of income/family enterprise	-0.022	-0.058	-0.139	-0.215*
	(-0.198)	(-0.490)	(-1.361)	(-1.778)
Dummy for divorce or separation	-0.522***	-0.591***	0.294*	0.202
	(-3.121)	(-3.219)	-1.854	-1.139

Continued on next page

Table 4.4 *Effect of pre-natal economic shocks on height of 5-year-old children* continued

	OLS Rural v1	IV Rural v1	OLS Urban v1	IV Urban v1
On log of height in centimetres at the age of 5 years				
Dummy for decrease in food availability	-0.008**	-0.008**	0.006	0.006
	(-2.444)	(-2.175)	-1.569	-1.645
Dummy for livestock death	0.004	0.005	0.004	0.005
	-1.275	-1.342	-0.548	-0.77
Dummy for crops failure	-0.001	0.003	-0.01	-0.011
	(-0.305)	-0.679	(-1.392)	(-1.266)
Dummy for death/reduction in household members	-0.013**	-0.016***	-0.008	-0.008
	(-2.461)	(-2.763)	(-1.109)	(-1.228)
Dummy for job loss/source of income/family enterprise	-0.001	-0.003	-0.005	-0.006
	(-0.170)	(-0.483)	(-1.168)	(-1.291)
Dummy for divorce or separation	-0.024***	-0.029***	0.012*	0.011
	(-3.152)	(-2.813)	-1.677	-1.125

Note: Figures in parenthesis are t-ratio; *** p<0.01, ** p<0.05, * p<0.1; p stands for the lowest level of probability at which the parameter is different from zero; V1 are full model, V2 is restricted model without x(t-1) variable, and v3 is restricted model where both x(t-1) and initial ln of height in round 1 are dropped. Endogenous variable is ln of height-for-age (age in months) in Round 1 ; Excluded the instruments: dummy variables for the child had long-term health problem and dummy variable for the household had severe illness or injury.

Source: own computation

In urban areas, among the pre-natal economic shocks, it is only crop failure and unavailability of food (but only under IV estimation) that have statistically significant negative effects on z-score of height-for-age and log of height. The result is robust when we control for initial wealth and malnutrition as well as for community fixed effect. Unexpectedly, divorce or separation of families that hit the household before the birth of the 5-year-old child affects z-score of child height-for-age and log of height positively, which is statistically significant, but requires further investigation. In general, the results in this study suggest that rural children are more vulnerable to economic shocks than urban children. Therefore, government social assistance programmes designed to reduce household vulnerability to various shocks should focus on rural areas. However, perhaps the type of economic shock included in the survey questionnaire is mainly focused on rural areas and those shocks that affect urban households (such as inflation) were not included. Therefore, further study on shocks in urban areas has to be conducted in order to examine the effects on nutritional achievement effect of other shocks which are not captured by Young Lives survey data.

Given such results, the next question is 'what are the policy options that help improve the nutritional achievements of children or reduce the malnutrition of children in rural Ethiopia?' As malnutrition is a question of household poverty or wealth and the highest effect on stunting is observed for household wealth, the first and most important policy option is increasing the wealth status of households substantially so as to reduce the incidence of stunting among children. Moreover, improving household wealth (income) will reduce households' vulnerability to various economic shocks which have short-term and long-term consequences on nutritional achievements of children.

However, given the frequency of shocks, especially area-wide shocks that hit rural and urban Ethiopia, it is unlikely that increasing income is the only option to reduce malnutrition in

Ethiopia. In many cases, household wealth is itself highly vulnerable to area-wide and idiosyncratic economic shocks. Over the last 15 years Ethiopia experienced area-wide economic shocks every four or five years. Not only poor but also richer households are vulnerable to area-wide economic shocks such as drought, insect and pests. Also, every year households are hit by various idiosyncratic economic shocks such as illness of household members, breadwinners and caregivers, as well as separation of family members or divorce. Surprisingly, a substantial number of households (more than 50 per cent) are vulnerable to these idiosyncratic economic shocks. Therefore, intensifying the social assistance programmes to effectively reduce households' vulnerability to both area-wide and idiosyncratic economic shocks seems the second option to reduce malnutrition of children in Ethiopia. To assess this latter option, we conducted a simulation exercise on the effectiveness of reducing household vulnerability to area-wide shock only, and to both area-wide and idiosyncratic economic shocks, via the intensification of social assistance programmes in Ethiopia.

The first simulation exercise comes from the fact that government and non-governmental organisations (NGOs) can intensify the social assistance programme to effectively reduce household vulnerability to area-wide shocks such as drought, insect, pests and diseases through allocating more resources to programmes including emergency relief, productive safety net and other food security programmes such as resettlement and household food security package. Currently, about 63 per cent of the Young Lives rural households are vulnerable to natural disaster such as drought, insect, pests and diseases. At the national level, about 12 per cent of the households are vulnerable to drought (Woldehanna et al. 2008b). The second simulation exercise examined what happened to the z-score of height-for-age, stunting and severe stunting when a household's vulnerability is reduced to both area-wide and idiosyncratic economic shocks by making social assistance programmes inclusive of not only area-wide economic shocks but also idiosyncratic shocks. The results of the simulation exercises are presented in Table 4.5.

For rural areas, by reducing area-wide shock such as drought from 63 per cent to 10 per cent, z-score of height-for-age could be increased by 6.2 per cent. On the other hand, if we reduced both the area-wide shocks (such as drought) by the same percentage (from 63 per cent to 10 per cent) and also the idiosyncratic shocks for death from 7 per cent to 5 per cent, for food availability from 50 per cent to 10 per cent and for divorce from 4 per cent to 2 per cent, the z-score of height-for-age could be increased by 10.4 per cent. For urban areas, reducing area-wide shock such as drought from 7.2 per cent to 2 per cent increased the z-score of height-for-age by 1.3 per cent, while reducing both the area-wide shocks (drought) by the same percentage (from 7.2 per cent to 2 per cent) and idiosyncratic shocks (crop failure shock from 7.5 per cent to 2 per cent) increased the z-score of height-for-age by 3.1 per cent.

Consequently, if a rural household's vulnerability to only area-wide shocks were reduced as stated above, Round 2 rural stunting would have declined from 36 per cent to 33 per cent, while Round 2 rural severe stunting would have declined from 11 per cent to 9 per cent. If, however, the social protection programmes are made strong and effective enough to reduce both area-wide and idiosyncratic shocks (resulting from death of household members, unavailability of food and divorce), stunting in Round 2 would have declined from 36 per cent to 31 per cent and severe stunting from 11 per cent to 8 per cent.

In urban areas, reducing a household's vulnerability to area-wide shock only reduces Round 2 stunting from 23.7 per cent to 22.8 per cent and severe stunting from 4.6 per cent to 4.5 per cent. On the other hand, if social assistance programmes become more effective in reducing the vulnerability of urban households to both area-wide and idiosyncratic shocks, Round 2 stunting would have declined from 23.7 per cent to 22.2 per cent and severe stunting from 4.6 per cent to 4.5 per cent, indicating the relative important of area-wide shocks.

This implies that although area-wide economic shocks such as drought are very important and it would be good for the government to focus more on them, idiosyncratic shocks have a considerable contribution to make to the improvement of children's height-for-age and consequently to the reduction of stunting and severe stunting in Ethiopia. Therefore, it would be beneficial if government assistance programmes included idiosyncratic shocks such as death and illness of household members (bread winners and caregivers) and separation of family or divorce.

Table 4.5 *Effect of reducing area-wide and idiosyncratic economic shocks on z-score of height-for-age, stunting and severe stunting*

	Total	Rural	Urban
Z-score of height-for-age in Round 1	-1.257	-1.463	-0.945
Z-score of height-for-age in Round 2	-1.452	-1.629	-1.185
Z-score of height-for-age in Round 2 if area-wide shocks is reduced*	-1.352	-1.529	-1.17
Z-score of height-for-age in Round 2 when area-wide shocks and idiosyncratic shocks are reduced**	-1.283	-1.46	-1.149
Stunting in Round 1	34.84	41.39	24.93
Stunting in Round 2	31.33	36.41	23.65
Stunting if drought shock reduced	28.09	33.57	22.83
Stunting if drought shock and idiosyncratic shocks reduced	25.89	31.04	22.18
Severe stunting in Round 1	15.46	19.36	9.57
Severe stunting in Round 2	8.22	10.63	4.6
Severe stunting if drought shock reduced	6.85	8.7	4.46
Severe stunting if drought shock and idiosyncratic shocks reduced	6.12	7.65	4.46
Number of observations	1863	1121	761

*Percentage of people affected by area-wide shocks such as drought shock reduced from 63% to 10% in rural areas and from 7.22% to 2% in urban areas

*Percentage of people affected by idiosyncratic shocks reduced (for rural areas, death reduced from 7% to 5%, food availability from 50% to 10%, and divorce from 4% to 2%; for urban areas, exposure to crop failure shock reduced from 7.5% to 2%)

Source: own computation

5. Summary and conclusions

Using longitudinal Young Lives younger cohort data, we examine the existence of permanent consequences of early childhood malnutrition and recovery of children from their early childhood malnutrition as well as the persistent effect of pre-natal and post-natal economic shocks on demand for child health nutritional achievement measured by z-score of height-for-age and height of 5-year-old children. The dataset used include Round 1 and Round 2 survey data collected in the third quarter of 2002 and 2006, respectively. The most serious pre-natal economic shocks reported by the respondents and used in the analyses are: (1) decrease in food availability; (2) crops failure; (3) death of livestock death; (4) severe illness or injury; (5) job loss/source of income/family enterprise; (6) birth of new household member; and (7) death of household members. The post-natal economic shocks collected in Round 2 are: (1) illness and death of household members; (2) drought; (3) crop failure; (4) pests and diseases; (5) place employment shutdown or job loss; (6) natural disaster such as drought and flooding; (7) divorce or separation of family; (8) death of livestock; (9) increased input prices; (10) decreased output prices; and (11) theft and robbery.

We employed OLS, instrumental variable (IV) and generalised method of moment estimation methods controlling for community fixed effects. Our results confirmed the existence of permanent consequences of early childhood malnutrition and recovery of children from their initial (early malnutrition). Pre-natal economic shocks are found to have significant effects on the 5-year-old children's nutritional achievements. In rural areas, increase in output prices has positively associated with nutritional achievement of children while reduction in household food availability, household head death and divorce that occurred before the child was born reduced children's growth. Natural disaster including drought that hit the households after the birth of the child reduced children's nutritional achievement. In urban areas, only crop failure that occurred before the child was born and natural disaster including drought that occurred after the child was born reduced children's z-score of height-for-age, while separation of mother and fathers and increase in input prices positively affect children's nutritional achievements. The same effect was found when we assessed the effect of these shocks on stunting, explaining the robustness of the result. We found consistent results from both OLS and IV estimations controlling for community fixed effect.

The simulation exercises indicate that dealing with the effectiveness of social assistance programmes on reducing vulnerability of household to area-wide economic shocks such as drought is much more important, providing additional focus on idiosyncratic shocks will also help reduce the malnutrition of children in Ethiopia, especially in rural areas. Therefore, in order to improve children's nutritional achievements, government and NGOs should consider intensifying the provision of social assistance programmes such as emergency relief, productive safety net, household food security packages, and resettlement programmes as well as provision of free healthcare facilities for the poor via the healthcare financing strategy. Since our results shows that rural children are more vulnerable to economic shocks than urban children, it would be beneficial for social assistance programmes to focus more on in rural areas.

The fact that idiosyncratic shocks have long-term impact on children's nutritional achievement shows that social assistance programmes should include not only area-wide shocks but also individual idiosyncratic shocks if one wants to protect our future children from being affected by shocks. Therefore, it is recommended that government and NGOs in Ethiopia revise their social assistance programmes to make them inclusive of the idiosyncratic shocks that frequently affect households and, consequently, children.

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Appendix A: Supporting tables

Table A4.8 *Community fixed effect IV estimation of ln height in Round 2 with and without initial condition (rural and urban areas)*

	Rural v1	Rural v2	Urban v1	Urban v2
Ln of height of a child in centimetres in Round 1	0.437**	0.452***	0.338***	0.350***
	-2.448	-2.586	-2.819	-2.842
Wealth index for 1-year-olds in Round 1	0.068		0.096**	
	-1.169		-2.154	
Square of wealth index in Round 1	-0.069		-0.092	
	(-0.386)		(-1.622)	
Gemons	-0.001	-0.001	-0.001	-0.001
	(-0.445)	(-0.528)	(-0.449)	(-0.486)
Dummy for male	-0.003	-0.003	-0.010***	-0.010***
	(-0.639)	(-0.736)	(-2.833)	(-2.940)
Number of children below 7 and above 65 years old	-0.002		0	
	(-0.889)		(-0.014)	
Number of children between 7 and 17 years old	0.001		0	
	-0.624		-0.253	
Number of male family members > 17 and less than 65 years	0		0	
	-0.061		(-0.162)	
Number of female family members > 17 and less than 65 years	-0.001		0.004**	
	(-0.219)		-2.124	
Dummy for illness	0.003	0.003	0.002	0.002
	-0.93	-0.826	-0.492	-0.604
Dummy for death	-0.002	-0.002	0.001	0.001
	(-0.374)	(-0.395)	-0.184	-0.229
Dummy for theft	0.003	0.003	-0.011*	-0.009*
	-0.807	-0.873	(-1.924)	(-1.656)
Dummy for increased input prices	0.004	0.005	0.001	0
	-1.334	-1.51	-0.196	-0.006
Dummy for decreased output prices	0.011**	0.012**	-0.02	-0.022
	-2.278	-2.293	(-1.130)	(-1.235)
Dummy for death of livestock	-0.004	-0.004	0.007	0.008
	(-1.322)	(-1.332)	-0.984	-1.217
Dummy for drought, crop failure, pests and diseases	-0.001	-0.001	0.005	0.002
	(-0.397)	(-0.388)	-0.584	-0.278
Dummy for natural disaster including drought	-0.003	-0.003	-0.012	-0.011
	(-0.755)	(-0.898)	(-1.628)	(-1.549)
Dummy for divorce or separation of family	0.001	0	-0.006	-0.007
	-0.091	-0.047	(-0.856)	(-0.952)
Dummy for place employment shutdown or job loss	-0.013**	-0.013**	-0.003	-0.002
	(-2.285)	(-2.224)	(-0.588)	(-0.575)

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Table A4.8 *Community fixed effect IV estimation of ln height in Round 2 with and without initial condition (rural and urban areas)* continued

	Rural v1	**Rural v2**	**Urban v1**	**Urban v2**
Dummy for decrease in food availability	-0.003	-0.003	0.001	0.001
	(-0.849)	(-0.952)	-0.324	-0.137
Dummy for livestock death	0.003	0.003	0.003	0.003
	-1.067	-1.077	-0.396	-0.346
Dummy for crops failure	0	0	-0.002	-0.004
	-0.005	(-0.118)	(-0.295)	(-0.586)
Dummy for death/reduction in household members	-0.007	-0.006	-0.008	-0.006
	(-1.312)	(-1.242)	(-1.075)	(-0.886)
Dummy for job loss/source of income/family enterprise	0.006	0.006	-0.004	-0.005
	-1.145	-1.208	(-0.758)	(-0.974)
Dummy for divorce or separation	-0.023***	-0.022***	0.015**	0.016**
	(-3.064)	(-3.034)	-2.083	-2.383
Constant	2.830***	2.778***	3.231***	3.213***
	-4.457	-4.478	-7.62	-7.312
Number of observations	1,101	1,101	734	734

Note: Figures in parentheses are t-ratio; *** p<0.01, ** p<0.05, * p<0.1; p stands for the lowest level of probability at which the parameter is different from zero; v1 are full model, v2 is restricted model without x(t-1) variables; endogenous variable is ln of height-for-age (age in months) in Round 1; excluded the instruments: dummy variables for the child who had a long-term health problem and dummy variable for the household which had severe illness or injury.

Source: own computation

Table A4.9 *Probit regression with dependent variable (1 if stunted and 0 otherwise) in rural and urban areas*

	Rural v1	Rural v2	Rural v3	Urban v1	Urban v2	Urban v3
Dummy for stunted child (r1_zhfa<-2) in Round 1	0.803***	0.827***		0.888***	0.968***	
	-9.546	-9.954		-7.385	-8.283	
X_{t-1}						
Wealth index for 1-year-olds in Round 1	-4.399***			-2.707**		
	(-3.044)			(-2.093)		
Square of wealth index in Round 1	7.074			1.828		
	-1.338			-0.988		
Dummy for male	-0.033	-0.037	0.054	0.237**	0.213*	0.272***
	(-0.395)	(-0.455)	-0.681	-2.103	-1.934	-2.583
Number of children below 7 and above 65 years old	0.068			0.016		
	-1.235			-0.197		
Number of children between 7 and 17 years old	-0.066**			-0.026		
	(-2.054)			(-0.593)		
Number of male family members > 17 and less than 65 years	0.14			-0.045		
	-1.607			(-0.563)		
Number of female family members > 17 and less than 65 years	0.039			-0.027		
	-0.384			(-0.355)		
Shocks after the child was born (S_{t-1})						
Dummy for illness	0.112	0.191**	0.104	-0.075	-0.049	-0.029
	-1.241	-2.184	-1.237	(-0.636)	(-0.421)	(-0.260)
Dummy for death	0.049	0.046	-0.002	-0.099	-0.099	-0.038
	-0.332	-0.316	(-0.012)	(-0.604)	(-0.617)	(-0.249)
Dummy for theft	-0.134	-0.113	-0.089	-0.022	-0.042	-0.077
	(-1.185)	(-0.999)	(-0.812)	(-0.114)	(-0.218)	(-0.412)
Dummy for increased input prices	-0.031	-0.017	-0.071	0.01	0.022	-0.009
	(-0.335)	(-0.191)	(-0.804)	-0.07	-0.151	(-0.061)
Dummy for decreased output prices	-0.247	-0.246	-0.241	1.178	1.121*	1.365**
	(-1.572)	(-1.582)	(-1.597)	-1.643	-1.718	-2.377
Dummy for death of livestock	-0.068	-0.057	-0.058	-0.476*	-0.35	-0.312
	(-0.759)	(-0.641)	(-0.675)	(-1.879)	(-1.457)	(-1.374)
Dummy for drought, crop failure, pests and diseases	0.207**	0.196**	0.157*	0.022	0.135	0.266
	-2.294	-2.194	-1.828	-0.078	-0.508	-1.05
Dummy for natural disaster including drought	0.173*	0.185**	0.200**	0.25	0.285	0.193
	-1.815	-1.971	-2.199	-1.039	-1.212	-0.867
Dummy for divorce or separation of family	-0.227	-0.168	-0.209	0.265	0.335	0.368*
	(-0.995)	(-0.759)	(-0.968)	-1.165	-1.531	-1.732
Dummy for place employment shutdown or job loss	0.021	-0.014	-0.024	0.178	0.157	0.153
	-0.119	(-0.077)	(-0.140)	-1.26	-1.12	-1.13

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Table A4.9 *Probit regression with dependent variable (1 if stunted and 0 otherwise) in rural and urban areas* continued

	Rural v1	Rural v2	Rural v3	Urban v1	Urban v2	Urban v3
Shocks before the child was born (S_{t-2})						
Dummy for decrease in food availability	0.146	0.174*	0.208**	0.005	0.015	0.1
	-1.519	-1.836	-2.246	-0.034	-0.118	-0.817
Dummy for livestock death	-0.076	-0.083	-0.026	-0.652**	-0.565*	-0.528*
	(-0.793)	(-0.881)	(-0.292)	(-2.077)	(-1.862)	(-1.809)
Dummy for crops failure	0.026	0.002	-0.088	0.27	0.380*	0.341
	-0.257	-0.018	(-0.924)	-1.17	-1.667	-1.545
Dummy for death/reduction in household members	0.171	0.156	0.157	0.287	0.291	0.139
	-1.081	-0.997	-1.048	-1.168	-1.224	-0.605
Dummy for job loss/source of income/family enterprise	0.101	0.095	0.102	0.081	0.063	0.02
	-0.686	-0.654	-0.716	-0.521	-0.407	-0.133
Dummy for divorce or separation	0.427*	0.281	0.315	-0.267	-0.246	-0.311
	-1.888	-1.295	-1.484	(-1.092)	(-1.029)	(-1.309)
Constant	-0.921***	-1.004***	-0.615***	-0.417	-1.201***	-0.955***
	(-4.576)	(-8.993)	(-6.112)	(-1.384)	(-10.609)	(-9.164)
Number of observations	1,101	1,101	1,101	734	734	734
Log-likelihood	-639.9	-654.08	-704.85	-341.05	-350.33	-385.02
Log-likelihood with only intercept	-718.627	-718.627	-718.627	-399.633	-399.633	-399.633
Adjusted R^2	0.11	0.09	0.019	0.147	0.123	0.037

Note: Figures in parentheses are t-ratio; *** p<0.01, ** p<0.05, * p<0.1; p stands for the lowest level of probability at which the parameter is different from zero; v1 are full model, v2 is restricted model without x(t-1) variables, and v3 is restricted model where both x(t-1) and Round 1 stunting are dropped.

Source: own computation

Table A4.10 *Probit regression of severe stunting in Round 2 (dep. Var = 1 if a child is severely stunted and 0 otherwise)*

	Rural v1	Rural v2	Rural v3	Urban v1	Urban v2	Urban v3
Dummy for severely stunted child (r1_zhfa<-3) in Round 1	0.465***	0.502***		0.4	0.562**	
	-3.703	-4.098		-1.565	-2.403	
X_{t-1}						
Wealth index for 1-year-olds in Round 1	-4.916**			-4.764**		
	(-2.359)			(-2.490)		
Square of wealth index in Round 1	7.728			3.829		
	-0.939			-1.305		
Dummy for male	0.018	-0.02	0.012	0.249	0.183	0.235
	-0.16	(-0.184)	-0.115	-1.335	-1.038	-1.362
Number of children below 7 and above 65 years old	0.145**			0.039		
	-2.051			-0.298		
Number of children between 7 and 17 years old	-0.056			-0.077		
	(-1.314)			(-1.051)		
Number of male family members > 17 and less than 65 years	0.09			0.043		
	-0.76			-0.321		
Number of female family members > 17 and less than 65 years	-0.155			0.017		
	(-1.071)			-0.13		
Shocks after the child was born (S_{t-1})						
Dummy for illness	0.134	0.205*	0.191*	-0.202	-0.181	-0.157
	-1.153	-1.837	-1.73	(-1.018)	(-0.962)	(-0.846)
Dummy for death	0.029	0.04	0.046	0.102	0.161	0.176
	-0.148	-0.212	-0.249	-0.405	-0.682	-0.763
Dummy for theft	0.023	0.024	0.039	0.175	0.098	0.098
	-0.158	-0.167	-0.272	-0.59	-0.344	-0.35
Dummy for increased input prices	-0.056	-0.041	-0.058	0.21	0.228	0.206
	(-0.455)	(-0.348)	(-0.499)	-0.95	-1.1	-1.003
Dummy for decreased output prices	-0.691***	-0.662***	-0.641***			
	(-2.774)	(-2.679)	(-2.651)			
Dummy for death of livestock	0.028	0.023	0.019	-0.112	0.137	0.071
	-0.235	-0.195	-0.168	(-0.294)	-0.406	-0.213
Dummy for drought, crop failure, pests and diseases	0.256**	0.238**	0.229**	0.31	0.415	0.534
	-2.147	-2.041	-1.994	-0.725	-1.066	-1.423
Dummy for natural disaster including drought	0.137	0.14	0.15	-0.325	-0.237	-0.193
	-1.066	-1.116	-1.218	(-0.743)	(-0.598)	(-0.503)
Dummy for divorce or separation of family	-0.261	-0.253	-0.224	0.245	0.358	0.41
	(-0.808)	(-0.806)	(-0.737)	-0.721	-1.16	-1.341
Dummy for place employment shutdown or job loss	0.098	0.071	0.039	-0.015	0.029	0.044
	-0.418	-0.309	-0.171	(-0.063)	-0.129	-0.193

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Table A4.10 *Probit regression of severe stunting in Round 2 (dep. Var = 1 if a child is severely stunted and 0 otherwise)* continued

	Rural v1	Rural v2	Rural v3	Urban v1	Urban v2	Urban v3
Shocks before the child was born (S_{t-2})						
Dummy for decrease in food availability	0.112	0.146	0.167	-0.259	-0.233	-0.218
	-0.872	-1.159	-1.341	(-1.158)	(-1.103)	(-1.050)
Dummy for livestock death	-0.065	-0.062	-0.072	-0.627	-0.265	-0.281
	(-0.508)	(-0.494)	(-0.587)	(-1.252)	(-0.588)	(-0.620)
Dummy for crops failure	-0.082	-0.121	-0.139	0.446	0.547*	0.478
	(-0.624)	(-0.941)	(-1.094)	-1.375	-1.731	-1.521
Dummy for death/reduction in household members	0.237	0.205	0.19	-0.303	-0.343	-0.342
	-1.203	-1.065	-0.993	(-0.581)	(-0.681)	(-0.694)
Dummy for job loss/source of income/family enterprise	-0.339	-0.325	-0.271	0.124	0.036	0.044
	(-1.514)	(-1.513)	(-1.285)	-0.497	-0.15	-0.184
Dummy for divorce or separation	0.747***	0.549**	0.541**			
	-2.788	-2.169	-2.165			
Constant	-1.448***	-1.608***	-1.503***	-0.880*	-1.876***	-1.842***
	(-5.247)	(-11.334)	(-10.963)	(-1.953)	(-10.656)	(-10.585)
Number of observations	1,101	1,101	1,101	685	685	685
Log-likelihood	-331.4	-342.68	-350.79	-116.71	-126.05	-128.74
Log-likelihood with only intercept	-364.246	-364.246	-364.246	-135.246	-135.246	-135.246
Adjusted R^2	0.09	0.059	0.037	0.137	0.068	0.048

Note: Figures in parentheses are t-ratio; *** p<0.01, ** p<0.05, * p<0.1; p stands for the lowest level of probability at which the parameter is different from zero; v1 are full model, v2 is restricted model without x(t-1) variables, and v3 is restricted model where both x(t-1) and Round 1 severe stunting are dropped.

Source: own computation

Table A4.11 *Regression of change in height-for-age (dependent variable=change in height-for-age)*

	OLS Rural	IV Rural	OLS Urban	IV Urban
Initial conditions				
Height-for-age (age in months) for Round 1 data	-0.958***	-0.966***	-0.957***	-0.961***
	(-749.931)	(-50.176)	(-551.508)	(-72.018)
Wealth index for 1-year-olds in Round 1	0.353***	0.375***	0.289***	0.291***
	-4.18	-3.506	-3.862	-4.271
Square of wealth index in Round 1	-0.703**	-0.730*	-0.269***	-0.272***
	(-2.334)	(-1.890)	(-2.602)	(-2.941)
Dummy for male	0.003	0.003	-0.014**	-0.013**
	-0.518	-0.602	(-2.200)	(-2.003)
Number of children below 7 and above 65 years old	-0.007**	-0.005	0.002	0.002
	(-1.993)	(-0.994)	-0.339	-0.419
Number of children between 7 and 17 years old	0.003	0.003*	0.004	0.004
	-1.601	-1.645	-1.495	-1.477
Number of male family members > 17 and less than 65 years	-0.003	-0.004	-0.002	-0.001
	(-0.574)	(-0.652)	(-0.512)	(-0.345)
Number of female family members > 17 and less than 65 years	0	-0.002	0.009**	0.009**
	-0.045	(-0.214)	-2.362	-2.461
Shocks after the child was born (S_{t-1})				
Dummy for illness	0.005	0.006	0.002	0.002
	-1.013	-1.023	-0.284	-0.282
Dummy for death	-0.003	-0.004	0	-0.001
	(-0.316)	(-0.447)	-0.001	(-0.136)
Dummy for theft	0.001	0.001	-0.022**	-0.020*
	-0.107	-0.109	(-2.008)	(-1.797)
Dummy for increased input prices	0.005	0.005	0.014*	0.015
	-0.873	-0.972	-1.682	-1.628
Dummy for decreased output prices	0.035***	0.035***	-0.037	-0.038***
	-3.868	-3.514	(-1.056)	(-3.545)
Dummy for death of livestock	-0.005	-0.005	0.01	0.011
	(-0.946)	(-0.995)	-0.785	-0.929
Dummy for drought, crop failure, pests and diseases	-0.001	-0.002	0.012	0.009
	(-0.263)	(-0.304)	-0.749	-0.523
Dummy for natural disaster including drought	-0.019***	-0.019***	-0.027*	-0.026**
	(-3.399)	(-3.313)	(-1.908)	(-2.269)
Dummy for divorce or separation of family	0.002	0.005	-0.014	-0.013
	-0.164	-0.36	(-1.012)	(-1.127)
Dummy for place employment shutdown or job loss	-0.007	-0.007	-0.01	-0.01
	(-0.616)	(-0.694)	(-1.238)	(-1.169)

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Table A4.11 *Regression of change in height-for-age (dependent variable=change in height-for-age)* continued

	OLS Rural	IV Rural	OLS Urban	IV Urban
Shocks before the child was born (S_{t-2})				
Dummy for decrease in food availability	-0.012**	-0.013**	0.003	0.002
	(-2.143)	(-2.142)	-0.38	-0.19
Dummy for livestock death	0.009	0.007	0.008	0.009
	-1.628	-1.011	-0.539	-0.858
Dummy for crops failure	0.007	0.008	-0.027*	-0.026*
	-1.253	-1.279	(-1.940)	(-1.801)
Dummy for death/reduction in household members	-0.022**	-0.020**	-0.01	-0.011
	(-2.292)	(-2.035)	(-0.722)	(-0.895)
Dummy for job loss/source of income/family enterprise	-0.008	-0.009	-0.012	-0.01
	(-0.931)	(-0.953)	(-1.338)	(-1.015)
Dummy for divorce or separation	-0.051***	-0.052***	0.033**	0.032*
	(-3.720)	(-2.947)	-2.378	-1.857
Constant	1.398***	1.446***	1.349***	1.375***
	-99.975	-12.242	-68.19	-17.154
Number of observations (N)	1,101	1,101	734	734
R^2	0.998	0.998	0.998	0.998
Adjusted R^2	0.998	0.998	0.998	0.998
Centered R^2 (r2c)		0.998		0.998
Uncentered R^2 (r2c)		1		1
Underidentification test (Kleibergen-Paap rk LM statistic) (idstat)		6.389		13.282
P-value for underidentification test (idp)		0.041		0.001
Hansen J statistics (overidentification test of all instruments) (j)		0.069		0.108
P-value for overidentification test (jp)		0.793		0.743
First stage regression				
R^2		0.03		0.062
Partial R^2 of excluded instruments		0.007		0.016
Test of excluded instrument (F and P value)		4.2 (0.015)		8.19(0.000)

Note: Figures in parentheses are t-ratio; *** p<0.01, ** p<0.05, * p<0.1; p stands for the lowest level of probability at which the parameter is different from zero; v1 are full model and v2 are restricted model where variables whose t-values less than one are excluded.

Endogenous variable is height-for-age (age in months) in Round 1; excluded the instruments: dummy variables for the child who had a long-term health problem and dummy variable for the household which had severe illness or injury.

	Rural		Urban	
Tests of endogeneity of:	hght_ager1		hght_ager1	
H0:	Regressor is exogenous		Regressor is exogenous	
Wu-Hausman F test:	0.25918 F(1,1075)	P-value = 0.61079	0.08250 F(1,708)	P-value = 0.77402
Durbin-Wu-Hausman chi-sq test:	0.26538 Chi-sq(1)	P-value = 0.60645	0.08552 Chi-sq(1)	P-value = 0.76995

Source: own computation

Table A4.12 *Regression of change in z-score of height-for-age (dependent variable= change in z-score of height-for-age)*

	OLS Rural	IV Rural	OLS Urban	IV Urban
Initial conditions				
Length/height-for-age z-score	-0.777***	-1.122***	-0.748***	-0.936***
	(-49.815)	(-4.027)	(-32.282)	(-3.618)
Wealth index for 1-year-olds in Round 1	4.055***	5.273***	2.082**	3.022**
	-3.915	-3.362	-2.379	-2.034
Square of wealth index in Round 1	-7.237*	-8.546*	-1.325	-2.276
	(-1.960)	(-1.757)	(-1.104)	(-1.338)
Dummy for male	0.022	-0.088	-0.195***	-0.270**
	-0.367	(-0.796)	(-2.638)	(-2.152)
Number of children below 7 and above 65 years old	-0.073*	-0.090*	0.002	-0.003
	(-1.821)	(-1.769)	-0.043	(-0.047)
Number of children between 7 and 17 years old	0.032	0.061*	0.012	0.024
	-1.412	-1.701	-0.419	-0.688
Number of male family members > 17 and less than 65 years	-0.04	-0.108	-0.016	0.018
	(-0.636)	(-1.139)	(-0.344)	-0.276
Number of female family members > 17 and less than 65 years	-0.025	-0.064	0.112**	0.115**
	(-0.341)	(-0.764)	-2.422	-2.549
Shocks after the child was born (S_{t-1})				
Dummy for illness	-0.039	0.109	0.032	0.03
	(-0.594)	-0.734	-0.407	-0.379
Dummy for death	-0.073	-0.029	0.05	0.009
	(-0.680)	(-0.219)	-0.473	-0.071
Dummy for theft	0.048	0.047	-0.249**	-0.223**
	-0.588	-0.508	(-1.973)	(-1.964)
Dummy for increased input prices	0.005	0.066	0.108	0.106
	-0.079	-0.693	-1.109	-0.992
Dummy for decreased output prices	0.317***	0.396***	-0.534	-0.664**
	-2.832	-2.613	(-1.301)	(-2.359)
Dummy for death of livestock	-0.096	-0.084	0.169	0.205
	(-1.478)	(-1.068)	-1.114	-1.389
Dummy for drought, crop failure, pests and diseases	-0.104	-0.048	0.092	-0.047
	(-1.586)	(-0.547)	-0.494	(-0.184)
Dummy for natural disaster including drought	-0.189***	-0.209**	-0.265	-0.182
	(-2.754)	(-2.528)	(-1.640)	(-1.019)
Dummy for divorce or separation of family	0.042	0.09	-0.187	-0.23
	-0.264	-0.498	(-1.150)	(-1.433)
Dummy for place employment shutdown or job loss	-0.208	-0.13	-0.134	-0.114
	(-1.600)	(-0.810)	(-1.384)	(-1.104)

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Table A4.12 *Regression of change in z-score of height-for-age (dependent variable= change in z-score of height-for-age)* continued

	OLS Rural	IV Rural	OLS Urban	IV Urban
Shocks before the child was born (S_{t-2})				
Dummy for decrease in food availability	-0.159**	-0.160*	0.113	0.065
	(-2.268)	(-1.915)	-1.317	-0.599
Dummy for livestock death	0.107	0.085	0.08	0.081
	-1.543	-1.01	-0.438	-0.581
Dummy for crops failure	-0.01	0.1	-0.253	-0.215
	(-0.140)	-0.812	(-1.575)	(-1.099)
Dummy for death/reduction in household members	-0.288**	-0.355**	-0.176	-0.139
	(-2.500)	(-2.502)	(-1.068)	(-0.865)
Dummy for job loss/source of income/family enterprise	-0.022	-0.093	-0.139	-0.082
	(-0.198)	(-0.649)	(-1.361)	(-0.587)
Dummy for divorce or separation	-0.522***	-0.664***	0.294*	0.348
	(-3.121)	(-2.607)	-1.854	-1.495
Constant	-1.111***	-1.664***	-1.478***	-1.865***
	(-7.672)	(-3.503)	(-7.282)	(-3.375)
Number of observations (N)	1,101	1,101	734	734
R^2	0.713	0.583	0.615	0.58
Adjusted R^2	0.707	0.574	0.602	0.565
Centered R^2 (r2c)		0.583		0.58
Uncentered R^2 (r2c)		0.589		0.586
Underidentification test (Kleibergen-Paap rk LM statistic) (idstat)		4.235		6.505
P-value for underidentification test (idp)		0.12		0.039
Hansen J statistics (overidentification test of all instruments) (j)		0.026		0.196
P-value for overidentification test (jp)		0.873		0.658
First stage regression				
R^2		0.061		0.097
Partial R^2 of excluded instruments		0.015		0.011
Test of excluded instrument (F and P value)		5.15 (0.002)		4.53(0.011)

Note: Figures in parentheses are t-ratio; *** p<0.01, ** p<0.05, * p<0.1; p stands for the lowest level of probability at which the parameter is different from zero.

v1 are full model and v2 are restricted model where variables whose t-values less than one are excluded.

Endogenous variable is z-score height-for-age (age in months) in Round 1.

Excluded the instruments: dummy variables for the child who had a long-term health problem and dummy variable for the household which had severe illness or injury.

	Rural		Urban	
Tests of endogeneity of:	r1_zhfa		r1_zhfa	
H0:	Regressor is exogenous		Regressor is exogenous	
Wu-Hausman F test:	1.46 F(1,1076)	P-value = 0.22602	0.55 F(1,708)	P-value = 0.46
Durbin-Wu-Hausman chi-sq test:	1.50 Chi-sq(1)	P-value = 0.22	0.57 Chi-sq(1)	P-value = 0.45

Source: own computation

Table A4.13 *Regression of change ln height (dependent variable = Change in ln of height)*

	OLS Rural	IV Rural	OLS Urban	IV Urban
Ln of height of a child in centimetres in Round 1	-0.688***	-1.000***	-0.656***	-0.634***
	(-31.516)	(-13.019)	(-20.815)	(-7.362)
Wealth index for 1-year-olds in Round 1	0.202***	0.227***	0.070*	0.068
	-4.242	-4.176	-1.787	-1.605
Square of wealth index in Round 1	-0.386**	-0.395**	-0.028	-0.025
	(-2.276)	(-2.008)	(-0.512)	(-0.464)
Age of the child in months in Round 2	0.006***	0.004***	-0.001	-0.001
	-5.205	-4.416	(-0.977)	(-1.122)
Dummy for male	0.001	0.007**	-0.009***	-0.009***
	-0.425	-2.058	(-2.777)	(-2.721)
Number of children below 7 and above 65 years old	-0.003	-0.004**	-0.001	-0.001
	(-1.528)	(-2.070)	(-0.221)	(-0.222)
Number of children between 7 and 17 years old	0.001	0.002**	0	0
	-1.414	-2.066	(-0.024)	(-0.082)
Number of male family members > 17 and less than 65 years	-0.001	-0.004	0	0
	(-0.497)	(-1.262)	(-0.057)	(-0.088)
Number of female family members > 17 and less than 65 years	-0.001	-0.002	0.005**	0.005**
	(-0.342)	(-0.597)	-2.237	-2.514
Shocks after the child was born (S_{t-1})				
Dummy for illness	-0.002	0.002	0.002	0.002
	(-0.583)	-0.587	-0.645	-0.541
Dummy for death	-0.004	-0.002	0.003	0.002
	(-0.749)	(-0.359)	-0.54	-0.478
Dummy for theft	0.002	0.003	-0.011*	-0.011**
	-0.616	-0.699	(-1.880)	(-2.256)
Dummy for increased input prices	0.001	0.002	0.003	0.002
	-0.294	-0.606	-0.684	-0.551
Dummy for decreased output prices	0.014***	0.017***	-0.027	-0.026***
	-2.752	-2.873	(-1.486)	(-3.171)
Dummy for death of livestock	-0.004	-0.004	0.009	0.009
	(-1.332)	(-1.200)	-1.354	-1.577
Dummy for drought, crop failure, pests and diseases	-0.005*	-0.003	0.001	0.002
	(-1.697)	(-1.057)	-0.129	-0.27
Dummy for natural disaster including drought	-0.009***	-0.009***	-0.009	-0.009
	(-2.751)	(-2.663)	(-1.237)	(-1.536)
Dummy for divorce or separation of family	0.003	0.003	-0.01	-0.01
	-0.389	-0.451	(-1.445)	(-1.391)
Dummy for place employment shutdown or job loss	-0.010*	-0.007	-0.005	-0.005
	(-1.679)	(-1.178)	(-1.267)	(-1.105)

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Table A4.13 *Regression of change ln height (dependent variable = Change in ln of height)* continued

	OLS Rural	IV Rural	OLS Urban	IV Urban
Shocks before the child was born (S_{t-2})				
Dummy for decrease in food availability	-0.008**	-0.008**	0.006	0.006
	(-2.367)	(-2.175)	-1.566	-1.645
Dummy for livestock death	0.004	0.005	0.004	0.005
	-1.312	-1.342	-0.546	-0.77
Dummy for crops failure	0	0.003	-0.01	-0.011
	-0.01	-0.679	(-1.368)	(-1.266)
Dummy for death/reduction in household members	-0.013**	-0.016***	-0.008	-0.008
	(-2.442)	(-2.763)	(-1.109)	(-1.228)
Dummy for job loss/source of income/family enterprise	-0.001	-0.003	-0.005	-0.006
	(-0.249)	(-0.483)	(-1.152)	(-1.291)
Dummy for divorce or separation	-0.027***	-0.029***	0.012*	0.011
	(-3.482)	(-2.813)	-1.677	-1.125
Age of the child in months in Round 1	-0.006***		0	
	(-4.500)		-0.336	
Constant	2.987***	4.395***	3.238***	3.138***
	-25.459	-15.891	-22.484	-10.123
Number of observations	1,101	1,101	734	734
R^2	0.61	0.536	0.544	0.544
Adjusted R^2	0.601	0.525	0.527	0.528
Centered R^2 (r2c)		0.536		0.544
Uncentered R^2 (r2c)		0.984		0.988
Underidentification test (Kleibergen-Paap rk LM statistic) (idstat)		98.841		32.586
P-value for underidentification test (idp)		0		0
Hansen J statistics (overidentification test of all instruments) (j)		0.243		0.762
P-value for overidentification test (jp)		0.886		0.683
First stage regression				
R^2		0.355		0.451
Partial R^2 of excluded instruments		0.117		0.085
Test of excluded instrument (F and P value)		22.71 (0.000)		23.61(0.000)

Note: Figures in parentheses are t-ratio; *** p<0.01, ** p<0.05, * p<0.1; p stands for the lowest level of probability at which the parameter is different from zero.

v1 are full model and v2 are restricted model where variables whose t-values less than one are excluded.

Endogenous variable is height-for-age (age in months) in Round 1.

Excluded the instruments: dummy variables for the child who had a long-term health problem and dummy variable for the household which had severe illness or injury.

	Rural		Urban	
Tests of endogeneity of:	lnH1		lnH1	
H0:	Regressor is exogenous		Regressor is exogenous	
Wu-Hausman F test:	16.96 F(1,1075)	P-value = 0.000	0.02369 F(1,707)	P-value = 0.878
Durbin-Wu-Hausman chi-sq test:	17.105 Chi-sq(1)	P-value = 0.000	0.02459 Chi-sq(1)	P-value = 0.87

Source: own computation

Table A4.14 *Regression of changes in height-for-age without wealth*

	OLS Rural	IV Rural	OLS Urban	IV Urban
Height-for-age (age in months) for Round 1 data	-0.957***	-0.959***	-0.957***	-0.958***
	(-741.203)	(-52.512)	(-541.849)	(-71.224)
Dummy for male	0.003	0.003	-0.012*	-0.012*
	-0.617	-0.626	(-1.883)	(-1.792)
Number of children below 7 and above 65 years old	-0.007**	-0.007	-0.001	-0.001
	(-2.249)	(-1.470)	(-0.163)	(-0.154)
Number of children between 7 and 17 years old	0.003	0.003	0.005*	0.005*
	-1.372	-1.365	-1.855	-1.835
Number of male family members > 17 and less than 65 years	-0.004	-0.004	0	0.001
	(-0.740)	(-0.727)	-0.076	-0.123
Number of female family members > 17 and less than 65 years	0.001	0.001	0.011***	0.012***
	-0.222	-0.139	-2.843	-3.078
Dummy for illness	0	0	0.001	0
	(-0.028)	(-0.026)	-0.106	-0.058
Dummy for death	-0.003	-0.003	-0.002	-0.002
	(-0.322)	(-0.316)	(-0.162)	(-0.237)
Dummy for theft	-0.001	-0.001	-0.020*	-0.019*
	(-0.123)	(-0.147)	(-1.780)	(-1.670)
Dummy for increased input prices	0.004	0.004	0.013	0.013
	-0.743	-0.778	-1.544	-1.366
Dummy for decreased output prices	0.035***	0.035***	-0.047	-0.046***
	-3.766	-3.533	(-1.295)	(-3.724)
Dummy for death of livestock	-0.005	-0.005	0.001	0.001
	(-0.987)	(-1.056)	-0.052	-0.074
Dummy for drought, crop failure, pests and diseases	-0.001	-0.001	0.004	0.004
	(-0.172)	(-0.182)	-0.269	-0.222
Dummy for natural disaster including drought	-0.021***	-0.021***	-0.028**	-0.027**
	(-3.678)	(-3.722)	(-1.970)	(-2.251)
Dummy for divorce or separation of family	0.001	0.002	-0.02	-0.019
	-0.063	-0.106	(-1.392)	(-1.488)
Dummy for place employment shutdown or job loss	-0.004	-0.004	-0.01	-0.01
	(-0.390)	(-0.427)	(-1.228)	(-1.174)
Dummy for decrease in food availability	-0.015**	-0.015**	0	0
	(-2.555)	(-2.407)	-0.032	(-0.008)
Dummy for livestock death	0.010*	0.01	0.003	0.004
	-1.79	-1.381	-0.174	-0.299
Dummy for crops failure	0.011*	0.011*	-0.034**	-0.034**
	-1.775	-1.731	(-2.417)	(-2.353)
Dummy for death/reduction in household members	-0.023**	-0.023**	-0.01	-0.01
	(-2.441)	(-2.350)	(-0.686)	(-0.757)
Dummy for job loss/source of income/family enterprise	-0.008	-0.008	-0.01	-0.009
	(-0.890)	(-0.905)	(-1.075)	(-0.915)

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Table A4.14 *Regression of changes in height-for-age without wealth* continued

	OLS Rural	IV Rural	OLS Urban	IV Urban
Dummy for divorce or separation	-0.047***	-0.047***	0.030**	0.029*
	(-3.373)	(-2.643)	-2.171	-1.749
Constant	1.419***	1.431***	1.409***	1.416***
	-104.08	-12.386	-91.59	-17.836
Number of observations	1,101	1,101	734	734
R^2	0.998	0.998	0.998	0.998
Adjusted R^2	0.998	0.998	0.998	0.998
Centered R^2 (r2c)		0.998		0.998
Uncentered R^2 (r2c)		1		1
Underidentification test (Kleibergen-Paap rk LM statistic) (idstat)		7.169		13.306
P-value for underidentification test (idp)		0.028		0.001
Hansen J statistics (overidentification test of all instruments) (j)		0.073		0.296
P-value for overidentification test (jp)		0.787		0.587

Note: Figures in parentheses are t-ratio; *** $p<0.01$, ** $p<0.05$, * $p<0.1$; p stands for the lowest level of probability at which the parameter is different from zero;

v1 are full model and v2 are restricted model where variables whose t-values less than one are excluded.

Endogenous variable is height-for-age (age in months) in Round 1.

Excluded the instruments: dummy variables for the childwho had a long-term health problem and dummy variable for the household which had severe illness or injury.

Source: own computation

Table A4.15 *Regression of changes in z-score of height-for-age without wealth*

	OLS Rural	IV Rural	OLS Urban	IV Urban
Length/height-for-age z-score	-0.769***	-1.023***	-0.732***	-0.913***
	(-48.840)	(-4.027)	(-31.610)	(-3.583)
Dummy for male	0.031	-0.048	-0.166**	-0.234*
	-0.515	(-0.479)	(-2.228)	(-1.939)
Number of children below 7 and above 65 years old	-0.083**	-0.099**	-0.02	-0.032
	(-2.038)	(-2.041)	(-0.368)	(-0.538)
Number of children between 7 and 17 years old	0.027	0.047	0.018	0.032
	-1.164	-1.463	-0.643	-0.902
Number of male family members > 17 and less than 65 years	-0.049	-0.102	0.013	0.052
	(-0.776)	(-1.153)	-0.277	-0.736
Number of female family members > 17 and less than 65 years	-0.012	-0.037	0.134***	0.142***
	(-0.162)	(-0.481)	-2.876	-3.148
Dummy for illness	-0.109*	-0.018	0.021	0.014
	(-1.680)	(-0.145)	-0.268	-0.175
Dummy for death	-0.076	-0.043	0.045	-0.006
	(-0.696)	(-0.351)	-0.42	(-0.046)
Dummy for theft	0.03	0.025	-0.230*	-0.198
	-0.363	-0.291	(-1.802)	(-1.629)
Dummy for increased input prices	-0.002	0.042	0.104	0.094
	(-0.036)	-0.477	-1.062	-0.857
Dummy for decreased output prices	0.308***	0.364***	-0.626	-0.772**
	-2.718	-2.617	(-1.507)	(-2.374)
Dummy for death of livestock	-0.101	-0.094	0.075	0.08
	(-1.528)	(-1.301)	-0.491	-0.519
Dummy for drought, crop failure, pests and diseases	-0.1	-0.058	0.039	-0.111
	(-1.504)	(-0.708)	-0.209	(-0.404)
Dummy for natural disaster including drought	-0.212***	-0.235***	-0.292*	-0.216
	(-3.059)	(-2.955)	(-1.790)	(-1.175)
Dummy for divorce or separation of family	0.027	0.058	-0.24	-0.292
	-0.167	-0.343	(-1.468)	(-1.632)
Dummy for place employment shutdown or job loss	-0.179	-0.112	-0.141	-0.116
	(-1.362)	(-0.751)	(-1.436)	(-1.119)
Dummy for decrease in food availability	-0.193***	-0.204***	0.082	0.03
	(-2.724)	(-2.636)	-0.945	-0.261
Dummy for livestock death	0.118*	0.103	0.028	0.02
	-1.676	-1.324	-0.155	-0.139
Dummy for crops failure	0.025	0.115	-0.323**	-0.313*
	-0.346	-0.966	(-1.997)	(-1.711)
Dummy for death/reduction in household members	-0.307***	-0.364***	-0.168	-0.131
	(-2.630)	(-2.756)	(-1.009)	(-0.800)
Dummy for job loss/source of income/family enterprise	-0.018	-0.069	-0.127	-0.067
	(-0.157)	(-0.522)	(-1.227)	(-0.468)
Dummy for divorce or separation	-0.468***	-0.560**	0.26	0.3
	(-2.765)	(-2.333)	-1.623	-1.344

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Table A4.15 *Regression of changes in z-score of height-for-age without wealth* continued

	OLS Rural	**IV Rural**	**OLS Urban**	**IV Urban**
Constant	-0.809***	-1.138***	-0.966***	-1.156***
	(-5.958)	(-3.157)	(-7.161)	(-3.830)
Number of observations	1,101	1,101	734	734
R^2	0.705	0.633	0.604	0.57
Adjusted R^2	0.699	0.626	0.592	0.557
Centered R^2 (r2c)		0.633		0.57
Uncentered R^2 (r2c)		0.639		0.576
Underidentification test (Kleibergen-Paap rk LM statistic) (idstat)		4.983		6.28
P-value for underidentification test (idp)		0.083		0.043
Hansen J statistics (overidentification test of all instruments) (j)		0		0.548
P-value for overidentification test (jp)		1		0.459

Note: Figures in parentheses are t-ratio; *** p<0.01, ** p<0.05, * p<0.1; p stands for the lowest level of probability at which the parameter is different from zero.

v1 are full model and v2 are restricted model where variables whose t-values less than one are excluded.

Endogenous variable is z-score height-for-age (age in months) in Round 1.

Excluded the instruments: dummy variables for the child who had a long-term health problem and dummy variable for the household which had severe illness or injury.

Source: own computation

Table A4.16 *Regression of change in ln of height in centimetres without wealth*

	OLS Rural	IV Rural	OLS Urban	IV Urban
Ln of height of a child in centimetres in Round 1	-0.678***	-0.991***	-0.634***	-0.616***
	(-30.719)	(-13.267)	(-20.214)	(-7.618)
Age of the child in months in Round 2	0.006***	0.004***	-0.001	-0.001
	-5.087	-4.35	(-1.059)	(-1.300)
Dummy for male	0.001	0.007**	-0.008**	-0.008**
	-0.481	-2.122	(-2.505)	(-2.424)
Number of children below 7 and above 65 years old	-0.003*	-0.005**	-0.001	-0.001
	(-1.760)	(-2.296)	(-0.578)	(-0.558)
Number of children between 7 and 17 years old	0.001	0.002*	0	0
	-1.161	-1.811	-0.15	-0.094
Number of male family members > 17 and less than 65 years	-0.002	-0.004	0.001	0.001
	(-0.653)	(-1.407)	-0.62	-0.637
Number of female family members > 17 and less than 65 years	-0.001	-0.001	0.006***	0.006***
	(-0.161)	(-0.381)	-2.67	-3.025
Dummy for illness	-0.005*	-0.002	0.002	0.001
	(-1.707)	(-0.532)	-0.532	-0.403
Dummy for death	-0.004	-0.002	0.002	0.002
	(-0.767)	(-0.344)	-0.505	-0.397
Dummy for theft	0.001	0.002	-0.010*	-0.009*
	-0.378	-0.436	(-1.694)	(-1.907)
Dummy for increased input prices	0	0.002	0.003	0.002
	-0.159	-0.492	-0.693	-0.521
Dummy for decreased output prices	0.014***	0.016***	-0.031*	-0.030***
	-2.628	-2.736	(-1.685)	(-3.172)
Dummy for death of livestock	-0.004	-0.004	0.005	0.006
	(-1.379)	(-1.284)	-0.787	-0.882
Dummy for drought, crop failure, pests and diseases	-0.005	-0.003	-0.001	0
	(-1.610)	(-0.994)	(-0.132)	(-0.032)
Dummy for natural disaster including drought	-0.010***	-0.010***	-0.01	-0.010*
	(-3.045)	(-3.025)	(-1.400)	(-1.663)
Dummy for divorce or separation of family	0.002	0.002	-0.013*	-0.012
	-0.289	-0.305	(-1.734)	(-1.596)
Dummy for place employment shutdown or job loss	-0.009	-0.006	-0.006	-0.005
	(-1.446)	(-0.917)	(-1.333)	(-1.134)
Dummy for decrease in food availability	-0.009***	-0.009***	0.004	0.005
	(-2.814)	(-2.684)	-1.156	-1.203
Dummy for livestock death	0.005	0.005	0.002	0.003
	-1.46	-1.463	-0.295	-0.482
Dummy for crops failure	0.002	0.004	-0.012*	-0.014
	-0.523	-1.207	(-1.739)	(-1.593)
Dummy for death/reduction in household members	-0.014***	-0.017***	-0.008	-0.008
	(-2.577)	(-2.928)	(-1.051)	(-1.164)
Dummy for job loss/source of income/family enterprise	-0.001	-0.003	-0.005	-0.005
	(-0.205)	(-0.458)	(-1.024)	(-1.158)

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Table A4.16 *Regression of change in ln of height in centimetres without wealth* continued

	OLS Rural	IV Rural	OLS Urban	IV Urban
Dummy for divorce or separation	-0.024***	-0.026**	0.01	0.009
	(-3.109)	(-2.507)	-1.439	-0.99
Age of the child in months in Round 1	-0.006***		0	
	(-4.519)		-0.284	
Constant	2.964***	4.386***	3.169***	3.089***
	-24.965	-16.219	-21.876	-10.461
Number of observations	1,101	1,101	734	734
R^2	0.598	0.522	0.532	0.531
Adjusted R^2	0.589	0.512	0.516	0.516
Centered R^2 (r2c)		0.522		0.531
Uncentered R^2 (r2c)		0.984		0.988
Underidentification test (Kleibergen-Paap rk LM statistic) (idstat)		100.954		36.333
P-value for underidentification test (idp)		0		0
Hansen J statistics (overidentification test of all instruments) (j)		0.02		1.093
P-value for overidentification test (jp)		0.99		0.579

Note: Figures in parentheses are t-ratio; *** $p<0.01$, ** $p<0.05$, * $p<0.1$; p stands for the lowest level of probability at which the parameter is different from zero.

v1 are full model and v2 are restricted model where variables whose t-values less than one are excluded.

Endogenous variable is height-for-age (age in months) in Round 1.

Excluded the instruments: dummy variables for the child had long-term health problem and dummy variable for the household had severe illness or injury.

Source: own computation

Appendix B: Definitions of wealth and asset indices

Definition of wealth index

An important variable in YL data is the wealth index, which attempts to measure the relative poverty status of households. The wealth index was constructed based on the following variables:

- The number of rooms per person as a continuous variable;
- A set of 11 consumer durable dummy variables, each equal to one if a household member owned a radio, fridge, bicycle, TV, motorbike/scooter, motor vehicle, mobile phone, landline phone, modern bed, table or chair, and sofa;
- A set of three dummy variables equal to one if the house had electricity, brick or plastered wall, or a sturdy roof (such as corrugated iron, tiles or concrete);
- A dummy variable equal to one if the dwelling floor was made of a finished material (such as cement, tile or a laminated material);
- A dummy variable equal to one if the household's source of drinking water was piped into the dwelling or yard;
- A dummy variable equal to one if the household had a flush toilet or pit latrine; and
- A dummy variable equal to one if the household used electricity, gas or kerosene.

The wealth index captures variables that are broader than production assets, such as home ownership and the durability of that home, plus access to infrastructure such as water and sanitation. The construction of the wealth index is summarised in the following table.

Table B1 *Construction of the wealth index*

Components of index and score	Contributing variables
H = Housing quality (/4)	Rooms/person, wall, roof, floor durability.
CD = Consumer durables (/11)	Radio, fridge, bicycle, TV, motorbike/scooter, motor vehicle, mobile phone, landline phone, modern bed, table or chair and sofa.
S = Services (/4)	Electricity, water, sanitation, cooking fuel.
Wealth index = (H+CD+S)/3 Range = 0.0 – 1.0	

Method used to construct asset index

The asset index is constructed in such a way that the possible values of the index are between 0 and 1, possibly inclusive. It is calculated so that the asset index for Round 1 is comparable to that for Round 2. The asset index is calculated as a simple average of the following five separate indices (each of which are between 0 and 1): livestock, land held, house owned, consumer durables owned and productive assets.

These five indices are in turn calculated as follows.

Livestock owned: the livestock are classified into the following four groups, with the weights (tropical livestock units, TLUs) attached to each group indicated in parentheses: draught animals (1); cattle (0.7); sheep, goat and pig (0.15); and rabbit and poultry (0.05). For each of these four groups of livestock, the maximum number of livestock owned by a household in each cohort (and for both rounds) is also taken into account in the computation.

Land held: this index is calculated as the ratio of land owned by the household to the maximum land size owned by a household in each cohort (and for both Rounds).

House owned: This is a dummy variable which is 1 if the household owned the house it lived in and 0 if it did not.

Consumer durables: This is calculated the same way it is calculated for the computation of wealth index. Thus, dummy variables for ownership of 11 items were assigned and the simple average of this variable is calculated.

Productive assets: There were two productive assets on which data exists about ownership in the two Rounds. These are pump and sewing machine. We used dummy variables to identify those who owned the item (with a value of 1) from those who do not (with a value of 0). We also used the average prices reported for these items in the surveys as weights to calculate a weighted average.

Young Lives is an innovative long-term international research project investigating the changing nature of childhood poverty.

The project seeks to:

- improve understanding of the causes and consequences of childhood poverty and to examine how policies affect children's well-being
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Young Lives Partners

Young Lives is coordinated by a small team based at the University of Oxford, led by Jo Boyden.

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Centre for Economic and Social Sciences, Andhra Pradesh, India

Save the Children – Bal Raksha Bharat, India

Sri Padmavathi Mahila Visvavidyalayam (Women's University), Andhra Pradesh, India

Grupo de Análisis para el Desarollo (Group for the Analysis of Development), Peru

Instituto de Investigación Nutricional (Institute for Nutritional Research), Peru

Centre for Analysis and Forecast, Vietnamese Academy of Social Sciences, Vietnam

General Statistics Office, Vietnam

Save the Children, Vietnam

The Institute of Education, University of London, UK

Child and Youth Studies Group (CREET), The Open University, UK

Department of International Development, University of Oxford, UK

Save the Children UK (staff in the Policy Department in London and programme staff in Ethiopia).

Young Lives
An International Study of Childhood Poverty

Department of International Development
University of Oxford
3 Mansfield Road, Oxford OX1 3TB, UK

Tel: +44 (0)1865 281751
Fax: +44 (0)1865 281801
Email: younglives@younglives.org.uk

www.younglives.org.uk