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Working Paper

What drives child health improvements in Indonesian households? A micro-level perspective on complementarities in MDG achievements

Discussion Papers, No. 155

Provided in Cooperation with:

Courant Research Centre 'Poverty, Equity and Growth in Developing and Transition Countries',
University of Göttingen

Suggested Citation: Lo Bue, Maria Carmela (2014) : What drives child health improvements in Indonesian households? A micro-level perspective on complementarities in MDG achievements, Discussion Papers, No. 155, Georg-August-Universität Göttingen, Courant Research Centre - Poverty, Equity and Growth (CRC-PEG), Göttingen

This Version is available at:

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‘Poverty, Equity and Growth in Developing and Transition Countries: Statistical Methods and Empirical Analysis’

Georg-August-Universität Göttingen
(founded in 1737)



Discussion Papers

No. 155

What drives child health improvements in Indonesian households? A micro-level perspective on complementarities in MDG achievements

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January 2014

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Abstract: Using panel data from Indonesia, this paper analyzes the linkages between child nutrition, health care, household wealth and parental education in order to detect transmission channels between health, education, nutrition, water and sanitation access, five critical MDG targets. This paper therefore also aims at providing an empirical analysis of the drivers of complementarities between these goals at the micro level micro-level perspective. We find that maternal education has a positive and long term effect on child health and that this effect is partly reflected in reproductive behavior and partly conveyed to child health outcomes through child caring practices such as breastfeeding. Although we cannot rule out the existence of strong complementarities existing between household wealth or income and child health, the effect of positive changes in this variable appears to be present only in the short term. On the other hand, there are supply-side factors such as lack of sanitation and access to health facilities which also strongly affect children in terms of anthropometric outcomes.

JEL Classification: I120, I30, O150

Keywords: Millennium Development Goals, Child undernutrition, Panel data, Mundlak model, Indonesia.

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Introduction

The reduction of child malnutrition represents a key challenge for the development community and has rightly been included as one of the MDGs. Other MDGs, such as promoting education, reducing gender gaps in education, and providing water and sanitation access are likely to affect nutrition outcomes but these complementarities between MDGs have not been studied in great detail at the micro level.

Many empirical studies have been carried out with the purpose of analyzing these determinants using a macro perspective. The studies relying on cross-country data provide us with quite mixed evidence supporting the existence and strength of the complementarities between child health and other income and non-income related MDGs indicators such as education, improved water, sanitation facilities and access to health infrastructure (Fay et al. 2005; Potts and Foso, 2007; Lo Bue and Klasen, 2013). A plausible explanation for these mixed findings provided in the macro studies could be related to the fact that important child and household characteristics which represent the bulk of the models of child health are lost in the aggregation process at the national level.

On the other hand, there is a micro literature studying the determinants of nutritional outcomes. A long-standing number of such empirical studies, inspired by the pioneering article by Caldwell (1979), have extensively argued that there exists a positive correlation between maternal education and child health, as better educated mothers are supposed to be more capable of earning money and might also be better able to process information and acquire skills to take care of the children. Alternatively, income alone may play an independent role in enhancing child health as having more resources available to a household should translate into higher expenditures on food and health. In poor environmental settings, lack of access to

material resources and meager living conditions may actually represent the most important obstacle to being adequately nourished and healthy. Nonetheless, the issue regarding the mechanisms lying behind the relationship that links child health, mother's education and household wealth still remains an important field of research as up until now-there seems to be no clear consensus on the transmission channels that lead to better health outcomes. In particular, a number of studies (Alderman, 1990; Sahn, 1994; Thomas et al., 1996; Desai and Alva, 1998) have failed to find a strong causal association between maternal education and child health outcomes. As discussed in Desai and Alva (1998), this weak evidence supporting the positive role of maternal education may be attributed to the fact that this variable is mostly a proxy for socioeconomic status and hence its effect vanishes once controlling for income.

This article contributes to improving the previous literature in a number of aspects which so far have received only limited attention. First, we argue that these determinants of undernutrition operate in a dynamic framework involving substantial time lags which is rarely captured in the literature. Indeed, the vast majority of published studies on this issue has solely relied on cross-sectional data -which although being useful in providing information on the total effect of maternal education and income-arguably informs us of the pathways through which these variables operates. Repeated observations which are available in longitudinal data have the advantage of improving the efficiency with which the relationship between these key factors can be assessed, as this data allows us to control for both the observables and the unobservables that often invalidate purely cross-sectional analyses. Moreover, longitudinal data gives us more confidence in analyzing such a complex relationship as it enables us to better examine the effects of proximate determinants (i.e. personal illness control as well as use and access to health

infrastructure) and other lagged health determinants (i.e. breastfeeding). Lastly, by relying on the dynamic essence of longitudinal data it is possible to account for the time-varying effects of explanatory variables and hence to follow the child over time. Second, the econometric model we use allows us to properly identify the effect of community, household and individual level variables on child health outcomes while accounting for household-level unobserved heterogeneity and-at the same time-considering the variation occurring between households. In order to analyze the transmission channels, we first estimate a simple linear probability model for breastfeeding which is unarguably considered as one of the most important proximate determinants of a child's health. Then -following Lay and Robiliard (2009) -we look at the gross effect of mothers' education on child nutrition and lastly link the two approaches by setting a full model which includes both the socioeconomic and proximate determinants of child nutrition.

Third, as the main focus of this study is on the dynamics of the relationship that links child nutrition, household income poverty and female education, we also advance our understanding of the complementarities which exist at the household level between different Millennium Development Goals (or MDGs, hereafter). The MDGs, which undoubtedly encapsulate key human development aspects, have certainly been successful in kindling commitments, efforts and actions at both the national and international level. Nevertheless, as up-to-date literature suggests, there is mixed progress towards the achievement of these goals (see Camfield et al. 2013; Klasen, 2012; Fukuda Parr et al. 2012; Karver et al. 2012). Perhaps the reasons for the failures and successes of the MDGs process are ascribable to different measurement and interpretation issues. Yet that is not what the current discussion on the MDGs post-2015 is focused on, instead it is ultimately concerned with what should be preserved

and what should be renewed in the system. One of the possible challenges pertains to the number of the goals. Are the MDGs too many or too few to capture the breadth of the UN Millennium Declaration? Which are the MDGs that can be said to have a leading role in fuelling improvements in other goals? This paper also contributes to this debate by examining the complementarities between some of the MDGs, while focusing on the determinants and transmission channels of child nutrition (MDG 1).

The remainder of this paper is organized as follows: Section 2 provides the literature background on the determinants of child health, from both the theoretical and empirical perspectives. Section 3 describes the data and outlines the main trends in child health outcomes and its determinants. In Section 4 we first present a simple model of the determinants of child health and proceed by showing our empirical results. The fifth Section concludes and points to research and policy issues which emerge from our findings.

2 The determinants of child health: theoretical background

The purpose of this study is to provide an empirical analysis of the determinants of child health. In doing so, the paper makes the case that the interplay between both demand side and supply side factors (which are themselves encapsulated in some of the MDGs) may have to go along several channels in order to affect child anthropometric developments.

Our approach largely relies on the analytical framework proposed by Mosley and Chen (1984). Although their approach is primarily concerned with child mortality, we broaden it to include other less severe aspects of child health. Even though child undernutrition is at first glance a biological event, it is not just merely determined by specific genetic endowments as there is a wide range of cultural, environmental,

socio-economic and behavioural factors which all influence the likelihood of ill health in early childhood.

Mosley and Chen's study has so far been one of the most frequently referenced articles in all the subsequent literature which has attempted to investigate the determinants of child health and mortality. The framework they design is indeed a useful tool which integrates research strategies employed by medical and social scientists while, at the same time, being closely connected to Caldwell's pioneering theory on the role of maternal education for child health (Caldwell 1979). The underlying idea of this framework is that the factors which may affect child health operate through different stages. The first stage is that of the so-called proximate determinants which directly influence child health. They comprise maternal factors (such as age at birth, parity and birth intervals); environmental conditions (i.e. water contamination and other hygienic factors); nutrition deficiency; as well as injury and personal illness control (use of preventive services, antenatal care, and use of curative measures for specific purposes). This set of proximate determinants can also be depicted as a pass through which a second set of variables affect individual health. These are the socio-economic determinants of child health which can be grouped at different levels: at the individual level (i.e. parental skills, health, time, values, beliefs and preferences); at the household level (income/wealth, intra-household decision power; quality of water supply, housing conditions) and at the community level where they range from ecological environmental factors (i.e. climate, altitude, rainfall) up to health system variables and political economy variables (i.e. physical infrastructure, organization of food production).

In a similar fashion, Schultz (1984) provides a simple model in order to estimate the possible biological and behavioural relationships that influences people's

opportunities and in turn their use of health related inputs, may affect child survival and health outcomes. Schultz provides an interesting framework that distinguishes the independent or exogenous variables from the dependent or endogenous variables used in studies of child mortality determinants and also identifies their level of aggregation (household or community).

Schultz's model departs from the identification of a health production function in which child mortality or morbidity linearly depends on a vector of proximate biological inputs as well as of a vector of persistent biological endowments of the child. So it is assumed that mothers choose the intermediate inputs in order to minimize the risk of mortality and morbidity of their child and to achieve other goals given their resource constraints. Hence these intermediate health inputs will be partly influenced by child health endowments which are due to genetic or environmental conditions and are out of the control of the family's behaviour; and partly by the socio-economic endowments of the family (including human and non human capital) and by the community-level factors such as prices, programs and environmental constraints and parents preferences.

It is of crucial importance to note that household and individual characteristics not only interact with each other but also with external factors, such as those linked to social norms, and traditions which can directly influence parental decisions regarding, for example, nutrition choices and health practices for their offspring. On the other hand, the effect of some crucial community-level variables such as the availability of vaccines and the presence of a health facility can be boosted or muffled by household and individual-level characteristics such as the willingness to use and the ability to pay for health services.

Thus, this theoretical guide leads us to postulate the existence of strong complementarities in a core set of the MDGs: child morbidity and mortality (MDG 1 and 4); mothers' education and their intra-household decision power (MDG 2 and 3); household wealth (MDG 1) and the presence of adequate sanitation infrastructure and health services (MDG 7).

It is worth to note that a large number of studies have analyzed empirically the determinants of child health by means of relying on the Mosley and Chen analytical framework, but they have done so along several different pathways (Hill, Bicego et al., 2001; Lay and Robilliard, 2009).

A first approach has linked the socio-economic factors to the proximate determinants of child health. This link has been explained for example by the strong interconnections existing between maternal education attainment and an increased ability to buy goods and services linked to health outcomes (Victora, Smith, Vaughan, 1986; Cleland and Van Ginneken, 1988; Defo, 1997). Also, higher levels of household incomes were found to be significantly correlated with better housing conditions such as latrine facilities, piped water and electricity (Barret and Browne, 1996; Defo, 1997; Martin et al., 1983) and a better ability to buy nutritional food, medicines, warm clothing and health care services which impact children's health. Many other studies have linked maternal education and reproductive behaviours, finding significant associations between higher education and lower fertility, reproduction at low risk ages, and longer birth intervals (Cleland and Van Ginneken, 1988). Although this type of approach is able to give us a clearer picture on how strong the complementarities can be at the very first stage of the framework conceived by Mosley and Chen, it neglects how child health outcomes can be influenced by these factors.

A second approach has instead focused more on the relationship between child morbidity or mortality outcomes and their proximate determinants and have confirmed the existence of a significant effect of water, sanitation, and hygiene on child health (see, *inter alia*, Esrey et al., 1991; Rutstein, 2000; Wang 2003).

On the other hand, another strand of the literature has attempted to include both socio-economic and proximate determinants in the estimation strategy. This approach appears to be more complete since it basically empirically traces all the links pointed out in the Mosley and Chen's theoretical framework.

Several studies found birth intervals, breastfeeding, birth order and maternal health to be significant on child stunting once controlling for important socio-economic variables such as maternal education or household wealth (Sommerfelt and Stewart, 1994; Forste, 1998; Boerma et al., 1991; Harttgen et al., 2013).

By relying on graphical chain models, Caputo et al., 2003 and Foraita et al., 2008 model the dependence chain of the immediate, intermediate and underlying factors affecting undernutrition and find that mother's education has strong indirect linkages to undernutrition through the effect that it has on important proximate factors such as the access to vaccination, the availability of water and breastfeeding practices.

Other empirical approaches have instead linked the socio-economic factors and child health outcomes through focusing more on the role of certain mediating factors such as mothers' health knowledge (Thomas Strauss and Henriques; 1991; Glewwe, 1999).

Lastly, based on DHS data from Bolivia, Frost et al. (2004) attempt to reconcile the literature on the transmission channels linking maternal education and child health by modeling the effects of socioeconomic status, knowledge, modern attitudes about health care, autonomy and reproductive behavior.

It is worth to note that even this more complete strand of the empirical literature has its own limitations. Indeed, up to date the vast majority of published studies on this field have solely relied on cross sectional data. Moreover, as also pointed out in Lay and Robilliard (2009), in practice, data availability constraints and measurement problems do not allow for a complete inclusion of all the possible determinants of child health.

Lastly, in many studies the variables associated with the local health environment or any other kind of community level variables were not included. This may be one of the main reasons why—as noted by Frost et al. (2005)—the arguments which have propped up the thesis that reproductive factors are the transmission channels linking socio-economic variables and child morbidity or mortality have found mixed empirical support.

3. Data

We examine the linkages which connect socio-economic factors and proximate supply-side variables to child health outcomes in Indonesia using longitudinal household data from the Indonesia Family Life Survey (IFLS). This data appears particularly appealing in terms of representativeness of the total population, as it represents about 83 percent of the Indonesian population, covers 13 major provinces out of a total of 33 provinces in Indonesia and also shows a relatively low rate of attrition between waves (Strauss et al., 1997).

This survey suits our research questions well as it contains a wealth of information collected at the household and community level, including indicators of socio-economic well-being (expenditure, assets, housing conditions, education) as well as information on fertility, anthropometric characteristics, immunization, health status,

as well as access and use of health services. Although the IFLS surveys were originally conducted in four waves i.e. 1993, 1997, 2000, and 2007, we restrict our analysis to a ten-years time period, using data from 1997 to 2007. These three waves of the survey span a period of several different events such as the dramatic economic and political upheavals in the late 1990s at the time of the Asian Crisis, and some natural disasters (i.e. the 2004 Indian Ocean tsunami) which unexpectedly affected the Indonesian population.

Since our main variable of interest is the nutritional status of children, we only keep observations for households with children aged 0-15 years and that have their height for age z-score in the plausible range of -5 to 3 (as recommended in O' Donnell et al. 2008). Hence, our (unbalanced) panel is restricted to 2,456 households: 32.04 percent of the households were followed in all the three years; 39.85 percent in 2000 and 2007, 24.70 percent in 1997 and 2000 and 3.4 percent in 1997 and 2007.

Original data from several IFLS files has been organized so that the level of observation in our panel is the individual child to which we link information on several households, community and individual characteristics¹. Based on height and age data, our dependent variable is the child z-score which was constructed by using the international standards provided in the WHO Multicentre Growth Reference Study². As also noted by Gillespie and Haddad (2001), the child z-score is a fine anthropometric measure to capture a child's nutritional status as it reflects pre and

¹ As we are mainly interested in the nutritional status of the child (given by her height for age, z-score), we are forced to keep observations in every year only for children younger than 15. Therefore, the same child can only be observed in two or three years consecutively, depending on the age of that child in the first year he is observed.

² These standards are indeed considered to be universally applicable as they are based on a sample of children from a diverse set of countries which has a considerable built-in ethnic or genetic variability as well as cultural variation in how children are nurtured. Furthermore, by being standards (and not references) they clearly define how children should grow and identify deviations from the pattern as abnormal growth (WHO, 2006).

post-natal growth with its deficit (i.e. stunted³) showing the long-term, cumulative effects of inadequacies in nutrition and/or health.

Table 1 provides descriptive statistics for these anthropometric individual characteristics together with some information on the share of children (separately for boys and girls) who are stunting and extremely stunting (i.e. where the z-score is below the -3 standard deviation of the height-for-age norm). Additionally, Table 1 shows figures on the weight for age z-score and on the percentage of children who are underweight and extremely underweight. Average height-for-age scores are low and close to the stunting threshold, confirming the findings of several studies on this issue for the whole South-East Asian region (see, inter alia, Klasen, 2008; Harttgen and Misselhorn, 2006, Gillespie and Haddad, 2000) which attribute high rates of undernutrition partially to measurement issues, and partially to genetic factors as they may reflect delayed impacts of past undernutrition (Klasen, 2008).

Consistent with the findings provided in the empirical literature on child undernutrition (e.g. O'Donnell et al. 2008; Klasen, 1996), figure 1 (reported in the Appendix) shows that height-for-age scores decrease as the age of the child increases. Also, the percentages of children who suffer from stunting seem to be quite high, especially for boys. These results are consistent with those presented in Kevane and Levine, 2003; Ralston, 1997; Frankeberg et al., 1996; Deolalikar, 1990; Basune, 1989 and may hint at the presence of a gender-bias (disadvantaging boys) in anthropometric failures which characterize several regions of this country. One of the possible reasons for this gap lies in the fact that—because of different activity patterns—male children may have a higher exposure to disease. Also (as hypothesized by Ralston, 1997), this nutritional bias can be attributable to parental preferences that evaluate

³ According to the National Center for Health Statistics/World Health Organization International Growth Reference, children whose z-score is two standard deviation below the median height-for age curve are classified as stunted (Dibley et al., 1987).

female children as being of greater net value relative compared to male children in Indonesia, as families of male offspring must pay a bride price to the bride's family.

As our analysis also aims to investigate the linkages between socio-economic factors and the proximate determinants of child health, we report in Table 1 the descriptive statistics relative to the percentage of children who were breast-fed, immunized, and given supplementary food and Vitamin A.

As extensively confirmed by numerous medical research findings, breastfeeding is an important practice for the development of the child since the breast milk contains several nutrients which make the child more resistant to disease. Although breastfeeding does not seem to be a common practice for the majority of the Indonesian mothers in our sample, vaccination rates (against BCG, polio, DPT and measles) appear relatively good and increasing over time.

[Table 1 here]

Table 2 reports descriptive statistics relative to mothers' health and education. As the nutritional status of the mother is supposed to strongly affect the nutritional status of the child we include in our regressions a dummy variable indicating whether the body mass index of the mother was below the critical threshold of 18.5. Even so, the prevalence of mothers whose nutritional status is weak seems to be relatively low given the high prevalence of anthropometric shortfall for their children. Tetanus immunization and use of health facilities to get checkups during pregnancy have both improved over time, now covering a large share of the population examined.

Some degree of improvement in educational achievement is also recorded in the higher levels of schooling (i.e. junior and senior high school as well as university). We should indeed note that the intertemporal variation of these figures can be partially attributed to the unbalanced nature of our panel. Still, even if we look at the

figures for the balanced sample we see a very similar picture suggesting a slight improvement in educational achievement for these women. Since the mothers interviewed were aged 15-49, it is likely that many of them were still in school and actually-as these descriptive statistics suggest-continued to go to school even while being mothers.

[Table 2 here]

Descriptive statistics for households and community level variables are given in Table 3. Ownership of proper sanitation facilities has increased over time while the use of piped water remains at low levels, hence around 80 percent of these household were indeed lacking access to clean water. When we look at the figures corresponding to presence and access to health facilities we see that if, on average, access to health facilities seems not to be of particular concern and the number of health posts has improved, the standard deviation of these figures is particularly high suggesting that many families living in rural remote areas does not actually have adequate access to the health infrastructure.

Table 3 also shows the average figures for household per capita expenditure (excluding expenses on medicine and health goods) which we use as a measure of wealth/income. We find that spending levels are likely to more accurately capture levels of long-term economic resources than income, which fluctuates seasonally to a greater degree.

[Table 3 here]

It should be noted that since the data in real terms is available for all the waves except for 2007, we estimate the missing value by using the available data in nominal terms and taking into account changes that occurred in the price index over the last period in order to obtain the temporal deflator. As a potential source of concern for the

robustness of our estimates lies in the fact that expenditure might be endogenously determined, following Filmer and Pritchett (2001), we have also constructed with principal component analysis an indicator of household wealth which includes information on household ownership of durable goods and household dwelling conditions. As the signs of the scoring coefficients suggest, higher values of the index correspond to lower values of household wealth (see Table 4 reported in the Appendix).

4 Estimation strategy and results

The empirical approach followed in this paper is based on the Schultz model (1984) in which utility depends on the health and nutrition of each household member as well as on consumption of several goods⁴.

The household behaves as if it is maximizing a long run utility function which has as arguments the health (or nutrition) of each household member given by the standardized anthropometric measurement of the height-for-age for individual i (H_i) and consumption of private and public goods (C_i) as well as leisure (L_i):

$$U = f(H_i, C_i, L_i) \quad (1)$$

The health status of each household member results as the outcome of a production function which can be formalized as:

$$H_i = f(E_i, PD_i, SE_i, b_i) \quad (2)$$

⁴ The underlying assumption here is that health and consumption enter separately in the utility function because good health has an intrinsic value and food is only partly consumed for its nutritive intake.

where E_i is the local health environment where the child lives including exogenous supplied health inputs at the community level (i.e. availability of health posts), b_i is the biological endowment of the child (proxied by father's height), SE_i is a vector of the socioeconomic determinants of child health. These variables are set at the household level and include the parental level of education (i.e. years of schooling) and household income (or wealth).

It is important to note that if a household's wealth or income contributes directly to enhancing child health outcomes (as they imply higher expenditures on food and health goods) then a mother's or father's education can exert a direct role; (as it is translated into better skills and knowledge on child caring practices) as well as an indirect role as it is translated into higher incomes.

PD_i is a vector of proximate determinants of the health status of the child which are both at the household level (I_{hi}), i.e. access to piped water, sanitation, maternal health and at the individual level (I_i), i.e. breastfeeding. As it can be assumed that the effect of the SE is channelled by the I_i vector, we will also consider the following function:

$$I_i = f(E_i, SE_i) \quad (3)$$

Hence, in the first step we will estimate the effect of the socio-economic factors on the probability of being breastfeed (Table 4). Second, we provide an empirical assessment of the gross-effect of the socio-economic determinants by excluding from (2) the child-related variables which can be influenced by the parents (Table 5). Lastly we estimate (2) in order to assess the relative importance that transmission channels

have in mediating the effect of maternal education on child nutritional status as well as consider the contribution of the supply-side factors at both the household and community level (Table 6).

In order to obtain consistent estimates of the effects of our explanatory variables we need to take into account the fact that there might be a correlation between the unobserved variables and the observed ones. More specifically, household-level variables such as parent education and income might be correlated with household level factors (i.e. culture, beliefs, and preferences) which are unobserved in the data. If this is the case, then the pooled ordinary least squares models and random effect models will yield biased estimates.

A possible solution would hence be to use household-level fixed effects which—by controlling for unobserved heterogeneity within household—would sweep out the bias. Unfortunately, there are two important limits entailed in the household fixed effects specification. First: when the ratio of within-to-between person variance declines to 0, fixed effects methods cannot estimate coefficients for variables that have no within-subject variation, implying that household-level variables that do not differ by child and are time-invariant are eliminated by that procedure. Second, fixed effects methods completely ignore the between-household variation and focus only on the within-household variation. Neglecting the variation that occurs between households, however, may not be a desirable option from both an econometric and economic perspective. The econometric reason is that this procedure can yield standard errors that are considerably higher than those produced by methods that look at both the within and the between variation. In a panel with large N and small T , the fixed-effects model has few degrees of freedom; consequently it cannot provide reliable estimates. From an economic perspective, even if we recognize the

importance of controlling for unobserved heterogeneity within household, we are still interested in capturing the variation occurring between households as it is exactly in there that the very bulk of heterogeneity takes place. Yet, the choice of the appropriate econometric model for our analysis is anchored to an arbitrary decision on the nature of the effect that we want to estimate and the type of inference that we want to obtain, as with the fixed effect model we are only able to make inference which is conditional on the effects that are in the sample.

Hence, in our approach—by using the Mundlak model—we opt for a "compromise" between the fixed and the random effect models.

The Mundlak model (1978) indeed relaxes the assumption of no correlation between the observed and unobserved variables by exploiting the knowledge that the only portion of the time constant variation in the explanatory variables that can be correlated with the error term must be correlated with only the time average values of these explanatory variables for each individual (or household). By accounting for potential correlation between unobserved household-specific heterogeneity and the explanatory variable, the Mundlak approach addresses any possible endogeneity bias which is due to household-invariant unobserved factors and hence it is able to deliver consistent parameter estimates (Wooldridge, 2002).

For comparison purposes, in all the specified models we will provide estimates obtained with pooled ordinary least squares and with the Mundlak approach. A second issue that deserves some discussion pertains to the potential endogeneity of the income variable. To address this problem, many authors have used instrumental variable techniques to estimate 2SLS or 3SLS models. Nevertheless, given the limit of data availability, we couldn't find any good instrument for expenditure and—as it is

widely recognized— the use of instrumental variables may also lead to biased estimates when the fit of instrumenting is poor.

However, it should be noted that since we are using panel data and our dependent variable is actually a measure of the long-term nutritional deficiencies, it might be the case that current income is unlikely to be endogenous. Moreover, it seems improbable that poor households with stunted children have much scope to adjust their income upwards through allocating additional labour to income earning activities, as in very poor areas there are many binding constraints which prevent people from having higher wages and incomes.

Nevertheless, we try to tackle any possible problem of endogeneity in the expenditure variable by: a) excluding expenses in medicine and other health goods and b) considering an alternative specification with household wealth (measured by a household asset index) to replace household expenditure.

Lastly, in order to reduce any possible bias stemming from the fact that real per capita expenditure was only indirectly estimated for the last year, we will include a third specification with expenditure per capita in nominal terms and interactions effects between time and provincial dummies in order to capture any possible difference in the level and changes of prices in different provinces.

The estimates that link the socio-economic determinants (i.e. mothers' years of education and household expenditure or wealth) to breastfeeding rely on a linear probability model and are reported in Table 4. Breastfeeding is coded as a dichotomous variable indicating whether the child was ever breastfed. The right-hand side variables also include sex and rural dummies as well as a community level variable that informs on the availability of midwives. Indeed, in this way, we account for the fact that health professionals who are involved in the prenatal care and

delivery of babies can influence their patients on the practice of breastfeeding. Although we fail to find a statistically significant effect for this variable, the positive sign of the estimated coefficients confirms our initial expectations.

When we look at the socio-economic variables, we see a positive and highly significant effect of mothers' education which gives us the first piece of proof for the existence of a transmission channel. Once controlling for the household-average-fixed effect in the Mundlak approach, our estimates confirm the existence of a positive independent role of maternal education, as this effect significantly explains the bulk of the between household variation in breastfeeding.

[Table 4 here]

Before discussing the results for the full specified model for child nutrition, we present in Table 5 an empirical assessment of the "gross-effect" of the socio-economic determinants. A first specification of these regressions (Col. 1, 6) includes only child characteristics which don't depend on parental choices and behavior (i.e. gender, genetic endowment) and mothers' education. Subsequently, we add fathers' education and household expenditure or wealth to see the extent to which part of the maternal educational effect is actually absorbed by the income variable.

The OLS regressions suggest that mother education has a significant large, positive and independent effect on child health (measured in terms of height-for-age z-scores) even though the effect of expenditure or wealth appears larger in magnitude. These results are confirmed after controlling for household-level average effect. These Mundlak regressions also suggest that maternal education exerts a long term effect on child health, whereas if we look at both the magnitude and statistical significance of variables such as household wealth or income, this is mainly a short term effect. In other words, if income poverty is important in preventing parents from not being able

to adequately care and nourish children, as less resources can be devoted to them, maternal education appears to yield a double dividend as it is partially reflected in the better capacity to earn higher wages in the long term. Still- its significant and positive sign suggests that this long term effect may also work through other channels which can only be captured in a full specified model.

[Table 5 here]

The theoretical expectation from our full-specified model is that the coefficient on the maternal education should be not significantly different from zero as, by definition; all variation in child nutrition status should be captured by the proximate determinants. Even after controlling for household-average effects, we see (Table 6) that the positive effect of mothers' education is indeed basically reflected in their reproductive behavior (proxied by mother age at birth) and channeled through child health seeking practices such as breastfeeding. On the other hand, the significant coefficient on household expenditure and wealth confirms the previous results from the gross-effect estimates that income alone has a strong independent role in determining child health in the short-term. Moreover, from this table we can confirm that strong complementarities exist between maternal and child health and are able to identify a separate strong and robust effect of the supply-side variables—at both the community and household level— such as the number of health posts and access to improved sanitation facilities and safe drinking water sources. Children living in households that have access to piped water are significantly better off than those without by 0.19 height-for-age z-scores whereas an improvement in the hygienic conditions at the household level (i.e. using own toilet instead of public latrines or other outdoor devices) would contribute to reduction in child malnutrition by around

0.13 height-for-age z-scores. From this last finding the provision of such basic infrastructure is confirmed to be an essential complement to the availability of food in preventing child malnutrition as it reduces the risk of bacterial infections and diarrheal diseases that hamper the intake of calories and micro-nutrients.

As it may be already inferred from Fig.1 (reported in Appendix) and as also suggested by some related literature (i.e. in Sahn and Aldermann, 1997) there might be some specific age effects which can drive part of the results. Pathogen exposure as well as the importance of a mother's care and nurturing have both specific age dimensions so that the effect of breastfeeding or access to health facilities may be expected to differ for children in different age-groups. Hence, in order to control for this child age effect, age dummies coded in months (not shown in the Table) are included in all the specifications.

[Table 6 here]

5 Conclusions

This study aims to ascertain patterns of complementarities between the MDGs by focusing on the determinants of child nutrition in Indonesia over the period 1997-2007. In doing so, we explore possible pathways which may affect achievements in child health and, following the Mosley and Chen theoretical framework, we have tested for the existence of powerful transmission channels connecting socioeconomic factors to child health outcomes.

After a critical review of the literature pertaining to the determinants of child health, we outline and estimate a simple model for analyzing the pathways to child health outcomes using longitudinal data from household surveys. The use of such data enables us to go beyond the limits imposed by traditional cross-sectional regressions as the relationship between our key variables can be determined with more efficiency.

Moreover, the novelty of this analysis also lies in the methodology applied, as by relying on the Mundlak approach of household-average fixed effects we are able to obtain robust and unbiased estimates while distinguishing the short-term or within household effect from the long-term or between household effect.

A key finding in this analysis is that there are strong and long-lasting complementarities between maternal education and child health and that this effect is largely conveyed by health care giving practices such as breastfeeding. As our results suggest, the bulk of the variation of child malnutrition between households is indeed driven by differences in the level of maternal educational achievements.

Although we cannot rule out the existence of strong complementarities between household wealth or income and child health, the effect of positive changes in income or wealth appear to be delimited in the short term. This means that although more material resources undoubtedly help to provide sufficient food and alleviate the expenditure constraints that many household face, they must be complemented by other factors in order to exert a long lasting effect on child health conditions. Interestingly, the supply side level factors (such as sanitation and health infrastructure) and mothers' health status also significantly and robustly account for shortages in child health anthropometric outcomes.

The provision of sanitation appears to be an essential complement to the availability of food in preventing child malnutrition, suggesting that the rise in the availability of these services may also have spill-over effects to other households in the neighborhood, as the probability of cross-infections from bacterial diseases caused by lack of hygiene will fall. On the other hand, our results suggest that just as much of the variation in child health is significantly explained by the number of health posts,

thus investments in such basic infrastructure will also contribute to reducing child malnutrition.

Overall, our key findings suggest that income poverty-alleviating policies complemented with investment in basic health infrastructure might strongly contribute to improving the health conditions of the Indonesian children. One of the greatest challenges for the country is given by the heterogeneous conditions in the regions, as our results revealed the presence of large disparities in the level of nutrition in different regions and between rural and urban areas as well as in the access to proper infrastructure. Expanding the coverage or improving the quality of such infrastructure would contribute effectively to improving the health conditions of children, particularly of those living in the most remote areas. On the other hand, as the linkages between maternal education, child nurturing practices and child health are found to be particularly strong, policies which are aimed at enhancing the quality of education can remarkably improve the nutritional status of children.

Acknowledgements: This paper has been produced as part of a collaborative research project between the University of Göttingen and KfW Development Bank on synergies and trade-offs in MDG achievements. Funding from the German Ministry of Economic Development and Cooperation bis KfW Development Bank is gratefully acknowledged. We would also like to thank Prof. Stephan Klasen, Prof. Inmaculada Martinez-Zarzoso, Prof. Almas Hesmati, Prof. Esfandiar Maasoumi, Dr. Robert Rudolph, Dr. Miguel Nino- Zarazua, and Dr. Malokele Nanivazo for helpful comments and suggestions.

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Table 1 Child health characteristics. Descriptive statistics

<i>Individual characteristics</i>	Mean	1997	2000	2007
Height for Age z-score	-1.61	-1.75	-1.63	-1.46
	(1.18)	(1.24)	(1.21)	(1.08)
boys	-1.60	-1.76	-1.65	-1.45
	(1.22)	(1.30)	(1.24)	(1.12)
girls	-1.61	-1.74	-1.63	-1.48
	(1.13)	(1.17)	(1.17)	(1.03)
Stunting (%)	37.30	42.76	38.99	30.88
% of boys	38.25	44.66	49.97	31.37
% of girls	36.29	40.87	37.94	30.34
Extreme Stunting (%)	11.15	14.35	12.01	7.57
% of boys	11.55	15.28	12.58	7.52
% of girls	10.73	13.43	11.41	7.62
Weight for Age z-score	-1.32	-1.43	-1.26	-1.25
	(1.89)	(1.79)	(2.33)	(1.25)
boys	-1.32	-1.44	-1.28	-1.24
	(1.89)	(1.23)	(2.31)	(1.31)
girls	-1.31	-1.43	-1.24	-1.28
	(1.88)	(1.11)	(2.36)	(1.17)
Underweight (%)	29.48	31.28	28.73	28.28
% of boys	30.70	32.57	30.14	28.88
% of girls	28.13	29.94	27.17	27.50
Extreme Underweight (%)	7.06	7.47	7.21	5.68
% of boys	6.95	7.45	6.99	5.81
% of girls	7.20	7.48	7.46	5.50
Ever Breastfed (%)	45.33	33.08	43.60	57.01
Born Home w/o assist. (%)	49.47	54.39	46.05	-
Vaccination (%)	72.03	49.83	69.29	99.92
Supplementary Food (%)	20.93	16.67	19.31	26.31
Vitamin A (%)	17.52	14.69	15.90	21.80

Sample Size: 4328 (unbalanced); Std. Dev. in parentheses; source: own elaboration on IFLS data

Table 2 Mothers' characteristics. Descriptive statistics

<i>Mother health</i>	Mean	1997	2000	2007
Mothers BMI \leq 18.5 (%)	7.30	8.39	7.87	5.67
Pregnancy checkups (%)	85.11	68.07	99.11	99.11
Tetanus Vaccination (%)	82.50	92.44	70.19	91.41
<i>Mother education</i>				
No education (%)	4.51	5.49	4.16	4.20
Primary Education (%)	51.72	58.52	51.53	46.65
Junior High School (%)	16.66	14.35	17.21	17.74
Senior High School (%)	19.75	18.20	19.79	20.89
Higher Education (%)	7.36	3.44	7.30	10.51
Working (%)	53.79	39.84	53.76	64.76

Sample Size: 2456 (unbalanced) Source: own elaboration on IFLS data

Table 3 Household and Community characteristics. Descriptive Statistics

<i>Household characteristics</i>	Mean	1997	2000	2007
Household Size	5.21	5.44	5.21	5.04
	(1.67)	(1.73)	(1.71)	(1.52)
Piped water (%)	23.92	24.53	24.57	22.58
Own Toilet (%)	68.82	61.66	65.84	78.25
	13.33	13.09	13.93	12.70
Distance to health facility (avg time in min.)	(6.18)	(5.92)	(6.62)	(5.69)
	12.269	12.202	12.204	12.463
Log monthly per capita expenditure	(0.66)	(0.67)	(0.66)	(0.63)
<i>Community characteristics</i>				
Number of Midwives	1.23	1.26	1.13	1.33
	(1.03)	(1.37)	(0.75)	(0.98)
Number of Health Posts	7.80	7.61	7.69	8.13
	(6.64)	(6.68)	(6.47)	(6.84)

Std. Dev in parentheses. Source: own elaboration on IFLS data

Table 4 Determinants of breastfeeding

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dep.Var.: Breastfeeding	OLS	OLS	OLS	OLS	Mundlak	Mundlak	Mundlak	Mundlak
Nr Midwives	0.0111 (0.00773)	0.00870 (0.00792)	0.0162* (0.00982)	0.00829 (0.00785)	0.00543 (0.00740)	0.00368 (0.00780)	0.00950 (0.0805)	0.00243 (0.00842)
Male	0.0336* (0.0196)	0.0346* (0.0202)	0.0272 (0.0182)	0.0337* (0.0191)	0.0355** (0.0141)	0.0363** (0.0146)	0.0243 (0.0152)	0.0334** (0.0140)
Rural	0.00279 (0.0200)	0.00782 (0.0207)	-0.0527*** (0.0194)	0.00174 (0.0206)	-0.000539 (0.0199)	0.00506 (0.0204)	-0.0725*** (0.0214)	0.00475 (0.0207)
Mother education ^a	0.00829*** (0.00170)	0.00712*** (0.00181)	0.00839*** (0.00168)	0.00796*** (0.00176)	0.000290 (0.00296)	-0.000591 (0.00326)	0.00888** (0.00353)	-0.00309 (0.00302)
Mother education ^b					0.0101*** (0.00354)	0.0114*** (0.00387)	0.00108 (0.00409)	0.0130*** (0.00368)
Ln nom.expenditure pc ^a				-0.0231 (0.0146)				-0.0359** (0.0168)
Ln nom.expenditure pc ^b								0.0278 (0.0198)
Ln real expenditure pc ^a		0.00134 (0.0145)				0.0617*** (0.0193)		

Ln real expenditure pc ^b						-0.0945***		
						(0.0273)		
Asset index ^a		0.00192					-0.0339***	
		(0.00576)					(0.00996)	
Asset index ^b							0.0460***	
							(0.0126)	
Constant	0.332***	0.304*	0.244***	0.689*	0.342***	0.718***	0.295***	0.303
	(0.0262)	(0.174)	(0.0256)	(0.384)	(0.0270)	(0.232)	(0.0280)	(0.272)
Time*Prov.dum.	NO	NO	NO	YES	NO	NO	NO	YES
Observations	4,940	4,558	3,644	4,910	4,940	4,558	3,644	4,910
Adjusted R ²	0.009	0.008	0.016	0.044				
Number of hid					1,618	1,516	1,537	1,611

Note: Robust standard errors in parentheses, *** p < 0.01, ** p < 0.05, * p < 0.1. ^a short term or within effect, ^b long term or between effect

Table 5 Determinants of Child Nutrition. "Gross-effect"

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Dep.Var: HAZ	OLS	OLS	OLS	OLS	OLS	Mundlak	Mundlak	Mundlak	Mundlak	Mundlak
Father height	0.0202*** (0.00269)	0.0199*** (0.00266)	0.0226*** (0.00288)	0.0167*** (0.00253)	0.0194*** (0.00257)	0.0103*** (0.00154)	0.0102*** (0.00155)	0.0121*** (0.00185)	0.0108*** (0.00154)	0.00947*** (0.00152)
Male	0.00595 (0.0313)	-0.00148 (0.0314)	-0.0124 (0.0325)	0.000624 (0.0320)	-0.00955 (0.0307)	-0.00265 (0.0249)	-0.00612 (0.0250)	-0.0133 (0.0261)	-0.0109 (0.0248)	-0.00946 (0.0246)
Rural	-0.339*** (0.0313)	-0.322*** (0.0315)	-0.281*** (0.0327)	-0.268*** (0.0330)	-0.243*** (0.0331)	-0.291*** (0.0346)	-0.278*** (0.0349)	-0.246*** (0.0378)	-0.202*** (0.0367)	-0.224*** (0.0364)
Mother education ^a	0.0273*** (0.00280)	0.0179*** (0.00327)	0.00924*** (0.00339)	0.0146*** (0.00329)	0.00958*** (0.00327)	0.00892 (0.00543)	0.00627 (0.00568)	0.000602 (0.00612)	-0.00151 (0.00571)	0.00116 (0.00613)
Mother education ^b						0.0254*** (0.00647)	0.0178** (0.00722)	0.0138* (0.00783)	0.0160** (0.00733)	0.0185** (0.00747)
Father education ^a		0.0147*** (0.00302)	0.00704** (0.00316)	0.00902*** (0.00306)	0.00893*** (0.00302)		-0.000894 (0.00538)	-0.00271 (0.00562)	-0.00673 (0.00542)	0.00188 (0.00567)
Father education ^b							0.0160** (0.00681)	0.0102 (0.00729)	0.0165** (0.00692)	0.00609 (0.00698)
Ln nom.expenditure pc ^a					0.271*** (0.0251)				0.173*** (0.0283)	

Ln nom.expenditure pc ^b									0.0803**	
									(0.0405)	
Ln real expenditure pc ^a			0.269***						0.189***	
			(0.0254)						(0.0306)	
Ln real expenditure pc ^b									0.0832	
									(0.0507)	
Asset index ^a				-0.0953***						-0.0454***
				(0.0112)						(0.0167)
Asset index ^b										-0.0659***
										(0.0226)
Constant	-4.951***	-4.963***	-8.574***	-4.403***	-8.591***	-3.410***	-3.469***	-6.985***	-7.127***	-3.247***
	(0.435)	(0.429)	(0.547)	(0.410)	(0.543)	(0.251)	(0.251)	(0.553)	(0.720)	(0.247)
Time*Prov.dum.	NO	NO	NO	NO	YES	NO	NO	NO	YES	NO
Observations	8,321	8,220	7,426	5,858	8,163	8,321	8,220	7,426	8,163	5,858
Adjusted R ²	0.077	0.080	0.095	0.109	0.121					
Number of hid						2,333	2,327	2,266	2,325	2,218

Note: Robust standard errors in parentheses, *** p < 0.01, ** p < 0.05, * p < 0.1. ^a short term or within effect, ^b long term or between effect

Table 6 Determinants of Child Nutrition. Full Model

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Dep.Var: HAZ	OLS	OLS	OLS	OLS	OLS	OLS	Mundlak	Mundlak	Mundlak	Mundlak	Mundlak	Mundlak
Father Height	0.0214*** (0.00273)	0.0215*** (0.00282)	0.0206*** (0.00277)	0.0218*** (0.00327)	0.0205*** (0.00274)	0.0179*** (0.00270)	0.0117*** (0.00173)	0.0122*** (0.00173)	0.0119*** (0.00175)	0.0131*** (0.00201)	0.0123*** (0.00175)	0.0118*** (0.00178)
Breastfeeding	0.0982*** (0.0348)	0.0780** (0.0354)	0.0653* (0.0356)	0.0941** (0.0386)	0.0411 (0.0393)	0.106*** (0.0368)	0.139*** (0.0293)	0.0823*** (0.0311)	0.0722** (0.0314)	0.0818** (0.0336)	0.0260 (0.0337)	0.107*** (0.0313)
Household size ^a	-0.0484*** (0.00999)	-0.0635*** (0.0106)	-0.0575*** (0.0108)	-0.0395*** (0.0113)	-0.0317*** (0.0112)	-0.0591*** (0.0112)	-0.0201 (0.0152)	-0.0225 (0.0155)	-0.0229 (0.0158)	-0.0146 (0.0176)	0.00110 (0.0166)	-0.0308* (0.0173)
Household size ^b							-0.0190 (0.0203)	-0.0408* (0.0211)	-0.0318 (0.0215)	-0.0168 (0.0231)	-0.0349 (0.0223)	-0.0273 (0.0226)
Piped water ^a	0.0732** (0.0373)	0.0618 (0.0378)	0.0590 (0.0382)	0.0222 (0.0395)	0.0360 (0.0394)		-0.0505 (0.0556)	-0.0446 (0.0562)	-0.0390 (0.0568)	-0.0444 (0.0605)	-0.0814 (0.0579)	
Piped water ^b							0.194** (0.0765)	0.175** (0.0769)	0.157** (0.0775)	0.123 (0.0813)	0.181** (0.0797)	
Sanitation ^a	0.219*** (0.0323)	0.198*** (0.0327)	0.151*** (0.0335)	0.115*** (0.0347)	0.124*** (0.0337)		0.138*** (0.0430)	0.125*** (0.0438)	0.131*** (0.0445)	0.124*** (0.0477)	0.0800* (0.0459)	
Sanitation ^b							0.134**	0.122*	0.0355	0.00434	0.0816	

							(0.0654)	(0.0658)	(0.0680)	(0.0709)	(0.0699)	
Male	0.0103	0.0160	0.00309	-0.0127	-0.0110	0.00301	-0.00582	-0.00166	-0.00916	-0.0181	-0.0164	-0.0133
	(0.0328)	(0.0330)	(0.0332)	(0.0341)	(0.0327)	(0.0345)	(0.0259)	(0.0260)	(0.0262)	(0.0270)	(0.0261)	(0.0265)
Rural	-0.223***	-0.217***	-0.188***	-0.180***	-0.171***	-0.187***	-0.203***	-0.199***	-0.167***	-0.169***	-0.144***	-0.162***
	(0.0355)	(0.0356)	(0.0361)	(0.0373)	(0.0375)	(0.0378)	(0.0403)	(0.0405)	(0.0410)	(0.0430)	(0.0421)	(0.0422)
Nr Health Posts	0.0157***	0.0155***	0.0147***	0.0140***	0.0120***	0.0131***	0.0132***	0.0127***	0.0113***	0.00967***	0.00825**	0.0118***
	(0.00252)	(0.00254)	(0.00254)	(0.00268)	(0.00283)	(0.00276)	(0.00296)	(0.00297)	(0.00301)	(0.00331)	(0.00333)	(0.00307)
Moth.age birth		0.0121***	0.0133***	0.0115***	0.0101***	0.0105***		0.0160***	0.0173***	0.0154***	0.0115***	0.0143***
		(0.00298)	(0.00299)	(0.00308)	(0.00299)	(0.00309)		(0.00290)	(0.00293)	(0.00305)	(0.00303)	(0.00292)
Moth.low BMI		-0.263***	-0.285***	-0.235***	-0.269***	-0.260***		-0.214***	-0.258***	-0.227***	-0.237***	-0.230***
		(0.0617)	(0.0629)	(0.0651)	(0.0631)	(0.0637)		(0.0591)	(0.0604)	(0.0625)	(0.0602)	(0.0682)
Moth.education ^a			0.00762**	0.00347	0.00513	0.00571			0.000926	-0.00429	-0.00285	-0.00251
			(0.00347)	(0.00358)	(0.00352)	(0.00353)			(0.00596)	(0.00643)	(0.00603)	(0.00648)
Moth.education ^b									0.0111	0.0122	0.0118	0.0117
									(0.00770)	(0.00819)	(0.00778)	(0.00802)
Fath.education ^a			0.00867***	0.00289	0.00491	0.00665**			-0.00462	-0.00386	-0.00708	-0.000930
			(0.00319)	(0.00330)	(0.00321)	(0.00326)			(0.00553)	(0.00567)	(0.00560)	(0.00586)
Fath.education ^b									0.0138*	0.00624	0.0138*	0.00721
									(0.00713)	(0.00742)	(0.00722)	(0.00735)

Exp.pc real ^a						0.197***						0.136***	
						(0.0281)						(0.0350)	
Exp.pc real ^b												0.0672	
												(0.0543)	
Exp.pc nom. ^a						0.196***						0.167***	
						(0.0283)						(0.0316)	
Exp.pc.nom ^b												-0.0199	
												(0.0428)	
Asset index ^a												-0.0826***	-0.0503***
												(0.0121)	(0.0176)
Asset index ^b													-0.0467*
													(0.0241)
Constant	-5.483***	-5.693***	-5.728***	-8.251***	-7.988***	-4.633***	-4.017***	-4.344***	-4.507***	-7.092***	-6.077***	-3.769***	
	(0.455)	(0.473)	(0.461)	(0.637)	(0.644)	(0.447)	(0.302)	(0.309)	(0.313)	(0.600)	(0.582)	(0.313)	
Time*Prov.dum.	NO	NO	NO	NO	YES	NO	NO	NO	NO	NO	YES	NO	
Observations	6,943	6,807	6,676	6,242	6,644	4,800	6,943	6,807	6,676	6,242	6,644	4,800	
Adjusted R ²	0.111	0.118	0.123	0.130	0.149	0.114							
Number of hid							1,931	1,912	1,904	1,850	1,904	1,781	

Note: Robust standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. ^a short term or within effect, ^b long term or between effect. Age dummies not shown. Real and nominal per capita expenditure are emasured in logarithms.

Appendix

Figure 1 Mean stunting z-score by age (three-month interval)

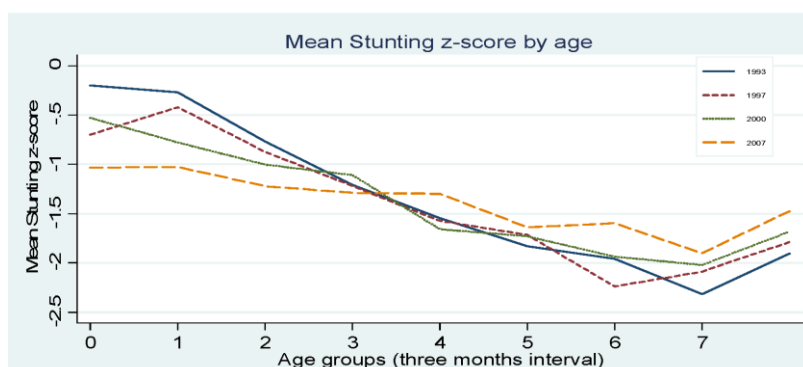


Table 7 Scoring Coefficients for asset index (PCA)

	1997	2000	2007
Car	-0.24	-0.23	-0.26
Low roof material	0.22	0.18	0.18
Low floor material	0.27	0.28	0.25
Low wall material	-	-	0.24
Electricity	-0.33	-0.31	-0.27
Piped drinking water	-0.24	-0.23	-0.11
Well water w/pump	-0.21	-0.22	-0.22
Well water (no pump)	0.17	0.28	0.25
Spring and surface water	0.32	0.17	0.22
Own toilet	-0.48	-0.51	-0.51
Public toilet	0.06	0.10	0.20
Out defec.	0.06	0.48	0.44

Source: own elaboration on IFLS data