ETHIOPIA
Strategy Support Program

ETHIOPIAN DEVELOPMENT RESEARCH INSTITUTE
EDRI

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE
IFPRI
A member of the CGIAR Consortium

WORKING PAPER 70

An analysis of trends and determinants of child undernutrition in Ethiopia, 2000-2011

Derek Headey

December 2014

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

This report uses two rounds of the Ethiopian Demographic Health Survey (EDHS) to statistically analyze patterns and trends in undernutrition (child growth) in Ethiopia over 2000 to 2011. Ethiopia remains one of the most undernourished populations in the world. In 2000 over half of Ethiopian preschool children were stunted (height for age z-scores (HAZ) of -2 standard deviations or less) and almost a third were severely stunted (HAZ ≤ -3.0). However, progress against child undernutrition over this period has been solid, with stunting prevalence reduced by 1.4 percent points per year between 2001 and 2011, although progress slowed to 1.0 point per year between 2011 and 2014.

In terms of the determinants of undernutrition outcomes, the report finds that household assets, maternal and paternal education, antenatal care, and birth intervals are the most consistent predictors of undernutrition outcomes, with other factors only having importance in either rural or urban areas, but not both (piped water, toilet facilities). However, improvements in these factors only explain a small proportion of the observed improvements in nutrition over 2000-2011. The report hypothesizes that income growth and improved food security – latent factors rather imperfectly captured by the DHS asset index – are likely to have been the main forces driving nutritional change in recent decades. The report also analyzes the sources of the large rural-urban discrepancy in child nutrition outcomes in Ethiopia. Here the statistical models in question much more successfully explain the rural-urban gap, and suggest that differences in household assets explain at least two-thirds of the gap.

The report then turns to an analysis of infant and young child feeding (IYCF) practices. IYCF practices in Ethiopia are very poor. While breastfeeding is widespread, exclusive breastfeeding is by no means universal. No less worryingly is the striking lack of diversity in children's diets, with most children regularly exposed only to basic staples (grains, roots, tubers), with cow milk constituting the only significant source of animal-based proteins and micronutrients. The most significant predictors of dietary diversity are household assets, parental education, cow ownership, antenatal care exposure, and maternal age, with older women giving their children less diverse diets. Going forward, improving the quality of Ethiopian diets will also be a major task for strategies to improve child growth.

1. INTRODUCTION

This paper aims to explain patterns and trends in child undernutrition outcomes and infant and young child feeding (IYCF) practices in Ethiopia over the period 2000-2011. The specific objectives of the paper are fourfold:

1. To document basic patterns and trends in Ethiopia, including at regional, rural-urban and gender levels;
2. To identify the main predictors of child nutrition outcomes;
3. To examine nutritional trends over time (2010-2011) and across the rural-urban divide (which is a large social and economic divide in Ethiopia);
4. To investigate IYCF feeding practices, particularly the determinants of dietary diversity.

To do so, the report uses two rounds of the Ethiopian Demographic Health Survey (EDHS) to statistically analyze patterns and trends in undernutrition (child growth) in Ethiopia over the period from 2000 to 2011. Ethiopia remains one of the most undernourished populations in the world. In 2000 over half of Ethiopian preschool children were stunted (height for age z-scores (HAZ) of -2 standard deviations or less) and almost a third were severely stunted (HAZ ≤ -3.0). However, progress against child undernutrition has been solid, with stunting prevalence reduced by 1.4 percent points per year between 2001 and 2011, although a new mini-DHS from 2014 shows that progress slowed to 1.0 point per year between 2011 and 2014.

In terms of the determinants of undernutrition outcomes, the report finds that household assets, maternal and paternal education, antenatal care, and birth intervals are the most consistent predictors of undernutrition outcomes, with other factors only having importance in either rural or urban areas (piped water, toilet facilities). However, improvements in these factors only explain a small proportion of the observed improvements in nutrition over 2000-2011. The report hypothesizes that income growth and improved food security – latent factors rather imperfectly captured by the DHS asset index – are likely to have been the main forces driving nutritional change in recent decades. The report also analyzes the sources of the large rural-urban discrepancy in child nutrition outcomes in Ethiopia. Here the models in question more effectively explain the rural-urban gap, suggesting that differences in household assets explain at least two-thirds of the gap.

The report then turns to an analysis of infant and young child feeding (IYCF) practices. IYCF practices in Ethiopia are very poor. While breastfeeding is widespread, exclusive breastfeeding is by no means universal. Even more worrying is the striking lack of diversity in children's diets, with most children regularly exposed only to basic staples (grains, roots, tubers), with cow milk constituting the only significant source of animal-based proteins and micronutrients. The most significant predictors of dietary diversity are household assets, parental education, cow ownership, antenatal care exposure, and maternal age, with older women giving their children less diverse diets. Going forward, improving the quality of Ethiopian diets will therefore also be a major task for strategies to improve child growth.

The remainder of this paper is structured as follows. Section 2 outlines the data and methods used in the paper. Section 3 looks at patterns and trends in child nutrition outcomes in Ethiopia. Section 4 aims to explain nutritional change over time and across the large rural-urban divide using statistical decompositions. Section 5 explains patterns and determinants of infant and young child feeding patterns. Section 6 concludes.

2. DATA AND METHODS

This paper primarily uses the 2000 and 2011 Ethiopian Demographic Health Surveys (EDHS), collected by the Ethiopian Central Statistical Agency (CSA) along with ICF International (previous Macro International) and funded by USAID. The Demographic Health Surveys are a highly regarded survey instrument conducted in around 60 countries that have been greatly refined over time. In addition to a wide range of demographic and health variables, the DHS for some years now have collected anthropometric data for children and mothers, as well as a range of IYCF practices, a household asset index, and various other household characteristics. As such, these surveys are almost ideally suited to understanding trends and determinants of undernutrition, although, as we will see below, the asset index does not perform particularly well in rural Ethiopia.

In terms of spatial coverage, the EDHSs are nominally nationally representative, although the 2000 EDHS did not cover all of the Somali region because of security and logistical issues. The 2011 EDHS did cover these areas, however. This small difference aside, the 2000 and 2011 EDHS are quite comparable. Moreover, the EDHSs are representative at the rural and urban level, and also at the level of Ethiopia's major regions, through the use of a complex design. This requires an application of sampling weights to our descriptive statistics, though this was not done for our regression analyses. However, we do report clustered robust standard errors for all our regressions.

In terms of methods, we utilize a range of statistical techniques using STATA version v13.0. Graphically we employ non-parametric smoothing techniques, particularly the local polynomial smoother with 95 percent confidence intervals (the *lpolyci* command) to explore non-linear relationships in key parameters of interest. This helps us identify whether our regression models require non-linear transformation of some variables. In terms of regressions, we use least squares regressions and linear probability models, but also the Poisson model for count variables. Our nutrition models closely follow the framework of the UNICEF (1990) nutrition framework and its subsequent variants. We model nutrition outcomes (N) for child *i* in population k as a function of the vector of time-varying intermediate determinants (***X*** : household assets, parental education, health service access, demographic outcomes, water and sanitation), a vector of control variables that are essentially fixed over time or space

($\boldsymbol{\mu}$:maternal height, child and maternal age dummies, location fixed effects), and the standard white noise term (ε):

$$N_{i,k} = \boldsymbol{\beta X}_{i,k} + \boldsymbol{\mu_i} + \varepsilon_{i,k} \tag{1}$$

The vector of parameters (β) constitutes the set of parameters of principal interest both for understanding which factors explain nutritional differences across children, and for decomposing changes across time or space. The simplest decomposition approach is simply to take the first difference of equation (1). Under the assumption that the $\boldsymbol{\beta}$ coefficients are the same across the two populations, and the error term (ε) terms has a mean of zero, the first difference of equation (1) between population 1 and population 2 can simply be given by:

$$\Delta\bar{N}_{i,t} = \boldsymbol{\beta}(\bar{\boldsymbol{X}}_1 - \bar{\boldsymbol{X}}_2) \tag{2}$$

where bars represent sample means. The questionable assumption in this approach is that the $\boldsymbol{\beta}$ coefficients are indeed fixed across the two populations. If the assumption of a stable vector of coefficients is dropped, then the economics literature generally advocates the Oaxaca-Blinder decomposition, in which predicted changes in the dependent variable are the sum of changes in endowments and changes in coefficients (or the returns to those endowments). An example of such a decomposition would be:

$$\Delta\bar{N}_{i,t} = \boldsymbol{\beta_2}(\bar{\boldsymbol{X}}_2 - \bar{\boldsymbol{X}}_1) + \bar{\boldsymbol{X}}_{\boldsymbol{1}}(\boldsymbol{\beta}_2 - \boldsymbol{\beta}_1) \tag{3}$$

Where the second term in equation (3) refers to changes in the coefficients across the two samples. Generally, changes in coefficients are hard to interpret and are referred to as the *unexplained* source of change, while changes in mean values are referred to as the *explained* portion. For more information on the Oaxaca-Blinder decomposition, including its application in STATA, see Jann (2008).

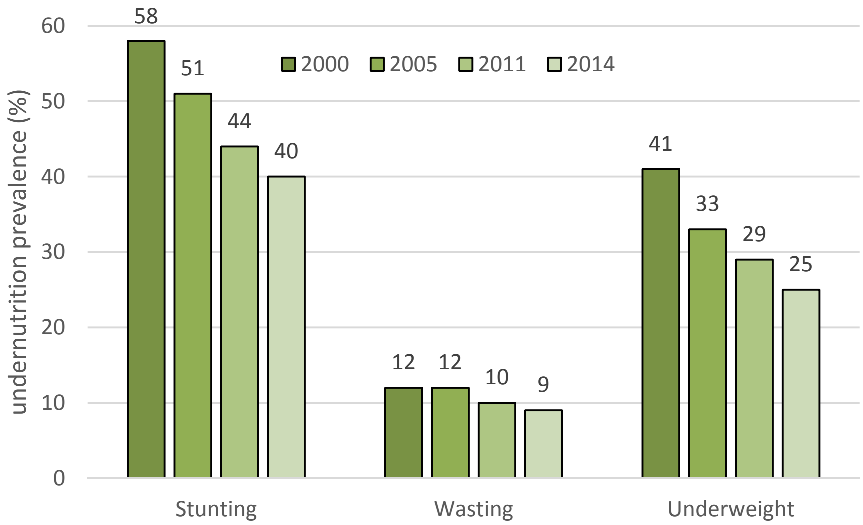
In addition to nutrition outcomes, we also model the determinants of children's dietary diversity in a Poisson count model, and children's consumption of dairy products, since dairy constitutes the most important source of animal-based proteins for young Ethiopian children and has also been shown to be an important source of child growth in rural Ethiopia (Hoddinott, Headey, & Dereje 2014).

3. PATTERNS AND TRENDS IN CHILD NUTRITION OUTCOMES IN ETHIOPIA

Ethiopia remains an extremely undernourished country, though it is a country that has made solid progress against undernutrition in the past decade. In 2000, 55.7 percent of Ethiopian preschool children were stunted (HAZ ≤ 2.0, using the 2006 WHO child growth norms). This declined to 43.4 percent in 2011 and to 40 percent in 2014 (Figure 1). By international standards, this rate of progress is solid and well ahead of many comparable countries, but not as rapid as others, such as Nepal (Headey & Hoddinott 2014) or Bangladesh (Headey, Hoddinott, Ali, Tesfaye, & Dereje 2014). Child wasting is also relatively high (around 10 percent) and child underweight prevalence is around 25 percent in 2014, down from 41 percent in 2000 (Figure 3.1).

Nutritional progress has also been somewhat uneven across Ethiopia (Table 3.1). Progress in child growth in urban areas was very rapid, with young child stunting rates falling from 46.6 percent in 2000 to 30.2 percent in 2011, a reduction of over one third. In rural areas – where around three quarters of Ethiopians reside – progress was far more modest, with stunting rates falling from 56.8 percent in 2000 to 45.3 percent in 2011. In proportional terms, stunting rates remain 50 percent higher in rural areas. Across Ethiopia's three largest regions, progress was rapid in Oromia and Southern Nations, Nationalities, and Peoples (SNNP) regions, but more modest in Amhara. In Ethiopia's smaller regions – for which statistical uncertainty is also greater – progress was rapid in Somali and Gambela regions, but more modest in Tigray, and very sluggish in Afar. Overall it appears that the drought-prone north of the country – comprising much of Tigray and Amhara – made more modest progress than the higher potential agricultural regions of Oromia and SNNP. Finally, consistent with aggregate trends for urban areas, progress in the predominantly urban areas of Addis Ababa was rapid, but more modest in the smaller twin cities of Dire Dawa and Harar.

Figure 3.1—Trends in preschool children stunting, wasting and underweight prevalence, 2000-2014



Source: Ethiopia Mini Demographic and Health Survey 2014 (CSA 2014).

Table 3.1—Trends in prevalence of stunted children in Ethiopia, 2000 to 2011, %

	2000	2011	Change	% change
All Ethiopia	55.7	43.4	-12.3	-22.1
Rural	56.8	45.3	-11.5	-20.2
Urban	46.6	30.2	-16.4	-35.2
Boys	57.2	45.5	-11.7	-20.5
Girls	54.3	41.3	-13.0	-23.9
Larger regions				
Oromia	53.0	40.5	-12.5	-23.6
SNNP	56.5	42.9	-13.6	-24.1
Amhara	61.0	50.6	-10.4	-17.0
Smaller regions				
Tigray	60.0	50.9	-9.1	-15.2
Somali	46.6	32.0	-14.6	-31.3
Afar	50.8	48.8	-2.0	-3.9
Gambela	41.5	27.2	-14.3	-34.5
Urban regions				
Addis Ababa	34.5	21.1	-13.4	-38.8
Dire Dawa & Harar	37.9	31.8	-6.1	-16.1

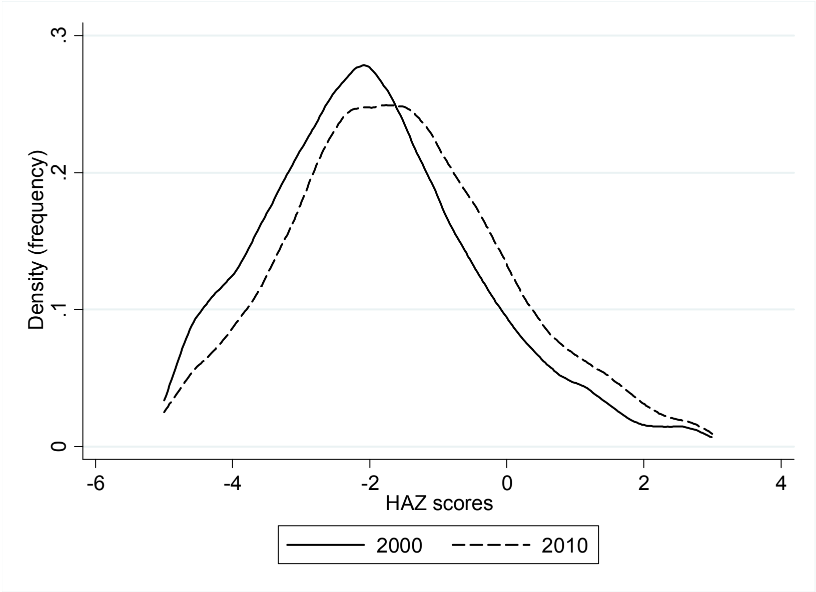
Source: Authors' estimates from the 2000 and 2011 Ethiopian Demographic Health Surveys (EDHS).
Notes: All estimates are weighted means, reflecting survey design.

Figure 3.2 shows changes in the distribution of HAZ scores from 2000 to 2011. For the most part, we observe a parallel rightward shift, implying that progress was quite uniform across the entire distribution.

Figure 3.3 shows trends in HAZ scores disaggregated by child age for both the 2000 and 2011 data, while Figures 3.4 and 3.5 plot the same relationship for rural and urban areas, respectively. These types of figures are useful for shedding light on the dynamics of growth faltering, but also on how growth faltering has changed over time (Victora, de Onis, Curi Hallal, Blössner, & Shrimpton 2009). The figures reveal several points of interest.

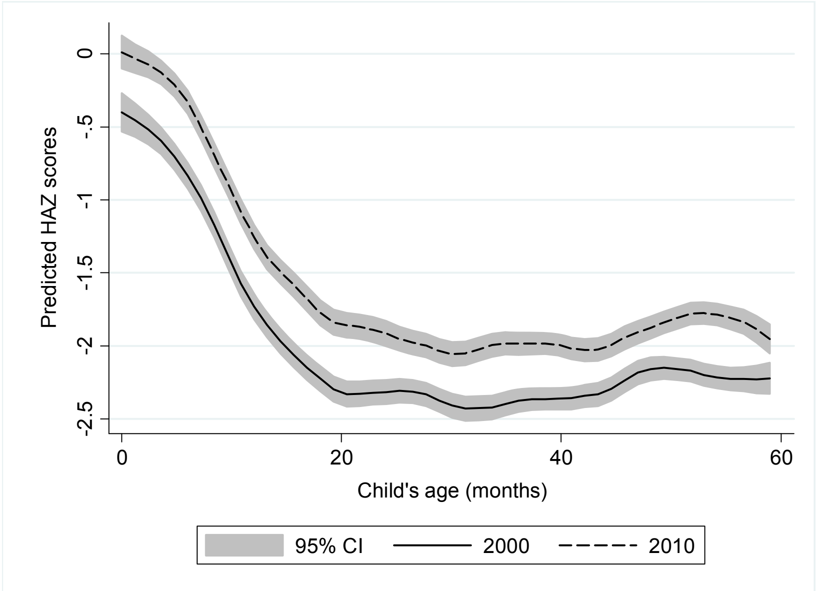
First and foremost, we observe an almost parallel shift in the aggregate HAZ-by-age curve and the rural curves. This suggests that much of the improvement in child growth outcomes – at least in rural Ethiopia, which accounts for the bulk of the sample and population - stems from larger birth sizes, and hence from growth in utero. In 2000, recently born rural Ethiopian children were some 0.5 standard deviations smaller than the WHO international growth standard, but in 2011 they were the same as the WHO growth standard. Broadly consistent with this conclusion are rural and urban trends in the subjective assessments of child birth sizes reported by mothers. The proportion of rural children 0-12 months of age reported to be below average size declined from 42.2 percent in 2000 to 33.8 percent in 2011. In contrast, the proportion of children reported to be below average was unchanged in urban areas, remaining at approximately 28 to 29 percent.

Figure 3.2—Distributions of child HAZ scores in 2000 and 2011



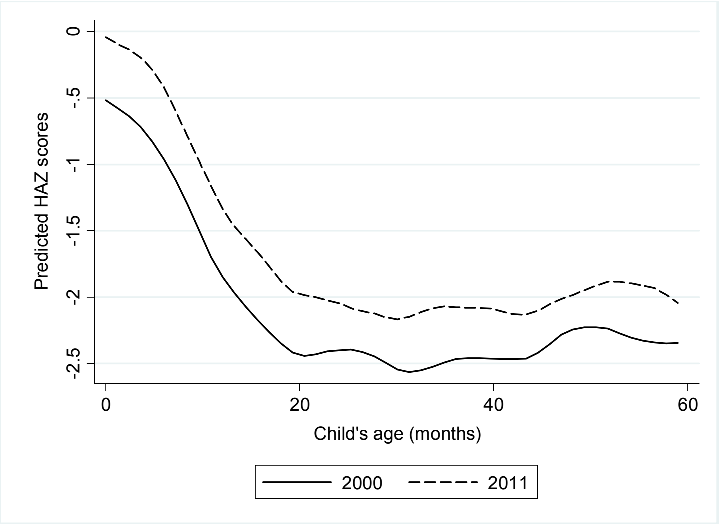
Source: Authors' estimates from the 2000 and 2011 Ethiopian Demographic Health Surveys (EDHS).
Notes: These are kernel density graphs.

Figure 3.3—Trends in child HAZ scores by children's age



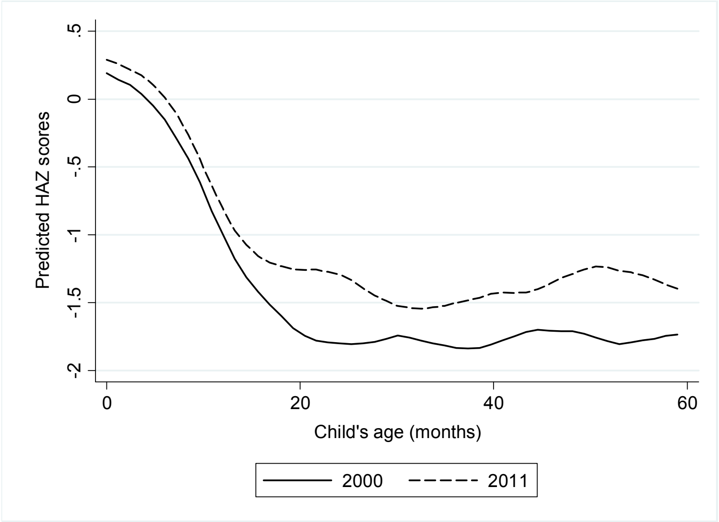
Source: Authors' estimates from the 2000 and 2011 Ethiopian Demographic Health Surveys (EDHS).
Notes: These are local polynomial smoothing estimates with 95 percent confidence intervals.

Figure 3.4—Trends in child HAZ scores by children's age, rural areas only



Source: Authors' estimates from the 2000 and 2011 Ethiopian Demographic Health Surveys (EDHS).

Figure 3.5—Trends in child HAZ scores by children's age, urban areas only



Source: Authors' estimates from the 2000 and 2011 Ethiopian Demographic Health Surveys (EDHS).

Table 3.2—Trends in the proportion of children reported by their mothers to be below average size at birth

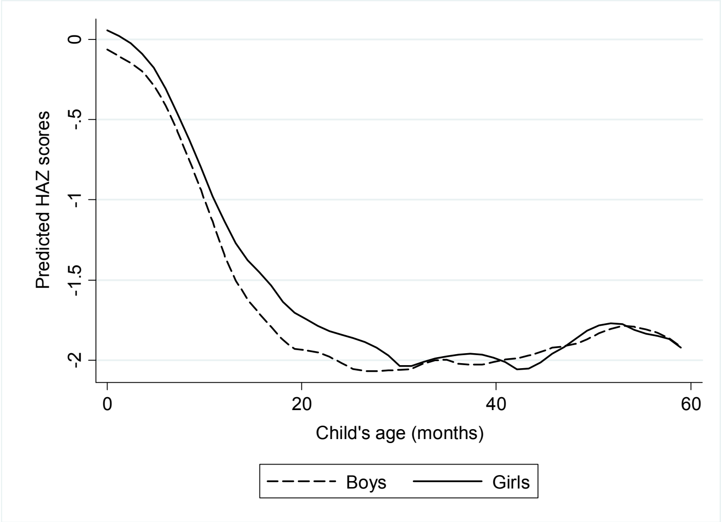
	Rural	Urban
2000	42.2	28.2
2011	33.8	29.4

Source: Authors' estimates from the 2000 and 2011 Ethiopian Demographic Health Surveys (EDHS).
Notes: All estimates are weighted means, reflecting survey design.

A second notable feature is the contrasting result for urban areas. In such areas we see no significant reduction in birth size (a fact corroborated by Table 3.2), but a marked difference in the process of growth faltering. From zero months to around 18 months of age, incidence of growth faltering is similar in 2000 and 2011, but from 18 months onwards there is a marked improvement in 2011. This may be related to better diets, better sanitation, or better healthcare in urban areas.

In Figure 3.6, we plot the same type of curve separately for boys and girls. The most salient difference appears at the stage of steepest growth, faltering from 12 months to about 20 months of age. In this period growth faltering is substantially slower among girls than boys.

Figure 3.6—Child HAZ scores by children's age, boys and girls separately, 2011



Source: Authors' estimates from the 2011 Ethiopian Demographic Health Survey (EDHS).
Notes: These are local polynomial smoothing estimates.

4. IDENTIFYING THE UNDERLYING CAUSES OF CHILD GROWTH OUTCOMES IN ETHIOPIA

The well-known UNICEF (1990) framework distinguishes between the immediate determinants of malnutrition (dietary quality, disease) and underlying causes, such as poverty, ignorance, and lack of access to basic services and infrastructure. In this section we focus on identifying the contribution of some of these underlying causes. We estimate two types of models to explain undernutrition. The first more parsimonious model focuses on economic status (wealth or assets) and parental education as two of the most important factors driving nutritional change, since these variables affect more intermediate pathways, such as fertility decisions, health service utilization and sanitation. The second includes these more intermediate factors. The assumption in such models is that if wealth and parental education are accurately controlled for, then fertility, health service utilization, and sanitation variables may reflect the effects of supply side factors, such as government policies.

Descriptive statistics of potential explanatory factors of child growth outcomes

ECONOMIC STATUS: CONSTRUCTION OF AN ASSET INDEX

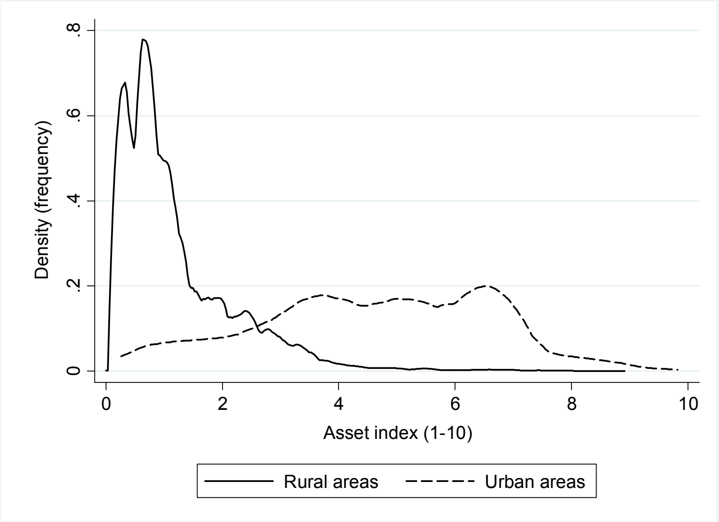
To measure economic status in the DHS, we must construct an asset index from 24 questions on ownership of household durables (cars, TVs, radios, tables, bicycles, motorcycles, kerosene lamps) and housing characteristics (number of sleeping rooms, floor and roof materials) using principal components analysis (PCA).[1] We then reweight the first principal component so that it varies between a minimum of zero and a maximum of 10. We do this with pooled 2000 and 2011 data, and we also pooled data across rural and urban areas. Figure 4.1 shows the distribution of asset index scores separately for rural and urban areas. We find very large differences, with the rural population clearly owning very few durable assets and having much inferior housing conditions. While we cannot rule out the possibility that such indices are urban biased[2] – certainly rural-urban asset differences are

[1] PCA constructs a composite index where the weights maximize the total variation in the full matrix of included variables.

[2] Pooling across rural and urban areas is sometimes not recommended (Rutstein & Staveteig 2014) on the grounds that rural people have different assets to urban people (e.g. land, livestock) and not just different levels of assets. However, in our experience it rarely makes much difference. Moreover, although we attempted to add agrarian assets to the PCA – such as livestock ownership and land ownership – the weights received for these indicators in the PCA exercise were close to zero, and in some cases negative. Nevertheless, to test this idea we separately calculated rural and urban weights and did indeed find some differences in weighting schemes, particularly in terms of housing characteristics. However, the correlation between the urban-based and rural-based PCA indices is a high 0.90, suggesting our choice of common factor weights across rural and urban areas was not very material. Nevertheless, better indicators of rural agrarian assets would be desirable, in principle.

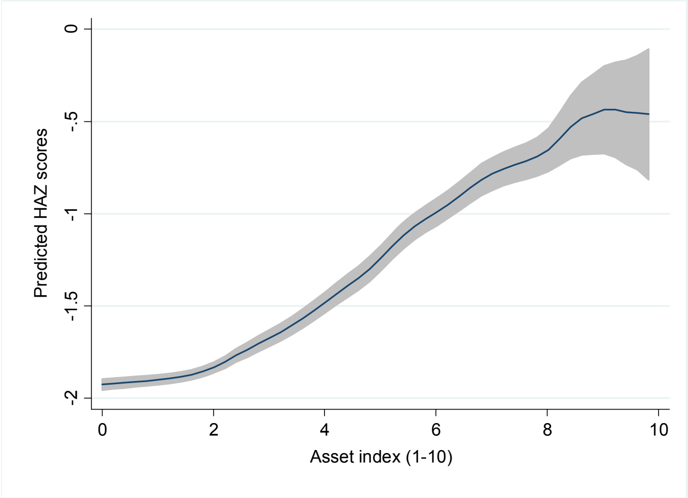
much larger than rural-urban expenditure differences in Ethiopia – it is important to recall the very large differences in nutrition outcomes across rural and urban areas. Bearing this in mind, Figure 4.2 shows that the asset index is quite strongly associated with child growth outcomes in Ethiopia, albeit with some non-linearity at the lower end of the asset distribution.

Figure 4.1—Distributions of asset index scores in rural and urban areas



Source: Authors' estimates.
Notes: These are kernel density estimates of the distribution of asset index scores.

Figure 4.2—HAZ scores and asset index scores

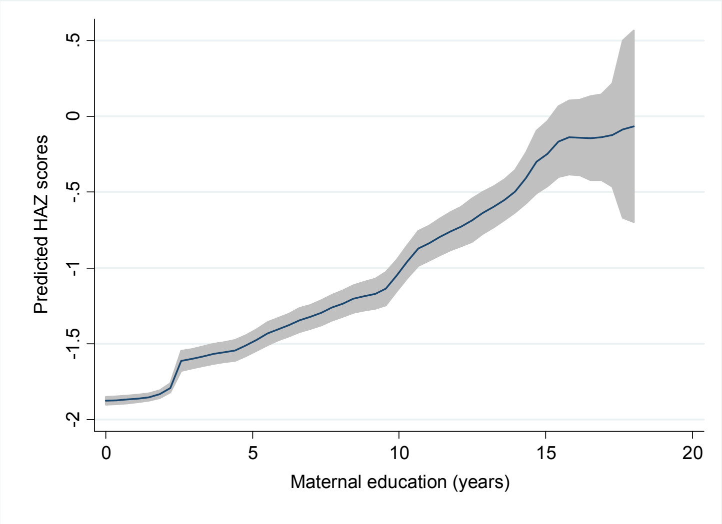


Source: Authors' estimates.
Notes: These are local polynomial smoother estimates with 95 percent confidence intervals.

PARENTAL EDUCATION

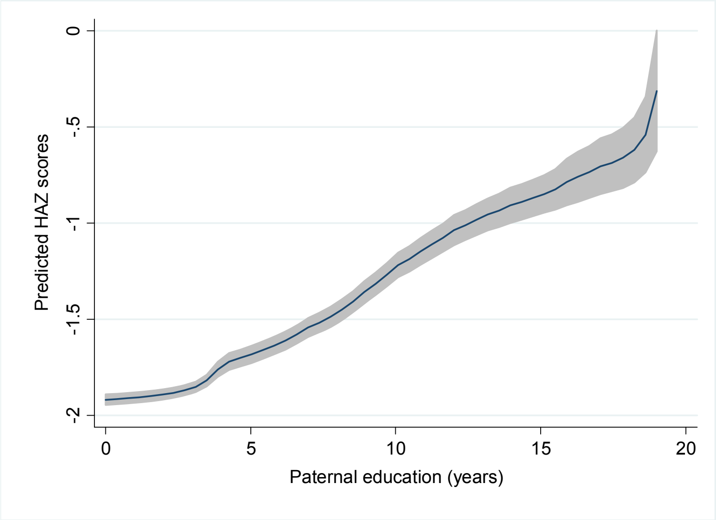
Parental education has long been identified as an important determinant of child nutrition outcomes, though with some debate about whether maternal or paternal education matters most and whether primary or secondary schooling thresholds exist (Behrman & Wolfe 1984, 1987; Burchi 2012; Desai & Alva 1998; Thomas, Strauss, & Henriques 1991). In Figure 4.3 we look at the association between maternal years of education and HAZ scores. We observe an approximately linear relationship that is reasonably strong. In Figure 4.4 we look at paternal years of education and also find a relatively strong and linear relationship.

Figure 4.3—HAZ scores and maternal education



Source: Authors' estimates.
Notes: These are local polynomial smoother estimates with 95 percent confidence intervals.

Figure 4.4—HAZ scores and paternal education



Source: Authors' estimates.
Notes: These are local polynomial smoother estimates with 95 percent confidence intervals.

HEALTH SERVICE UTILIZATION AND ACCESS

Given the vulnerability of infants and young children to disease, health services can have a range of impacts on child growth outcomes. In this study we focused on three indicators of health service utilization and access that cover different stages of a young child's life cycle. First, we created a dummy variable for whether a mother received the recommended four or more antenatal care (ANC) visits from a health professional. Second, we created a dummy variable for whether a mother delivered her baby in the presence of a health professional. Third, we created a dummy for whether older children in the household had received all recommended vaccinations. However, this last variable was almost invariably insignificant and often yielded the unexpected sign (vaccinations predicted increased undernutrition), so was subsequently dropped from the regression analysis.

In terms of simple correlations, we found a surprisingly weak bivariate correlation between receiving four or more ANC visits and child HAZ scores, and a very strong correlation between HAZ scores and delivery by a health professional. However, in multivariate analysis below we tend to find the opposite: ANC visits are strongly associated with child growth outcomes, while medical deliveries are not. The explanation of this appears to lie in Table 4.2; medical deliveries are strongly correlated with household wealth and parental education, whereas ANC visits are not. This suggests that ANC visits may be a better indicator of publicly provided health service delivery, whereas medical deliveries largely represents private household wealth.

Table 4.1—Health service utilization and mean HAZ scores

	4 or more antenatal care visits	Medical delivery
No	-1.79	-1.92
Yes	-1.84	-0.99

Source: Authors' calculations.
Notes: All estimates are weitghted means, reflecting survey design.

Table 4.2—Correlations between health service utilization, household wealth, and parental education

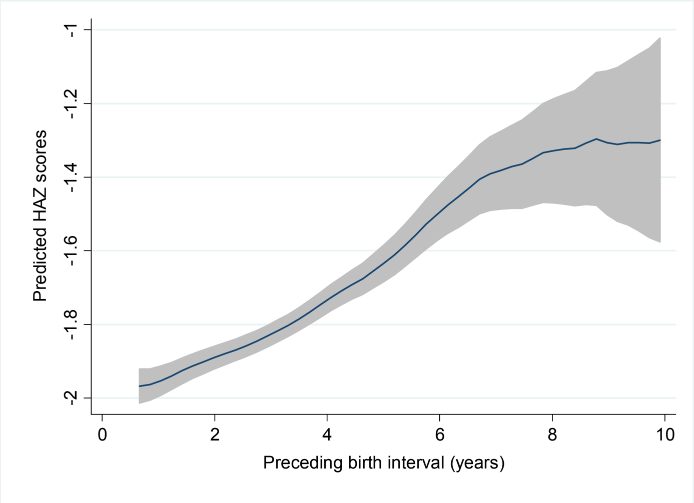
	Assets	Maternal education	Paternal education	4 or more antenatal care visits	Medical delivery
Assets	1.00				
Maternal education	0.56	1.00			
Paternal education	0.52	0.64	1.00		
4 or more antenatal care visits	0.21	0.18	0.17	1.00	
Medical delivery	0.58	0.53	0.47	0.19	1.00

Source: Authors' calculations.

FERTILITY OUTCOMES

A substantial literature has examined the association between fertility outcomes and child nutrition, particularly birth intervals (Rutstein 2005, 2008) and birth order (Behrman 1988; Horton 1988; Jayachandran & Pande 2013).[3] Having more children, especially over shorter time intervals, reduces the amount of household resources available for a child, including food and parental care/time. Figure 4.5 shows a relatively strong relationship between the length of the preceding birth interval and HAZ scores – with longer birth intervals being beneficial for child growth – although the strength of the relationship declines after about six years. The estimated growth differential between a relatively short birth interval (2 years) and a long birth intervals (6 years) is about 0.5 standard deviations in the HAZ score.

Figure 4.5—HAZ scores and preceding birth intervals

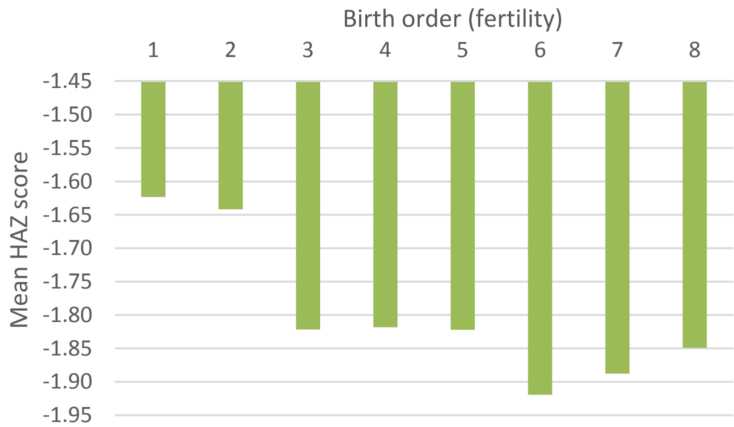


Source: Authors' estimates.
Notes: These are local polynomial smoother estimates with 95 percent confidence intervals.

[3] Birth order is obviously also very closely associated with total fertility rates, since lower birth orders only exist for families with high fertility rates

Figure 4.6 shows mean HAZ scores by birth order. Notably the relationship is non-linear. The first two children are predicted to have roughly equal HAZ scores, but all subsequent children have lower HAZ scores, with the difference varying between 0.2 to 0.3 standard deviations. However, this gradient is relatively mild compared to the gradients observed in Figures 4.2, 4.3, and 4.4 examining the association between assets and parental education to mean HAZ scores.

Figure 4.6—Mean HAZ scores by birth order

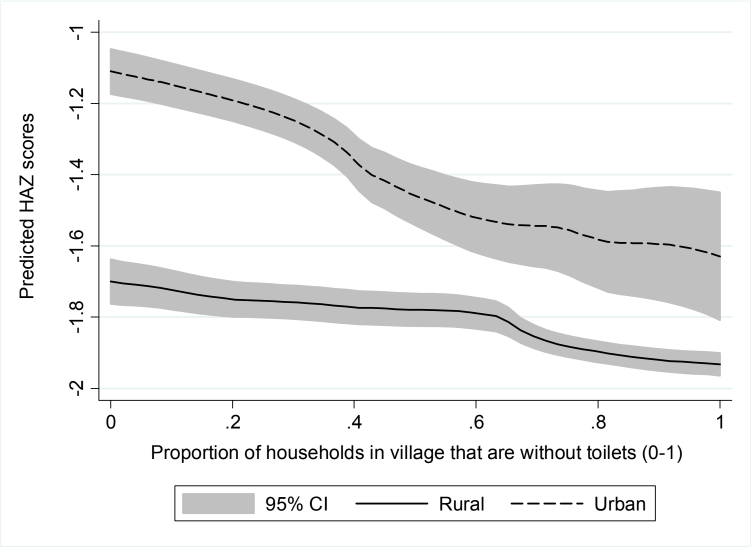


Source: Authors' estimates.
Notes: All estimates are weighted means, reflecting survey design.

SANITATION AND WATER

In recent years considerable evidence has emerged on the contribution of sanitation to child growth outcomes, particularly the very harmful effects of open defecation at the community level, which tends to be more harmful in higher density areas (Headey, et al. 2014; Humphrey 2009; Spears 2013). In Figure 4.7 we look at the village-level open defecation hypothesis separately for rural and urban areas, where urban areas are obviously higher density. Consistent with previous evidence we do indeed find a steeper gradient for urban areas, although the gradient appears somewhat non-linear. When open defecation falls below 40 percent the gains to further reductions are relatively low. In rural areas the gradient is relatively flat throughout.

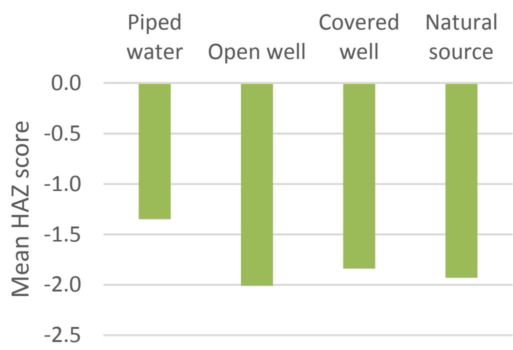
Figure 4.7—Mean HAZ scores and village-level open defecation in rural and urban areas



Source: Authors' estimates. These are local polynomial smoother estimates with 95 percent confidence intervals.

For water, Figure 4.8 looks at predicted HAZ scores by four categories of water source. The most striking result is that only piped water is associated with better child growth outcomes. Though not shown, we also note that this result holds for both rural and urban areas.

Figure 4.8—Mean HAZ scores by drinking water source



Source: Authors' estimates.
Notes: All estimates are weighted means, reflecting survey design.

Modeling the determinants of child growth outcomes in Ethiopia

In Tables 4.3, 4.4, 4.5 and 4.6, we turn to more formal multivariate tests of the associations between child nutrition outcomes and the explanatory factors described above. Table 4.3 examines HAZ scores as the dependent variable, while Tables 4.4 and 4.5 examine stunting and severe stunting, respectively, and Table 4.6 explains variation in the self-reported low birth size variable.

For each dependent variable, we estimate four regression models

1. A parsimonious model that includes assets and parental education as the only time-varying explanatory variables;
2. A fuller specification for all areas that includes health, fertility, sanitation and water variables;
3. A fuller specification for rural areas only; and
4. A fuller specification for urban areas only.

Also note that all regressions include regional dummies variables, an urban dummy variable, a dummy variable for the 2011 round, monthly dummy variables for child's age, and maternal age controls. All regressions are either OLS or linear probability, though we note that the linear probability results are also robust to the use of logit or probit model specifications.

The main results of these regressions are as follows:

First, the household asset index and both maternal and paternal educational attainment are essentially always significantly and strongly associated with child growth outcomes. The difference between having no assets and having the maximum number of assets is about 1.1 standard deviations in the HAZ score, or a 30 point reduction in stunting, a 26 point reduction in severe stunting, and an 18 point reduction in small size at birth. For parental education, the difference between a parent having no education and having 12 years of education is typically in the range of 0.24 to 0.36 standard deviations in HAZ scores, and about 12 points in stunting reduction. The effects on small size at birth are significant, but fairly small. We also typically find no significant difference between maternal and paternal education.

In terms of health variables, we find robust, significant and fairly large nutritional returns to four or more ANC visits, but no associations between nutrition outcomes and delivery by a health professional. As noted above, this appears to be explained by the strong association that medical deliveries have with household wealth and parental education. In any event, ANC visits are associated with a 0.22 point increase in HAZ scores, a 7 point reduction in stunting, a 4.4 point reduction in severe stunting, and a 4 point reduction in small size at birth.

With regard to fertility variables, we find that preceding birth intervals are robustly associated with nutrition outcomes. An extra year birth interval increases child HAZ scores by around 0.04 standard deviations, or around 1 percentage point in stunting prevalence. These are obviously quite modest effects. However, we find no impact of birth intervals on small size at birth, though lower birth orders are significantly associated with small size at birth, increasing the probability by just 3 percentage points.

With regard to open defecation, we never find it to be strongly associated with child growth outcomes. The one exception is that this variable yields a coefficient that is almost significant at the 10 percent level in the stunting regression for urban areas (significant at the 13 percent level). Based on the graphical evidence above we suspect that open defecation is a problem in more densely populated urban areas, but that the relatively small sample size of urban areas prevents us from identifying a statistically significant effect. Future research would do well to estimate the nutritional impacts of open defecation as a function of local population density, as in Spears (2012).

With regard to piped water, we find this to be a significant and fairly robust determinant of nutrition outcomes, except in urban areas. The insignificant coefficient of this variable in our urban sample regressions could be explained by several factors. First, most households in urban areas (80 percent) have piped water, so there is little variation within urban areas. Second, existing research has found that inconsistently piped water supplies can actually breed disease and be more harmful than alternative water sources, such as collected rainfall (Klasen, Tobias, Kristina, & Johannes 2012). Certainly piped water supply in Ethiopia is very uneven, with frequent shortages.

Finally, there are some interesting results among our control variables:

First, the urban dummy is rarely significant, suggesting that the models may perform reasonably well in explaining rural and urban differences in nutrition outcomes.

Second, a dummy variable for female children is significant and usually suggestive of a female advantage in nutrition, except in urban areas and with regard to birth size. For example, controlling for other factors, girls are 2 to 3 percentage points less likely to be stunted, but 8 percent more likely to be reported as being small at birth by their mothers.

Third, the regional dummy variables – all based relative to the largest region, Oromia – are often large in absolute magnitude and highly significant, suggesting that the household level variables disappoint in explaining regional variations in child nutrition outcomes. Relative to Oromia, children in Amhara and Tigray are 6 to 7 points more likely to be stunted. As noted above, northern Amhara and much of Tigray are drought-prone regions, suggesting that agroclimatic factors and food insecurity could explain these poor nutrition outcomes in these regions. In contrast, children in Somali, Harar, and Gambela regions are respectively 8, 5, and 11 points less likely to be stunted. Many rural people in these regions are pastoralist or agropastoralist populations that suffer from relatively high levels of wasting (and also high rates of small size at birth), but relatively low levels of stunting.

Finally, the dummy variable for the 2011 round of the data is usually significant, large and positive, suggesting that these models do not fully account for changes in undernutrition over time. Furthermore, in the next section of this paper we conduct a statistical decomposition of the sources of nutritional change over 2000-2011, and show that these models explain just under one third of the changes in stunting over this time period.

Table 4.3—Explaining child HAZ scores

Regression number	1	2	3	4
Variation	Assets & education only	Full specification	Rural areas only	Urban areas only
Asset index (1-10)	0.11***	0.10***	0.08***	0.14***
Maternal education (years)	0.03***	0.02**	0.01	0.02**
Paternal education (years)	0.02***	0.02***	0.02***	0.01
4+ ANC visits		0.22***	0.22***	0.25***
Medical delivery		0.07	0.05	0.09
Birth interval (years)		0.04***	0.05***	0.02
Birth order		-0.01	-0.01	-0.01
Open defecation (village)		0.00	0.04	-0.03
Piped water		0.09*	0.14***	-0.14
Urban dummy	-0.02	-0.06		
Female child dummy	0.09***	0.07***	0.08***	0.02
Year 2011 dummy	0.11***	0.10***	0.08***	0.14***
Regional effects (relative to Oromia)				
Afar	-0.09	-0.10	-0.15*	0.37
Amhara	-0.24***	-0.24***	-0.24***	-0.32*
Somali	0.30***	0.32***	0.26***	0.39*
Benishangul-Gumuz	-0.03	-0.05	-0.07	0.35**
SNNP	-0.15**	-0.17***	-0.16**	-0.06
Gambela	0.46***	0.47***	0.46***	0.31
Tigray	-0.28***	-0.26***	-0.26***	-0.49***
Harar	0.24***	0.20***	0.27***	0.18
Addis	-0.20**	-0.01		-0.22
Dire Dawa	0.14*	0.20***	0.07	0.22
R-squared	*0.24*	*0.24*	*0.22*	*0.29*
N	*17,196*	*14,046*	*12,146*	*1,900*

Source: Authors' estimates.

Notes: These are ordinary least squares (OLS) regressions with clustered standard errors. *, ** and *** represents statistical significance at the 1%, 5% and 10% levels, respectively. The regression also includes dummy variables for the age of child, by month, as well as maternal age dummies.

Table 4.4—Explaining child stunting

Regression number	1	2	3	4
Variation	Assets & education only	Full specification	Rural areas only	Urban areas only
Asset index (1-10)	-0.03***	-0.03***	-0.02***	-0.04***
Maternal education (years)	-0.01***	-0.01***	0.00	-0.01**
Paternal education (years)	-0.01***	-0.01***	-0.01***	0.00
4+ ANC visits		-0.07***	-0.08***	-0.05**
Medical delivery		-0.01	0.01	-0.03
Birth interval (years)		-0.01***	-0.02***	-0.01
Birth order		0.00	0.00	0.0
Open defecation (village)		-0.01	-0.01	-0.04
Piped water		-0.03*	-0.04**	0.06
Urban dummy	-0.01	0.00		
Female child dummy	-0.03***	-0.02***	-0.03***	0.00
Year 2011 dummy	-0.08***	-0.09***	-0.09***	-0.10***
Regional effects (relative to Oromia)				
Afar	0.03	0.04*	0.04	-0.04
Amhara	0.06***	0.06***	0.06***	0.05
Somali	-0.07***	-0.08***	-0.06***	-0.07
Benishangul-Gumuz	0.00	0.01	0.01	-0.07
SNNP	0.03*	0.03**	0.04**	-0.01
Gambela	-0.10***	-0.11***	-0.10***	-0.08
Tigray	0.08***	0.07***	0.08***	0.07
Harar	-0.06**	-0.05***	-0.05**	-0.09*
Addis	0.08**	0.01		0.04
Dire Dawa	-0.03	-0.05**	-0.01	-0.07
R-squared	*0.15*	*0.15*	*0.14*	*0.16*
N	*17,180*	*14,037*	*12,136*	*1,901*

Source: Authors' estimates.
Notes: These are ordinary least squares (OLS) regressions with clustered standard errors. *, ** and *** represents statistical significance at the 1%, 5% and 10% levels, respectively. The regression also includes dummy variables for the age of child, by month, as well as maternal age dummies.

Table 4.5—Explaining severe child stunting

Regression number	1	2	3	4
Variation	Assets & education only	Full specification	Rural areas only	Urban areas only
Asset index (1-10)	-0.026***	-0.025***	-0.027***	-0.026***
Maternal education (years)	-0.005***	-0.003	-0.006**	-0.001
Paternal education (years)	-0.003***	-0.003**	-0.003*	-0.003
4+ ANC visits		-0.044***	-0.052***	-0.023
Medical delivery		-0.021	-0.035	-0.039**
Birth interval (years)		-0.010***	-0.014***	-0.001
Birth order		0.004	0.004	0.003
Open defecation (village)		0.005	-0.004	0.04
Piped water		-0.014	-0.024*	0.035
Urban dummy	0.007	0.021		
Female child	-0.025***	-0.022***	-0.026***	0.007
Year 2011 dummy	-0.059***	-0.060***	-0.061***	-0.045**
Regional effects (relative to Oromia)				
Afar	0.073***	0.065***	0.081***	-0.028
Amhara	0.061***	0.055***	0.063***	0.023
Somali	0.006	-0.002	0.015	-0.033
Benishangul-Gumuz	0.023	0.024	0.03	-0.061
SNNP	0.064***	0.060***	0.070***	-0.042
Gambela	-0.028	-0.038**	-0.018	-0.068
Tigray	0.046***	0.036***	0.042***	0.068
Harar	-0.022	-0.024	-0.027	-0.029
Addis	0.073***	0.030*		0.029
Dire Dawa	0.007	-0.008	0.002	0.001
R-squared	*0.08*	*0.08*	*0.08*	*0.10*
N	*17,180*	*14,037*	*12,136*	*1,901*

Source: Authors' estimates.
Notes: These are ordinary least squares (OLS) regressions with clustered standard errors. *, ** and *** represents statistical significance at the 1%, 5% and 10% levels, respectively. The regression also includes dummy variables for the age of child, by month, as well as maternal age dummies.

Table 4.6—Explaining self-reported low birth weight

Regression number	1	2	3	4
Variation	Assets, education, and mother's age	Full specification	Rural areas only	Urban areas only
Asset index (1-10)	-0.020***	-0.018***	-0.024***	-0.013**
Maternal education (years)	-0.003*	-0.003*	-0.001	-0.006**
Paternal education (years)	-0.005***	-0.005***	-0.006***	-0.002
4+ ANC visits		-0.041***	-0.034***	-0.044**
Birth interval (years)		0.000	0.007	-0.043
Birth order		-0.028***	-0.025**	-0.037
Open defecation (village)		-0.003	-0.016	0.038
Piped water		-0.015	-0.019	0.026
Mother aged 15-19 yrs	-0.004	-0.008	-0.009	-0.001
Mother aged 30-34 yrs	-0.007	0.004	0.003	0.008
Mother aged 35-39 yrs	-0.001	0.016	0.013	0.027
Mother aged 40+ yrs	0.020	0.037**	0.041**	-0.010
Urban dummy	-0.001	0.005		
Female child dummy	0.085***	0.085***	0.086***	0.075***
Regional effects (relative to Oromia)				
Afar	0.196***	0.193***	0.208***	0.072
Amhara	0.107***	0.101***	0.107***	0.014
Somali	0.053**	0.054***	0.054**	0.074
Benishangul-Gumuz	-0.021	-0.025	-0.029	0.013
SNNP	-0.046***	-0.049***	-0.052***	-0.006
Gambela	0.040*	0.035*	0.035	0.045
Tigray	0.056***	0.053***	0.056***	0.017
Harar	0.029	0.03	0.034	0.023
Addis	0.070***	0.077***		0.064
Dire Dawa	0.057***	0.059***	0.052**	0.062
Year 2011 dummy	-0.008	-0.007	-0.017	0.037**
Constant	0.309***	0.322***	0.346***	0.217***
R-squared	*0.05*	*0.05*	*0.05*	*0.03*
N	*17,162*	*17,157*	*14,463*	*2,694*

Source: Authors' estimates.
Notes: These are marginal effects from probit regressions with clustered standard errors. *, ** and *** represents statistical significance at the 1%, 5% and 10% levels, respectively. The regression also includes dummy variables for the age of child, by month.

5. EXPLAINING NUTRITIONAL CHANGE OVER TIME AND ACROSS THE RURAL-URBAN DIVIDE

In this section we use the regression results from the previous section to engage in statistical decompositions that aim to explain both changes in nutrition across time and rural-urban differences in nutrition. Specifically, we use the Oaxaca-Blinder decomposition, described in Section 2.

In Table 5.1 we report the results of decomposing changes in stunting prevalence across the rural-urban divide. The first column lists the dependent variable (stunting) and the five independent variables that significantly explain changes over the rural-urban divide. These are the asset index, maternal and paternal education, the 4+ ANC visit dummy variable, and the preceding birth interval. The next two columns show changes in means for these variables. As noted in Section 1, there is a very large rural-urban divide in stunting rates to the order of 14.3 percent. We also observe large differences in household assets, with urban areas having a mean asset score over three and a half times larger than rural areas. Likewise, there are large gaps in both maternal and paternal education: 3.6 and 4.6 years respectively – and a 20.6 percent difference in access to ANC visits. Combined with significant coefficients in the regression models (which the Oaxaca-Blinder model re-estimates) these large rural-urban differences in economic status, education, and health access explain all of the actual changes in stunting. However, differences in household assets provide by far the largest explanation. Differences in assets across rural and urban areas by themselves predict a 14 point gap in stunting rates, which accounts for over two-thirds of the predicted difference. Differences in maternal and paternal education explain another 4.5 point difference in rural-urban stunting rates, whilst ANC visits account for a surprisingly small share, as do birth intervals. Overall, the model performs very well, but differences in means predict a larger rural-urban difference (20.7 points) than is observed in reality (14.3 points), largely because of some significant coefficient differences.[4]

Table 5.1—Explaining changes in stunting prevalence across rural and urban areas

	Rural	Urban	Difference urban-rural	Predicted difference in stunting (differences in means), %	Proportion of predicted difference explained, %
Stunting prevalence, %	51.18	38.32	-12.86		
Asset index (1-10), avg.	1.24	4.06	2.82	14.0	67.6
Maternal education, yrs, avg.	0.59	3.66	3.07	2.2	10.4
Paternal education, yrs, avg.	1.73	5.81	4.08	2.3	11.2
4+ ANC visits, % of mothers	38.29	58.09	19.8	1.1	5.2
Preceding birth interval, yrs, avg.	3.04	3.89	0.85	1.2	5.6
Predicted change as percentage of actual change:					***145***

Source: Authors estimates.
Notes: These results are derived from an Oaxaca-Blinder decomposition of the predicted differences in stunting between rural and urban areas. Sample means are weighted means, reflecting survey design.

In Table 5.2 we turn to explaining changes in stunting rates over 2000 to 2011. The table is structured in a similar way to Table 5.1, but here we observed much smaller changes in key explanatory variables. The asset index only changed by 0.63 over this period, despite rapid economic growth. Changes in paternal education were also modest (as was maternal education), as were changes in ANC visits. Perhaps unsurprisingly, then, the model only accounts for a small fraction of the actual changes in stunting rates observed over this period (15.3 percent). Most of this predicted change is attributed to asset accumulation. When we conduct a similar decomposition with small size at birth, we find similar results: the model overall performs poorly in explaining the observed changes over time, but suggests that asset accumulation is the main factor driving change, followed by education and antenatal care.

In summary, the regression models perform relatively well in accounting for rural-urban differences in nutrition, but perform badly in accounting for changes in stunting rates over time. Both models identify improvements in economic status as a lead factor. We conjecture that improvements in economic status probably do explain much of the improvements in stunting over time, but that the asset index does not fully reflect these improvements. Improvements in food security, for example, might be driving much of the reduction in stunting, but such improvements might not be well captured by the asset index.

Table 5.2—Explaining changes in stunting prevalence over 2000 to 2011

	2000	2011	Difference 2000-2011	Predicted difference in stunting (differences in means), %	Proportion of predicted difference explained, %
Stunting prevalence, %	55.9	43.3	-12.6		
Asset index (1-10), avg.	1.26	1.87	0.63	1.2	9.3
Paternal education, yrs, avg.	1.99	2.76	0.75	0.4	3.3
4+ ANC visits, % of mothers	39.80	45.30	5.50	0.4	2.7
Predicted change as percentage of actual change:					***15.3***

Source: Authors estimates.
Notes: These results are derived from an Oaxaca-Blinder decomposition of the predicted differences in stunting between rural and urban areas. Sample means are weighted means, reflecting survey design.

[4] The model finds coefficient differences for assets, piped water, and open defecation.

6. PATTERNS AND DETERMINANTS OF INFANT AND YOUNG CHILD FEEDING PATTERNS

In this section we focus on examining patterns and potential determinants of infant and young child feeding (IYCF) practices. Table 6.1 reports on a select set of IYCF practices for Ethiopia's regions, and the country as a whole. In general, Ethiopia has very poor IYCF practices. Under 60 percent of newborns are taken to the breast within the first hour after birth. Exclusive breastfeeding is relatively low (73 percent), and the timely introduction of solid foods is even worse (44 percent). Continued breastfeeding after age one year is relatively good (93 percent), but the proportion of children that achieve minimum dietary diversity (4 out of 7 food groups) is appallingly low (3 percent).

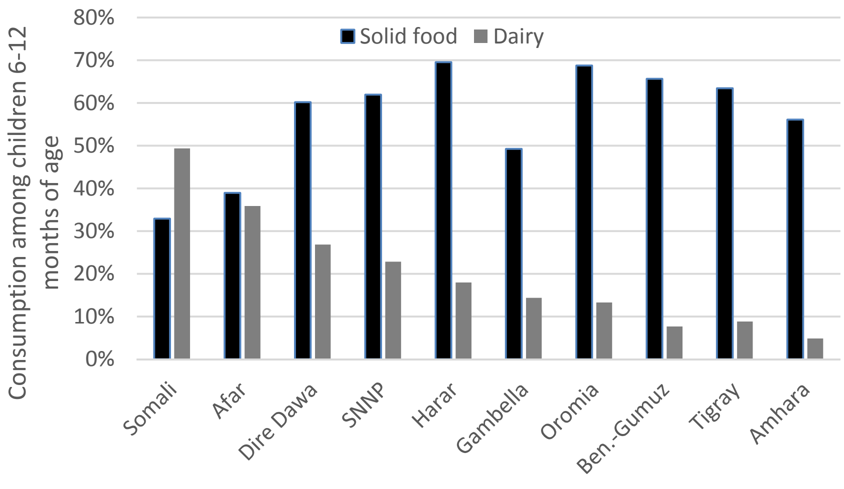
Across the regions, there are some sizeable variations in these indicators. In SNNP, for example, around three-quarters of newborns are immediately breastfed after birth, but in many other regions this falls to around one-half. The timely introduction of solid foods also varies, being particularly low in the more pastoralist regions of Somali and Afar (22 percent each), but also in Amhara. A likely explanation is that pastoralist groups give young children more dairy products and less solid food. The data bear this out. The proportion of children aged 6 to 12 months who consume milk in Somali and Afar regions is much higher than the rest of the country (Figure 6.1). But minimum dietary diversity is scarcely reached by any children anywhere in Ethiopia.

Table 6.1—IYCF practices across Ethiopia's regions, 2011

Region	Oromia	SNNP	Amhara	Tigray	Somali	Afar
Breastfed in 1st hour after birth, %	68	77	39	47	48	52
Exclusive breastfeeding in first 6 months, %	81	81	89	80	49	45
Timely introduction of solid foods (6-8 mos.), %	48	48	32	49	22	22
Continued breastfeeding (12-15 mos.), %	93	98	99	91	75	83
Minimum dietary diversity (4 food groups), %	2	2	1	3	2	2
Region	**Benishangul-Gumuz**	**Gambela**	**Harar**	**Dire Dawa**	**Addis Ababa**	**All Ethiopia**
Breastfed in 1st hour after birth, %	52	63	72	67	63	59
Exclusive breastfeeding in first 6 months, %	72	52	72	71	84	73
Timely introduction of solid foods (6-8 mos.), %	64	38	53	44	66	44
Continued breastfeeding (12-15 mos.), %	97	100	86	90	76	91
Minimum dietary diversity (4 food groups), %	3	5	4	6	7	3

Source: Authors estimates.
Notes: Sample means are weighted means, reflecting survey design.

Figure 6.1—Introduction of solid foods and dairy products among children aged 6-12 months, 2011



Source: Authors estimates.
Notes: Sample means are weighted means, reflecting survey design.

In Table 6.2 we look at children's food consumption patterns in more detail by examining the seven food groups that comprise the dietary diversity score. Staple foods consisting of grains, roots, and tubers are the most common consumption item, with over a third of children consuming these foods. Dairy products are the next most consumed item, with 20 percent of children having consumed them in the last 24 hours. Recent research suggests that milk plays a particularly important role in child growth in Ethiopia precisely because it is more widely consumed than any other animal sourced food, and is a proven predictor of child growth (Hoddinott, Headey, & Dereje 2014). However, on a daily basis, other nutrient-rich foods are consumed by very few children.

Across regions, there are a few patterns of note. The first is the aforementioned variation in dairy consumption, which is about twice as prevalent in pastoralist areas relative to the highland regions. A second pattern to note is the relatively high consumption of vitamin A-rich fruits and vegetables in SNNP and Gambela (both 16 percent). Meat consumption is also relatively high in Gambela, while pulses are a reasonably common in Tigray (16 percent), but relatively rare elsewhere. Of course, the use of the 24-hour recall method to collect these data lowers these consumption rates beyond what they would be with a 7-day recall method. Nonetheless, the extremely low diversity in the diets of young Ethiopian children is quite remarkable.

Table 6.2—Food consumption patterns among children aged 6-24 months, 2011, by food group

Region	Staples	Pulses	Dairy	Meat	Eggs	Vitamin A rich fruits & vegetables	Other fruit
Oromia	34	10	13	3	5	6	2
SNNP	34	4	23	1	2	16	3
Amhara	34	11	6	3	2	3	0
Tigray	45	16	13	6	7	4	1
Somali	19	1	41	3	1	5	1
Afar	31	4	38	2	1	4	1
Benishangul-Gumuz	42	11	8	9	4	13	2
Gambela	30	4	24	11	9	16	3
Harar	43	3	16	3	8	13	4
Dire Dawa	38	3	30	6	7	12	4
Addis Ababa	33	11	22	2	6	13	8
All Ethiopia	***35***	***8***	***19***	***4***	***4***	***9***	***2***

Source: Authors estimates, based on 24-hour food consumption recall data from EDHS 2011.
Notes: Sample means are weighted means, reflecting survey design.

In Table 6.3 we explore the sources of dietary diversity more systematically through multivariate regressions. We focus on the dietary diversity indicator in regressions 1 and 2 using Poisson regressions and on dairy consumption in regressions 3 and 4 using the linear probability model (LPM). Explanatory variables are grouped into assets (the asset index, parental education and livestock ownership), health and demographic variables, and regional fixed effects (which are not reported for the sake of brevity). In regression 1, we specify a more parsimonious model that excludes demographic variables and also the indicator of ANC visits. We observe that the asset index is significantly correlated with dietary diversity, while maternal and paternal education share somewhat weaker associations. However, the average marginal effects of the asset index and education are fairly low, which are consistent with the generally low levels of dietary diversity throughout the Ethiopian population.

Cow ownership also turns out to be a strong predictor of dietary diversity, as is chicken ownership. These livestock variables may be a decent proxy for rural wealth, but with Ethiopia's very underdeveloped food markets and high rates of own-consumption of farm products, it is also likely that livestock ownership directly influences the availability of animal-sourced foods (Hoddinott, et al. 2014). Interestingly, the urban dummy is positive but not significant, even though urban areas are generally assumed to have access to a wider array of food types. The female child dummy is also insignificant. However, maternal age dummies are highly significant, suggesting that older mothers give their children fewer types of food.

In regression 2, we add the ANC visits measure, birth intervals, and birth order. It is possible that mothers who have access to the recommended number of four ANC visits also receive nutritional advice. Strikingly, the association between ANC visits and dietary diversity proves to be rather strong – dietary diversity is expected to increase by 0.537 food items when a mother makes 4 or more ANC visits. Longer birth intervals, surprisingly, serve to reduce dietary diversity. Moreover, an important impact of adding ANC visits, is that the asset index and the education variables no longer reach statistical significance.

In regressions 3 and 4, we look at dairy consumption specifically, since this was the most important source of animal sourced foods. We also observed a significant effect of cow ownership in the dietary diversity regressions in Table 6.10. As expected, regressions 3 and 4 reveal that cow ownership is a significant predictor of dairy consumption, increasing the probability of dairy consumption by about 10 percent. Also significant is sheep/goat ownership, which increases the probability of dairy consumption by a more modest 2.3 percent. This is consistent with the relatively rare occurrence of goat milk and goat cheese in Ethiopian diets. Regression 4 also reveals that 4+ ANC visits is a strong predictor of dairy consumption, increasing the chances by about 13 percent. Also significant, and relatively large, is the coefficient of the urban dummy, which increases dairy consumption by almost 8 percent. Again we find that older mothers are less likely to give their children dairy products.

Table 6.3—Multivariate regressions explaining variation in dietary diversity and milk consumption

Regression number	1	2	3	4
Model	Poisson	Poisson	LPM	LPM
Dependent variable	Diet diversity	Diet diversity	Consumes dairy	Consumes dairy
Coefficient	Average marginal effect	Average marginal effect	Marginal probability	Marginal probability
Assets:				
Asset index (1-10)	0.027***	0.014	-0.003	-0.006
Maternal education (yrs)	0.014**	0.002	0.003	0.00
Paternal education (yrs)	0.007*	0.005	0.004**	0.003
Owns cow(s)	0.123***	0.13***	0.103***	0.108***
Owns chickens	0.068**	0.051*	-0.006	-0.006
Own sheep/goats	-0.019	-0.002	0.025**	0.023*
Health & demography				
4+ ANC visits		0.537***		0.126***
Birth interval (yrs)		-0.025***		-0.005*
Birth order		0.005		0.003
Urban dummy	0.077	0.096	0.054*	0.077**
Female dummy	0.001	0.009	-0.007	-0.004
Mother aged 30-34	-0.057*	-0.075**	-0.022*	-0.032**
Mother aged 35-39	-0.079**	-0.085	-0.027*	-0.035*
Mother aged 40 plus	-0.208***	-0.16**	-0.059***	-0.053**
Intercept	-0.598***	-1.098***	0.234***	0.224***
R-squared			*0.19*	*0.21*
N	*7,934*	*6,465*	*7,934*	*6,465*

Source: Authors' estimates.
Notes: These are ordinary least squares (OLS) regressions with clustered standard errors. *, ** and *** represents statistical significance at the 1%, 5% and 10% levels respectively. The regression also includes dummy variables for the age of child, by month, as well as maternal age dummies.

7. CONCLUSIONS

Ethiopia has made impressive progress in reducing child undernutrition, though this progress remains somewhat enigmatic. Conventional statistical models are only able to explain a very small proportion of this improvement, though we conjecture that broader economic progress explains much of the improvement, although this is poorly measured by the DHS asset index. Ethiopia has experienced rapid growth in agricultural productivity, for example, but improvement in the asset index in rural areas was very modest. Likewise, the dietary diversity indicators recorded in the DHS perform reasonably in capturing diversity and quality of the diet, but probably perform poorly in capturing improvements in basic calorie consumption.

Moving forward, nutritional improvements in Ethiopia will require vast social and economic change. The Ethiopian population remains overwhelmingly poor, with rural areas seemingly lagging well behind urban areas. Both maternal and paternal education levels are extremely low, but these have reasonably large effects on nutrition, suggesting that educational improvements could play a larger role in the future. More conjecturally, antenatal care seems to have positive associations with child growth outcomes, but access to antenatal care is still very low, especially in rural areas. Ethiopia's demography is also changing quite rapidly, which will make a sizeable contribution to nutrition outcomes over the longer term. Finally, there is some weak evidence that water quality and sanitation are important, though there are seemingly important rural and urban nuances with regard to their potential impacts on child growth outcomes.

REFERENCES

Behrman, J. 1988. Nutrition, health, birth order and seasonality: Intrahousehold allocation among children in rural India" *Journal of Development Economics.* 28: 43-62.

Behrman, J.R., and B.L. Wolfe. 1984. More evidence on nutrition demand: Income seems overrated and women's schooling underemphasized. *Journal of Development Economics.* 14: 105-128.

Behrman, J.R., and B.L. Wolfe. 1987. How does mother's schooling affect family health, nutrition, medical care usage, and household sanitation? *Journal of Econometrics.* 36: 185-204.

Burchi, F. 2012. Whose education affects a child's nutritional status? From parents' to household's education. *Demographic Research.* 27: 681-704.

CSA (Central Statistical Agency). 2014. *Ethiopia Mini Demographic and Health Survey 2014.* Addis Ababa: CSA.

Addis Ababa, EthiopiaDesai, S., and S. Alva. 1998. "Maternal education and child health: Is there a strong causal relationship?" *Demography.* 35: 71-81.

Headey, D., and J. Hoddinott. 2014. *Understanding the rapid reduction of undernutrition in Nepal, 2001-2011.* International Food Policy Research Institute Discussion Paper 1384. Washington DC: IFPRI.

Headey, D., J. Hoddinott, D. Ali, R. Tesfaye, and M. Dereje. 2014. *The other Asian enigma: Explaining the rapid reduction of malnutrition in Bangladesh*. International Food Policy Research Institute Discussion Paper 1358. Washington DC: IFPRI.

Hoddinott, J., D. Headey, and M. Dereje. 2014. "Cows, Missing Milk Markets and Nutrition in Rural Ethiopia." *Journal of Development Studies.* forthcoming.

Horton, S. 1988. Birth order and child nutritional status: Evidence from the Philippines. *Economic Development and Cultural Change.* 36: 341-354.

Humphrey, J.H. 2009. Child undernutrition, tropical enteropathy, toilets, and handwashing. *The Lancet.* 374: 1032-1035.

Jann, B. 2008. "The Blinder-Oaxaca decomposition for linear regression models." *Stata Journal.* 8: 453-479.

Jayachandran, S., and R. Pande. 2013. *Why are Indian children shorter than African children?* Department of Economics Working Paper. Cambridge MA: Harvard University.

Klasen, S., L. Tobias, M. Kristina, and R. Johannes. 2012. *Benefits trickling away: The health impact of extending access to piped water and sanitation in urban Yemen*. Courant Research Centre Poverty, Equity and Growth Discussion Paper 110. Göttingen: Courant Research Centre, University of Göttingen.

Rutstein, S.O. 2005. Effects of preceding birth intervals on neonatal, infant and under-five years mortality and nutritional status in developing countries: Evidence from the Demographic and Health Surveys. *International Journal of Gynecology and Obstetrics.* 89: 26.

Rutstein, S.O. 2008. *Further evidence of the effects of preceding birth intervals on neonatal, infant, and under-five-years mortality and nutritional status in developing countries: Evidence from the Demographic and Health Surveys.* DHS Working Paper 41. Calverton, MD: Macro International Inc.

Rutstein, S.O., and S. Staveteig. 2014. *Making the Demographic and Health Surveys wealth index comparable.* DHS Methodological Reports no. 9. Rockville, MD: ICF International.

Spears, D. 2013. *How much international variation in child height can sanitation explain?* World Bank Policy Working Paper 6351. Washington, DC: World Bank.

Thomas, D., J. Strauss, and M.H. Henriques. 1991. How does mother's education affect child height? *Journal of Human Resources.* 26: 183-211.

UNICEF (United Nations Children's Fund). 1990. "Strategy for Improved Nutrition of Children and Women in Developing Countries." In *UNICEF Policy Review 1990-1 (E/ICEF/1990/L.6)*. New York: UNICEF.

Victora, C.G., M. de Onis, P. Curi Hallal, M. Blössner, and R. Shrimpton. 2009. Worldwide timing of growth faltering: Revisiting implications for interventions." *Pediatrics.* 2010: 473-480.

About the Author/s

Derek Headey is a Senior Research Fellow in the Poverty, Health and Nutrition Division of International Food Policy Research Institute, Washington, DC.

Acknowledgement

Acknowledgements are due to John Hoddinott for comments and suggestions, and Mekdim Dereje for preparing the data. Funding for this work was received through the Transform Nutrition consortium funded by the Department for International Development (UK).

About ESSP

The Ethiopia Strategy Support Program is an initiative to strengthen evidence-based policymaking in Ethiopia in the areas of rural and agricultural development. Facilitated by the International Food Policy Research Institute (IFPRI), ESSP works closely with the government of Ethiopia, the Ethiopian Development Research Institute (EDRI), and other development partners to provide information relevant for the design and implementation of Ethiopia's agricultural and rural development strategies. For more information, see http://www.ifpri.org/book-757/ourwork/program/ethiopia-strategy-support-program or http://essp.ifpri.info/ or http://www.edri-eth.org/.

About these working papers

The ESSP Working Papers contain preliminary material and research results from IFPRI and its partners in Ethiopia. These papers are circulated in order to stimulate discussion and critical comment.

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

2033 K Street, NW | Washington, DC 20006-1002 USA | T: +1.202.862.5600 | F: +1.202.457.4439 | Skype: ifprihomeoffice | ifpri@cgiar.org | www.ifpri.org

IFPRI–ESSP ADDIS ABABA

P.O. Box 5689, Addis Ababa, Ethiopia | T: +251.11.617.2000 | F: +251.11.646.2318 | mahlet.mekuria@cgiar.org | http://essp.ifpri.info

ETHIOPIAN DEVELOPMENT RESEARCH INSTITUTE

P.O. Box 2479, Addis Ababa, Ethiopia | T: +251.11.550.6066 ; +251.11.553.8633 | F: +251.11.550.5588 | info@edri-eth.org | www.edri-eth.org

The Ethiopia Strategy Support Program is financially supported by The United States Agency for International Development (USAID) and the Department for International Development (DFID) of the United Kingdom.