Agricultural Production Subsidies and Child Health: Evidence from Malawi

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DRAFT - NOT FOR CITATION

Selected paper prepared for presentation for the 2016 Agricultural and Applied Economics Association, Boston, MA, July 31–August 2.

Abstract

Can rapid increases in agricultural productivity lead to improved nutritional outcomes for children in developing countries? In the 2005-06 growing season, the Malawi government introduced the Farm Input Subsidy Program (FISP), a high-profile and large-scale agricultural inputs subsidy targeting small farmers. This paper links new data on sub-district subsidy allocation across Traditional Authorities – an administrative level beneath districts and above the village in Malawi – to more than 20,000 observations of anthropometric outcomes for children born in rural Malawi between 1995 and 2010. We use the considerable spatial variation in TA-level per household fertilizer voucher allocation and the differences across birth cohorts introduced by the timing of FISP to study the effect of the program on child anthropometrics. We find a small, positive effect of Malawi's farm subsidy program on child anthropometric outcomes in Malawi's Central region – the region with the the historically highest stunting and underweight rates. Our estimates suggest that the Malawi fertilizer subsidy has increased child height-for-age z-scores in the Central Region by approximately 0.04 standard deviations, a two percent increase, on average. We investigate mechanisms of the effect and discuss its potential significance.

Keywords: farm input subsidies, Africa, Malawi, mineral fertilizer, agricultural productivity and nutrition, food security, child health, maize

JEL Codes: O12, O13, O15, Q01, Q12

Introduction

Can rapid increases in agricultural productivity lead to improved health outcomes for children growing up in developing countries? The question takes on new consequence given the renewed prevalence of programs in Sub-Saharan Africa designed to help large populations of small farmers acquire mineral fertilizer and hybrid seed at reduced cost. One key objective of these programs is to increase staple cereal yields, with consequent improvement to household and national food security. Prevailing wisdom suggests that programs to increase agricultural production should improve food security; agricultural growth has been shown to drive poverty reduction and income growth has been linked to improved calorie consumption (Strauss 1984; Abdulai and Aubert 2004) and micronutrient consumption (Ecker and Qaim 2011; Ecker et. al 2010) among the poor. Nonetheless, credible research quantifying nutritional impacts of agriculture is still limited. In particular, we know surprisingly little about the potential of stronger agricultural production and food security to reduce the physiological impact of malnutrition.

In the 2005-06 growing season, the Malawi government introduced the Farm Input Subsidy Program (FISP), a high-profile and large-scale agricultural inputs subsidy targeting small farmers. This subsidy has dramatically reduced the cost of mineral fertilizer and hybrid seed and has reached more than one million farmer households in each year since its inception. A subsidy for mineral fertilizer and hybrid maize seed could plausibly effect malnutrition in Malawi, a country characterized by shortfalls in production of maize, its primary staple crop, and a recent history of serious problems with chronic and acute food insecurity. The short stature of Malawian children reflects the widespread and persistent nutrition deficit; a 2009 UNICEF report found that 53% of children under the age of five were stunted, the fifth highest rate in the world at the time (UNICEF 2009). Maize dominates Malawian farm production and household consumption. Nearly 100 percent of farm households grow maize (IHS, 2005; IHS, 2010) and the majority of these maize growers produce primarily to meet their own families' consumption needs; only about 20 percent of households marketed maize in 2010 (IHS, 2010). Malawians consume 133 kg of maize annually per capita and the dependence of the Malawian diet on maize is among the highest in the region; on average, a little more than 50 percent of households' calories came from maize in 2004 (Dorward and Chirwa, 2011).

The Malawi fertilizer and hybrid seed subsidy has been credited with significant national increases in maize production and maize yields (Sanchez 2009; Dorward and Chirwa 2011)[1]. Rarely has a country so quickly increased production of a staple commodity critical to the meeting the subsistence needs of the

[1] The magnitude of these increases is controversial and an area of ongoing research; estimates based on nationally-representive household survey data are lower than the aggregate production increases reported by the government. We present and discuss recent estimates of post-FISP maize production in Section 1.1.

majority of its population, offering a unique opportunity to study the response of child health outcomes to a rapid, significant increase in households' agricultural production. Moreover, though the Malawi government stated that improving food security is a primary objective of the FISP, as yet no research has assessed the effects on this outcome. Note that a number of analyses have studied the changes in household level outcomes including farmer yields (Chibwana et. al, 2014) and production as well as assets (Ricker-Gilbert and Jayne, 2011).

Improvements in child health could have longer-term implications for individuals as well as for the overall strength of the economy; a large literature has established the important effects of early life health on longer-term outcomes such as health, education, and economic productivity (Maccini and Yang, 2009; Maluccio et al., 2009). However, most existing studies linking agricultural productivity to nutrition rely on correlations among the quantity of a household's agricultural production and the height and weight of children residing in the household. Correlations between unobservable household characteristics related to agricultural productivity and child anthropometrics could introduce important bias into these estimates[2].

This paper links new data on sub-district subsidy allocation across Traditional Authorities (TAs) – an administrative level beneath districts and above the village in Malawi – to more than 20,000 observations of anthropometric outcomes for children born in rural Malawi between 1995 and 2010. We use the considerable spatial variation in TA-level per household fertilizer voucher allocation and the differences across birth cohorts introduced by the timing of FISP to study the effect of the program on child anthropometrics. We analyze the allocation of voucher coupons to Traditional Authorities over time and find that the amount of the allocation (coupons and fertilizer) is tightly predicted by population.

Child nutritional outcomes exhibit considerable variation across Malawi's three regions (Madise et al., 1999, Chirwa and Ngalawa, 2008). The North has the lowest rates of underweight and stunted children while the Central region has the highest stunting and underweight rates. Regions also vary by mean household landsize, cultivated crops, and population density. For these reasons we test for differences in the effect of the FISP program across Malawi's three regions.

We find a small, positive effect of Malawi's farm subsidy program on child anthropometric outcomes in Malawi's Central region. Our estimates suggest that FISP increased child height-for-age z-scores by approximately 0.04 standard deviations. Given that the mean z-score for children born in Malawi before 2005 is -1.96 standard deviations (using the 2004 DHS sample), this represents a two percent increase, on average, in children's height-for-age z-scores attributable to FISP. Effects are robust to the inclusion

[2]The bias could go in either direction; households demonstrating aptitude in agriculture could also excel in child nutrition or households with higher agricultural productivity might rely on family (and child) labor with negative consequences for child health.

of Traditional Authority fixed effects, birth year cohort controls, and a range of administrative TA and child and household controls. We find no effects on children living in Northern or Southern regions.

We use a difference-in-differences estimation, exploiting the insight that a child's exposure to the program was determined both by the intensity of the allocation in his or her TA and by the timing of the child's birth with respect to FISP's start. We compare children who had no exposure to the program (born before the 2006 harvest) with children exposed to FISP in the critical first years of their lives. Once we control for the traditional authority of residence and cohort effects, we argue that an interaction between dummy variables indicating whether the child was born before or after 2005 and the intensity of the program in the TA is exogenous to anthropometric outcomes, but the identifying assumption should not be taken for granted. We test for pre-program (pre-2005) trends in anthropometric scores. We also use children born between 1995 and 2000 (and measured in 2000) as an additional control group. Changes in anthropometric outcomes should not differ systematically across high and low treatment areas for either children measured in 2000 (born 1995-2000) or for those measured in 2005 (born 2000-2005). Results from this control experiment suggest that results are not driven by faulty identification assumptions.

Our explanation of the mechanism subtending this effect is that households in TAs receiving more subsidy are increasing the supply of maize that they use for self-provisioning. Given that only 20 percent of Malawian farm households reported selling maize in markets (according to representative national surveys conducted in 2005 and 2010), and that research published in 2013 found that 66 percent of Malawian small farm households ran out of maize from their own production before the next harvest, we expect that subsidies have shortened the hunger season – when household stocks of maize run low – for some rural households. The less food a household must purchase during the season when prices are at their highest, the more money a household retains for other expenses, including non-maize staples, sources of protein, or health services. We find evidence that the subsidy increased household Food Consumption Scores, a composite measure of diet diversity, food frequency, and nutrition.

Research elsewhere has identified modest increases in household maize production attributable to the subsidy, in the range of 200-400 additional kilos of maize per hectare. Because mean household landholdings for farms in these regions are 1.08 hectares and mean per capita annual maize consumption is 133 kilos, a production increase of 200 to 400 kilos could signify annual maize self-sufficiency for between two and three additional members of each household. If many of these households before the subsidy were forced to cope with an annual maize deficit, then the subsidy could be improving nutrition and quality of life by decreasing the length and severity of that shortfall.

We must bear in mind that Malawi may present a special case among countries implementing small farmer input subsidies. With a large and growing population, a single production season, and a long-term decrease in per capita farm acreage devoted to maize production, Malawi's economy is nonetheless centered in the production of maize. Because maize comprises the bulk of the diet, and because most households consume what they grow and do not market the crop, the pathways linking increases in production household food security and nutrition outcomes may be unique to Malawi. Nonetheless, the health impact we observe from the subsidy program in Malawi is important and should be investigated in other nations where similar experiments are underway.

This analysis is related to research on the relationship between agriculture and household food security and child health outcomes but also contributes to the current debate surrounding the possible welfare effects attributable to the new wave of input subsidy programs targeting small farmers. Since the late 1980s, Sub-Saharan African countries have largely eliminated agricultural price supports and subsidies for farming inputs. Yet a reinvigorated pro-subsidy movement is emerging. In light of Malawi's experience, donors and countries are incorporating mineral fertilizer subsidies into near-term national agricultural strategies. The Malawi inputs subsidy is widely seen as a test case for implementation of similar programs in other parts of Sub-Saharan Africa. Our analysis contributes to this evolving literature.

For the child anthropometric data we use three rounds of the Malawi Demographic and Health Surveys (DHS 2000, 2004, 2010) and two rounds of the Malawi Integrated Household Surveys (IHS 2005 and 2010). An additional contribution of this research is to document discrepencies between the surveys in stunting rates and in the underlying height-for-age z-scores; the IHS surveys, which are carried out by the Malawi government in cooperation with the World Bank Living Standards Measurement Survey Group, document significantly lower stunting rates in both 2005 and 2010 than the DHS data and data collected by UNICEF's Multiple Indicator Cluster Survey (MICS). We demonstrate that the surveys are only comparable in trends in the Central region and therefore limit our use of the IHS surveys to the Central region data. This discrepency was noted in Aberman et. al (2015) but to our knowledge this is the first detailed documentation of the problem.

The paper is organized as follows. Section 1 provides background on Malawi's Farm Subsidy Program and Section 2 describes the motivation for the analysis. Section 3 presents the subsidy allocation data, describes the survey data used in the analysis, and documents important discrepencies between the IHS and DHS child anthropometric data. Section 4 describes the empirical identification strategy and Section 5 presents results from the estimations, and explores mechanisms of effect using the IHS and DHS data. Section 6 considers other policy variables that changed over time including sanitation and health services. Section 7 concludes with a discussion of the magnitude of the effect relative to other interventions.

1 Malawi's Farm Subsidy Program

Agriculture accounts for more than 90 percent of Malawi's export earnings and 80 percent of the workforce is employed in smallholder farming (Minot, 2010). The country is densely populated and land constrained – mean landholdings are 1.08 hectares per household (Mason and Ricker-Gilbert, 2012). Nearly 100 percent of farm households cultivate maize (IHS 2005, 2010) and cultivation is overwhelmingly rainfed. Famers plant between November and January and harvest between April and June depending on the region and the timing of the rains. Primary food crops include maize, sorghum, pulses, and tubers but maize comprises the bulk of the Malawian diet.

The Farm Input Subsidy Program (FISP) is the large-scale national fertilizer and hybrid seed subsidy program that has operated in Malawi since the 2005/06 production season, but the country has been experimenting with agricultural inputs support programs in more modest ways since the late 1990s and fertilizer subsidies have existed in one form or another since Malawian independence in the 1960s[3]. The immediate precursor to the FISP were Malawi's targeted input programs and universal starter pack projects (1998-2003), interventions designed to promote food security through the provision to all smallholders of sufficient mineral fertilizer and seed to plant 0.1 hectares of maize. The government widely scaled up existing input programs to create the Farm Input Subsidy Program after a particularly poor harvest resulting from drought in 2004/05.

The FISP allocates to recipient households one voucher redeemable for a subsidized 50kg bag of NPK fertilizer, a second voucher redeemable for a subsidized 50kg bag of urea fertilizer, and a voucher for improved seed (either 5 kg hybrid maize seed or 10 kg open pollinated variety). The package is designed to support at least one hectare of maize cultivation, a significant scale-up from previous Malawian input subsidies. In its first year, the FISP allocated coupons to farmers to purchase mineral fertilizer for maize production, but voucher allocations for tobacco fertilizers and vouchers for subsidized improved maize seed were added to the program after the second year. The voucher value as a share of the full retail price of the fertilizer has ranged between 64 and 91 percent, with the government absorbing the difference between the annual fixed price and the retail price (Dorward and Chirwa, 2011). The FISP is a costly undertaking, dwarfing other programs undertaken by the Malawian government during this period. The cost of the program is directly related to the price of mineral fertilizer; when the international price of mineral fertilizer spiked dramatically in 2008/09, the cost of the FISP reached 16 percent of Malawi's total national budget and 80 percent of the agricultural budget though it has since fallen back to between

[3]Background on Malawian agricultural policy from 1980–2000 can be found in Harrigan (2003)

six and eight percent of the total budget (Lunduka et al 2013). FISP entered its tenth year in 2015, reaching an estimated 1.4-1.6 million households (50-67% of rural households). Dorward and Chirwa (2011) provide detailed background on FISP design, objectives and implementation.

Fertilizer and seed voucher allocation to farm households is accomplished by the government in three stages. First, the Ministry of Agriculture and Food Security allocates coupons across districts according to population estimates (Dorward and Chirwa 2013). Second, districts work with Traditional Authority leaders, NGOs and religious leaders to distribute coupons across villages. Then, villages and village leaders decide on households to receive the coupons. An objective of the FISP was to provide subsidy to the "productive middle" – coupons were intended to reach households who were not using mineral fertilizer and hybrid seed but for whom it could be profitable to adopt. The program has been criticized for problems with targeting and leakage (Holden and Lundaka 2010) and Lunduka et al (2013) report that targeting has changed over time. More details on subsidy targeting and leakage can be found in Dorward et al. (2008) and Kilic et al. (2013).

Data from government sources suggest that maize production has doubled or tripled since the subsidy program began in 2005-06. However, government maize production statistics have been viewed with some skepticism (Lunduka et al., 2013) especially in light of the expense and political sensitivity of the subsidy and the fact that trade flow data that suggests that Malawi continued to import maize between through the 2009/10 production season (Jayne et al, 2010), though the country was a net exporter of maize annually after 2010. The country seems to have experienced large increases in maize production in the FISP era; the precise magnitude of these increases and the degree to which they can be attributed to the subsidy program are areas of ongoing study.

Researchers have turned to nationally representative household surveys to estimate the household-level production effects of the FISP. Results from these studies based on household survey data vary in magnitude but indicate a substantial increase in maize production among recipient households. For example, Chibwana et al. (2014) estimate that households that received and used the full farm input subsidy package (mineral fertilizer and hybrid maize seed) increased maize production 447 kilograms per hectare. Ricker-Gilbert and Jayne (2011) find that an additional kilo of mineral fertilizer increased maize production by 1.82 kilograms in the current year but they find that the effect is stronger the longer farmers have received the fertilizer subsidy; having received fertilizer in each of the three prior years upped the current year increase in maize production to 3.16 kilos. The Ricker-Gilbert and Jayne (2011) analysis, then, suggests a per household production increase (for a household that received two subsidized bags of mineral fertilizer and assuming no use of mineral fertilizer previous to the FISP) of between 182 and 316 kilograms of maize. If the subsidy reached two million small farm households (NSO, 2010), the micro-data based estimates suggests an annual national production increase of perhaps 400,000-800,000 metric tons of maize attributable to the subsidy (given assumptions about who received the vouchers and for how many years sequentially), which represents an increase of about 30-50 percent relative to pre-2006 production levels.

2 Motivation

With respect to the objectives of our study, the relationships between agriculture and child nutritional outcomes are complex – mediated by markets, weather, and behavior and preferences. At least three related pathways link the fertilizer and maize seed subsidies with child nutritional outcomes: price effects, income effects, and increases in subsistence production.

First, rapid and significant increases in production could have driven down the price of maize within Malawi. The majority of Malawian small farmers are net buyers of maize and the urban poor spend a considerable share of their incomes on maize, so decreases in maize price could have important and substantive effects on households' ability to purchase both maize and other food, increasing household food security and improving child nutritional outcomes. Interestingly, Lunduka et al. (2013) document that maize prices in Malawi increased during this time[4] and conclude that "the FISP appears to have exerted little downward pressure on maize prices in Malawi" (p. 573).

Second, the FISP might increase household income if increasing household maize production changed market outcomes - increasing the quantity sold by the household or the price the farmer received. This could be the case if production increases translated into sales increases, changes in the type of buyer farmers can sell to (a larger buyer who pays a higher price for example) or shifts in the timing of their sales (if increased production allows them to wait until the price rises after harvest for at least a share of their production). Households could use additional income to purchase more calories or better (in terms of micronutrients) calories. Or households might use additional income to purchase health services or improved water or sanitation, both of which have been shown to improve children's health and caloric utilization (Fink et al, 2011).

However, given that only 20 percent of Malawian farm households reported selling maize in markets (IHS 2005 and IHS 2010), a third pathway – also income-related – is a more likely candidate to affect

[4]Dorward et al. (2010) suggest that the increasing price trend could be attributable to a range of factors including increased exportation of maize during the period, increased purchases by the Malawi government for national grain stocks, or changes in regional maize trade in East and Southern Africa.

child height-for-age z-scores for the majority of recipient farm households – increasing maize production serves to shorten the hungry season for rural households. Mason and Ricker-Gilbert find that 66% of Malawian small farmers ran out of maize from own production before the next harvest[5]. The less food a household has to purchase during the lean season, when prices are at their highest, the more money a household has available for other sorts of expenses such as non-maize staples, sources of protein, or health services. Increased household production quantities in the range of 200-400 additional kilos of maize per hectare are modest, but given mean household landholdings are 1.08 hectares (Mason and Ricker-Gilbert, 2012) and mean per capita annual maize consumption is 133 kilos, a production increase of 200-400 kilos represents annual maize self-sufficiency for between two and three additional annual household members[6]. Note that increases in income could effect children directly through improvements in calorie quantity or quality or access to health services or indirectly through improvements in diet and health of mothers during pregnancy. We test for these mechanisms in Section 4.

3 Data

3.1 Subsidy allocation data

Malawi is made up of 28 districts: six Northern Region districts, nine Central Region districts, and 13 Southern. Districts are further divided into administrative units called traditional authorities (TAs), which are headed by chiefs. Malawi consisted of 351 Traditional Authorities and Sub-Traditional Authorities (also known as Sub-Chiefs), including protected areas, parks, and wards (areas within cities) in the 1998 and 2008 census reports. Each TA is composed of villages, which are presided over by village headmen.

The village-level subsidy allocation data used in this paper comes from Malawi's government logistics unit and to our knowledge has never before been used in an analysis. The logistics unit compiles an annual database documenting how many fertilizer subsidy coupons the government sent to every village in Malawi. Databases are organized as excel spreadsheets, one spreadsheet per district, and include the name of the village, the name of the TA, the Extension Planning Area (EPA)[7], the registration numbers of the vouchers allocated to each village and the total number of families in the village that received vouchers in a given year. These databases are accompanied by a final report on the year's implementation summarizing challenges encountered that year related to fertilizer sourcing and voucher

[5] Mason and Ricker-Gilbert (2012) pool data from nationally representative surveys conducted in 2006-07 and 2008-09.
[6] Mean household size is 4.4 individuals during this period (NSO, 2010).
[7] An EPA can include multiple TAs.

printing and distribution. Data aggregation and reports by the logistics unit began in the third year of the subsidy, 2007-2008. The logistics unit reports provide us with information on how much fertilizer went to every village in Malawi annually beginning in the 2007-2008 growing season through 2013-2014.

We aggregate the village-level allocation data from the logistics unit up to the traditional authority level, a unit for which we also have 1998 and 2008 census statistics on demographic characteristics, production area and poverty and for which we can extract from spatial data files 2005 data on hectares under cultivation.

Table 3 presents the mean, minimum maximum TA-level allocations and the number of TAs included in the administrative data from the logistics unit, by allocation year. Table 2 presents correlations in TA-level allocations across the seven years. Note that there is little variation after 2009-10 in TA-level allocations. Before 2009 the inter-annual correlations are still high but slightly less strong (ranging between 0.80 and 0.85 rather than between 0.95 and 0.98 after 2008-09).

The analysis uses the 2008-09 allocation data at the Traditional Authority level. We use the 2008-09 allocations because they are the earliest data we have in a year in which there were no known, documented problems related to allocation and no discrepancies between the logistics data and the final allocations. The 2008 logistics report (Logistics Unit, 2008; also see Dorward et. al, 2013) indicates that 2007-08 was a special year in that the database totals do not reflect the true number of vouchers that circulated in the market[8]. While we use the 2008-09 TA allocations in the analysis but results hold if we use the 2010-11 or subsequent year allocations (not surprisingly given the inter-annual correlations in TA allocations in Table 3).

Given persistent questions about the validity of the Malawi government's maize production data since FISP, it is important to view the logistics reports on village-level allocations with some skepticism. For this reason, we check the logistics unit data on subsidy allocations against aggregated reported household subsidy recipients from the IHS 2010 household survey (the survey is representative at the district level). We use the IHS 2010 data to calculate the share of households, by district, who reported receiving a fertilizer subsidy coupon in the 2009-2010 long rains season. We compute the same statistic using the logistics unit allocation data by aggregating the vouchers sent to villages in the 2009-2010 season up to the district level and then dividing by the number of households in the district according to the 2008 census. We calculate the IHS statistics using the household survey weights. These statistics are presented for comparison in Table 1 and Figure 1 presents the relationship between the logistics unit

[8]The report describes problems in 2007-08 related to the printing and circulation of at least one million additional vouchers in the marketplace. They write, "what was not clear was how many additional were being printed, how they were being distributed and which EPA in each district was benefiting" (p. 15). The implication is that these were fake vouchers. In subsequent years the government introduced security features on the vouchers that seemed to remedy the problem.

data and the statistics compiled from the household survey data. The correlation coefficient between the two district-level statistics is 0.81. Figure 1 plots the relationship. This is a strong correlation given that households have been found to have engaged in some reallocation and sharing of subsidy coupons (Holden and Lunduka, 2012).

	Share of households IHS 2010	Logistics unit data
Chitipa	0.70 (0.03)	0.42
Karonga	0.40 (0.03)	0.51
Nkhata Bay	0.31 (0.05)	0.56
Rumphi	0.58 (0.04)	0.88
Mzimba[a]	0.54 (0.04)	0.48
Kasungu	0.53 (0.05)	0.67
Nkhota Kota	0.40 (0.04)	0.49
Ntchisi	0.63 (0.02)	0.87
Dowa	0.47 (0.06)	0.61
Salima	0.49 (0.05)	0.51
Lilongwe[b]	0.50 (0.05)	0.35
Mchinji	0.61 (0.05)	0.71
Dedza	0.41 (0.06)	0.51
Ntcheu	0.67 (0.04)	0.72
Mangochi	0.26 (0.04)	0.42
Machinga	0.59 (0.05)	0.58
Zomba[c]	0.69 (0.04)	0.69
Chiradzulu	0.78 (0.03)	0.79
Blanytyre[d]	0.80 (0.05)	0.41
Mwanza	0.61 (0.05)	0.72
Thyolo	0.62 (0.06)	0.75
Mulanje	0.60 (0.06)	0.64
Phalombe	0.68 (0.03)	0.84
Chikwawa	0.03 (0.02)	0.19
Nsanje	0.07 (0.02)	0.27
Balaka	0.58 (0.04)	0.73
Neno	0.55 (0.07)	0.69

[a] includes Mzuzu City [b] includes Lilongwe City [c] includes Zomba City [d] includes Blantyre City

Table 1: Share of households per district allocated subsidy vouchers in 2009-10 from the government logistics unit data and the share who reported receiving any coupons by district according to the 2010 IHS data. The correlation coefficient between the two district-level statistics is 0.81.

3.2 Analysis of TA-level fertilizer allocations

Data from 1998 and 2003 administrative geospatial files indicate that Malawi had 368 Traditional Authorities (we include in the TA category the within-city administrative unit classifications of sub-TAs, SCs, and Areas and Wards). Data from the logistics unit indicates that in 2008-09 113 of the 203 TAs represented in the pooled DHS child anthropometric data received coupons. The DHS data include nine

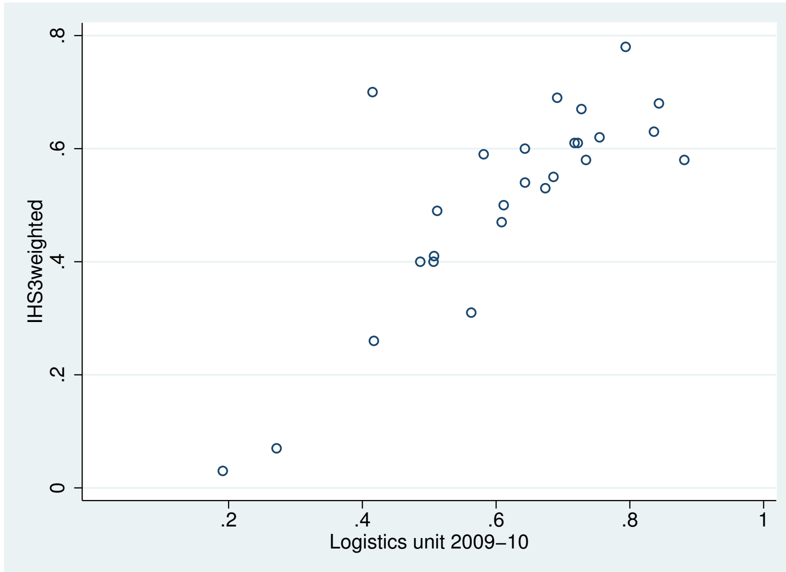

Figure 1: Relationship between calculated district-level household recipient shares using data from logistics unit against the shares calculated using the national IHS 2010 sample. Correlation coefficient between the two district-level statistics is 0.81.

Table 2: Correlations between annual subsidy voucher allocations to Traditional Authorities between the 2007-08 growing season and 2013-14.

	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
2007-08 allocation	1.00						
2008-09 allocation	0.85	1.00					
2009-10 allocation	0.82	0.90	1.00				
2010-11 allocation	0.80	0.88	0.98	1.00			
2011-12 allocation	0.83	0.89	0.97	0.97	1.00		
2012-13 allocation	0.84	0.91	0.95	0.95	0.96	1.00	
2013-14 allocation	0.83	0.90	0.96	0.95	0.95	0.96	1.00

TAs that do not appear in the logistics unit TA-level data and did not receive subsidy allocations according to these records. We include them as zeros in the analysis; they are home to 1301 children. The DHS data also include 3,098 children living in 74 administrative areas within cities, forest areas or reserves. Table 4 presents a list of these TAs and within-city administrative areas that do not appear in the logistics unit allocation data. Table 5 presents the distribution of children measured in the pooled DHS data across reported urban or rural residence and the allocation status of their TA (preserves, within-city administrative areas) of residence. The sample is overwhelmingly rural and made up of children living in TAs where subsidy was allocated under the FISP program.

Analysis of the logistics unit fertilizer voucher data indicates that coupons were allocated to non-urban and non-protected area (forests, reserves) TAs in a way that was roughly proportional to TA population;

Table 3: Descriptive statistics for TA-level allocation: mean, minimum, maximum, and total annual allocations and the number of TAs included in the administrative data from the logistics unit, by allocation year

	mean TA voucher allocation	(s.d.)	min	max	n	total
2007-08	13343.14	(11761.79)	15	60515	250	3.3m
2008-09	15676.31	(12527.17)	28	61892	255	4.0m
2009-10	13062.85	(11505.58)	264	66446	268	3.5m
2010-11	13445.21	(11883.84)	316	77590	265	3.6m
2011-12	11424.65	(9971.17)	326	57112	268	3.1m
2012-13	12935.80	(11103.10)	92	59898	266	3.4m
2013-14	12150.91	(10533.68)	226	63784	269	3.3m

this is consistent with the Ministry of Agriculture's stated strategy to distribute coupons based on the population of farm families in a district. A regression of the logarithm of the number of coupons allocated to the TA in 2008-09 on the logarithm of the 2008 population[9] and the logarithm of annual cultivated area in the TA in 2000 (measured in square meters) – two criteria that have been proposed as used by the government to allocate fertilizer vouchers – finds a close relationship between population and allocation. Table 6 presents the results and Figure 3 plots the relationship between the population and the number of allocated vouchers at the TA level. The coefficient on population is close to one, suggesting a tight relationship between the population of the TA and the number of FISP vouchers allocated. Figure 4 plots the relationship between the logarithm of the number of coupons allocated per household in the TA in 2008-09 and the logarithm of the TA population.

Population is not predictive of the number of subsidy coupons a TA received per unit area of maize cultivation (pre-subsidy measure taken in 2003) because of variable population density and variable patterns in maize cultivation across TAs. Figure 4 plots the relationship between the logarithm of the number of 2008-09 coupons allocated per square kilometer of maize area (measured in 2003 by the government) and the logarithm of the TA population. The government's subsidy allocation by population introduces variation in the allocation by unit area of maize across TAs. Because we are concerned that population could also be an allocation criteria for other programs or that population could be associated with unobserved variable trends in child anthropometrics, we use the natural log of the number of FISP fertilizer voucher coupons allocated per sqkm of maize as the measure of treatment in our regressions. We also run specifications in which we use the log of the number of per household FISP voucher allocation as the treatment variable, controlling for the TA population. Results are consistent across the specifications

[9]Estimated using a linear trend between census data on TA populations from 1998 and 2008.

and are presented in the next section. [10] Figure 2 presents the number of FISP fertilizer vouchers allocated per square kilometer of maize culitivated (2008-09 allocation).

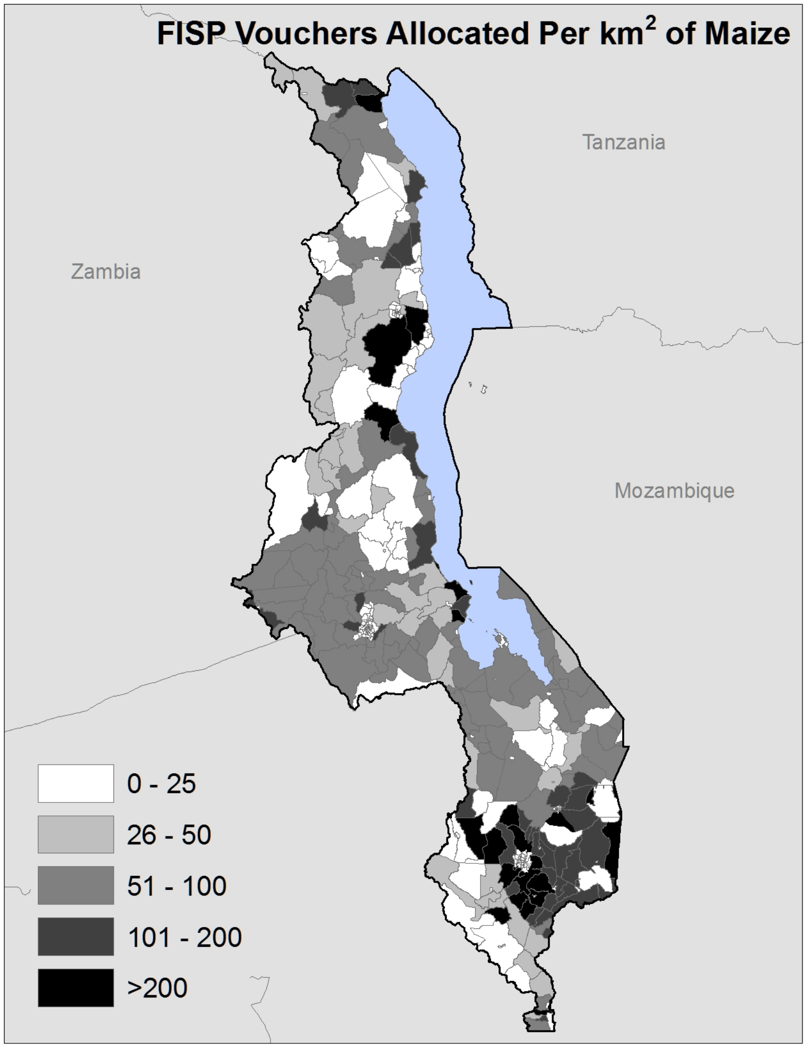

Figure 2: FISP fertilizer vouchers allocated per sqkm of maize culitvated, 2008-09 allocation.

3.3 Child anthropometric data

Our analysis uses two common measures of child nutrition and health as outcome variables: height-for-age and weight-for-height z-scores. Height-for-age is considered a measure of longer term nutritional

[10] In fact we would expect these results to be the same if we assume that production increases are shared over individuals. Consider two TAs of the same maize cultivation areas but different populations. Children living in the higher population TAs were exposed to a more intensive local (TA-level) fertilizer subsidy allocation per unit area of maize cultivated but not in a per household or per individual sense while a child living in a low population would see lower maize production increases but in a context in which the production increases were shared among a smaller local population.

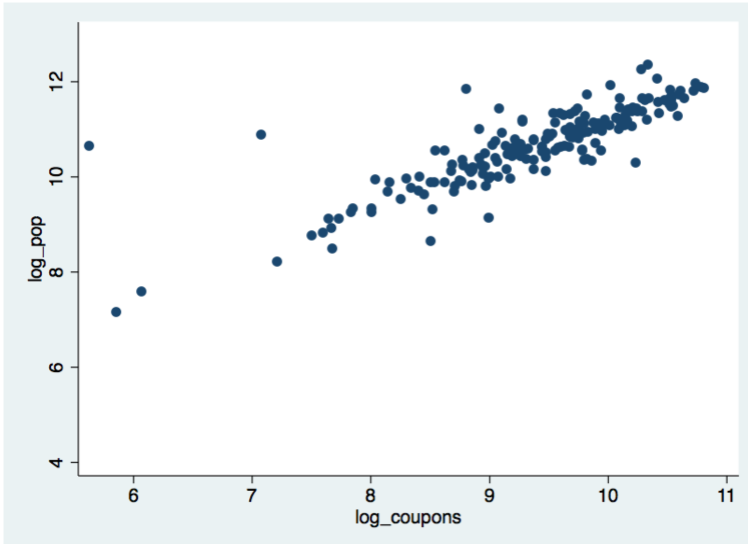

Figure 3: Relationship between the logarithm of the 2008 TA population and the logarithm of the number of vouchers the TA received in 2008-09.

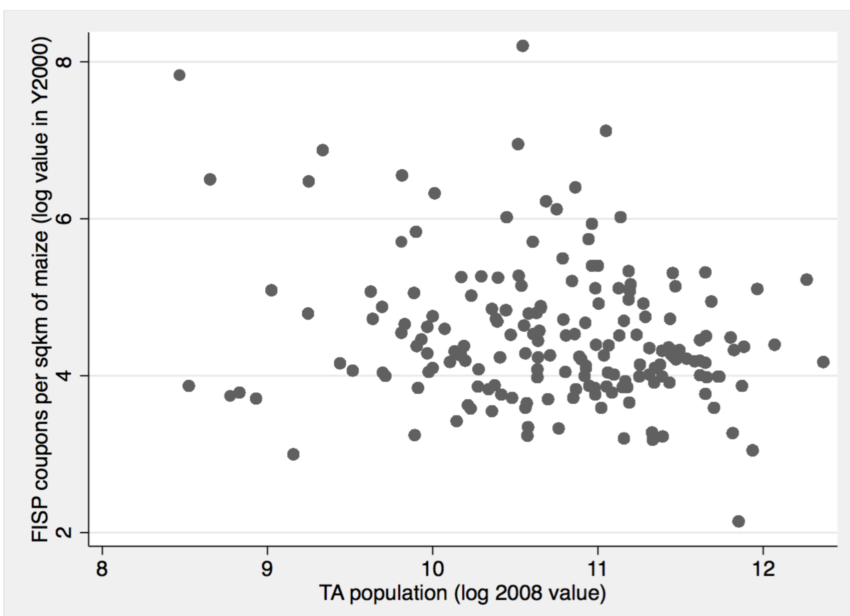

Figure 4: Relationship between the logarithm of the 2008 TA population and the logarithm of the number of vouchers allocated per sqkm of maize (measured by the government in 2003) in the TA.

Traditional Authority, Ward, or Forest Area	DHS2000	DHS2004	DHS2010	Total
Area 1	17	0	2	19
Area 10	16	0	0	16
Area 2	0	0	18	18
Area 21	0	17	0	17
Area 22	46	4	0	50
Area 23	11	26	0	37
Area 25	42	10	0	52
Area 26	0	15	0	15
Area 3	0	6	6	12
Area 33	12	0	11	23
Area 36	22	0	0	22
Area 37	9	0	5	14
Area 39	0	0	4	4
Area 41	23	0	0	23
Area 44	17	14	4	35
Area 45	22	14	3	39
Area 49	35	3	0	38
Area 50	0	0	2	2
Area 52	17	0	5	22
Area 53	0	19	0	19
Area 55	0	10	0	10
Area 56	0	0	5	5
Area 57	26	18	0	44
Area 58	0	10	1	11
Area 7	0	0	11	11
Area 8	0	0	4	4
Balaka Town	0	0	7	7
Bangwe Ward	11	0	0	11
Blantyre Central Ward	8	0	0	8
Blantyre East Ward	0	3	2	5
Blantyre West Ward	0	3	0	3
Chambo Ward	0	0	3	3
Chibanja Ward	27	0	0	27
Chichiri Ward	0	5	3	8
Chigumula Ward	9	0	7	16
Chilomoni Ward	0	9	15	24
Chipoka Urban	0	10	0	10
Chiputula Ward	40	27	0	67
Chiradzulu Boma	0	0	4	4
Chirunga East Ward	41	13	3	57
Chirunga Ward	16	5	0	21
Chitipa Boma	0	0	13	13
Dedza Boma	19	0	2	21
Jombo Ward	0	25	0	25
Karonga Town	100	43	28	171
Kasungu Boma	88	30	7	125
Katoto Ward	24	0	0	24
Lake Malombe	19	17	0	36
Lakes Chilwa/Chiuta	0	0	7	7
Lengwe National Park	29	21	0	50
Likangala Central W..	44	10	0	54
Likangala South Ward	24	0	0	24
Likhubula Ward	8	41	15	64
Limbe East Ward	0	24	4	28
Limbe West Ward	0	0	6	6
Liwonde Town	117	33	2	152
Luchenza Town	33	0	19	52
Lupaso Ward	0	18	0	18
Mangochi Town	80	0	9	89
Mapanga Ward	0	14	0	14
Masasa Ward	8	13	0	21
Masongola Ward	0	12	0	12
Mchengautuwa	43	0	0	43
Mchinji Boma	0	11	7	18
Michiru Ward	34	29	0	63
Misesa Ward	0	10	5	15
Monkey Bay Urban	18	0	10	28
Mponela Urban	0	0	12	12
Msamba Ward	20	0	4	24
Mulanje Boma	33	23	4	60
Mwanza Boma	0	7	19	26
Mzedi Ward	22	25	8	55
Mzimba Boma	16	16	26	58
Nancholi Ward	20	3	3	26
Ndirande North Ward	39	32	14	85
Ndirande South Ward	44	28	6	78
Ndirande West Ward	0	0	7	7
New Airport Site	7	32	0	39
Nhkata Bay Bomba	0	63	10	73
Nkhorongo Ward	14	0	0	14
Nkhotakota Boma	0	0	6	6
Nkolokoti Ward	0	0	11	11
Nsanje Boma	0	39	12	51
Ntcheu Boma	0	0	2	2
Nyambadwe Ward	17	0	5	22
Phalombe Boma	0	0	9	9
Rumphi Boma	0	0	8	8
SC Chilooko	40	28	42	110
SC Nthondo	0	24	18	42
Sadzi Ward	9	0	0	9
Salima Town	93	27	3	123
Soche East Ward	12	0	0	12
Soche West Ward	41	4	2	47
South Lunzu Ward	0	0	1	1
TA Chikho	23	0	32	55
TA Kalembo	102	104	56	262
TA Kalumo	34	40	72	146
TA Kanduku	24	45	42	111
TA Kasakula	0	33	38	71
TA Musisya	0	0	1	1
TA Mwase	25	29	8	62
TA Ngozi	0	0	31	31
TA Nthache	25	14	79	118
TA Nyambi	69	62	9	140
TA Pemba	140	72	44	256
TA Symon	0	21	36	57
Thyolo Boma	0	11	0	11
Viphya Ward	31	0	0	31
Vwaza Marsh Reserve..	0	0	3	3
Zolozolo Ward	28	0	0	28
Total	2,083	1,374	942	4,399

Table 4: Towns, city wards and areas, TAs, and forests and reserves with children in DHS but not appearing in logistics unit reports of subsidy allocations.

	Rural resident	Urban resident	Total children
Children living in TAs with subsidy allocations	18,799	665	19,464
Children living in TAs with no subsidy allocation	1,805	2,594	4,399
Totals	20,604	3,259	23,863

Table 5: Distribution of children across TAs in Malawi that received subsidy allocations in 2008-09, by urban and rural residence, pooled DHS sample (2000, 2004, 2010).

	Vouchers (log 2008-09 allocation)
TA Population (log of 2008 population)	0.928***
	(0.081)
TA Cultivated area (log of m^2 cultivated in 2000)	-.013
	(0.051)
Observations	183
R-squared	0.71

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6: FISP Voucher Allocation to Traditional Authorities, 2008-09

status and weight-for-height is considered a shorter term indicator of nutritional deprivation (Strauss and Thomas, 1995). These z-score measures are the basis for classifications of stunting, wasting, severe stunting and severe wasting. Children with height-for-age z-scores less than -2.0 are considered stunted and children with z-scores less than -3.0 are considered severely stunted. Children with weight-for-height z-scores less than -2.0 are considered wasted and less than -3.0 are considered severely wasted.

The research question requires data which include: (1) anthropometric outcomes for children (2) observations on children born both before and after the first 2006 post-subsidy harvest (3) geographic identifiers that we can use to link observations to the TA-level subsidy allocation data from the logistics unit. Two sources of survey data for Malawi are therefore appropriate: Demographic Health Surveys (DHS) conducted in 2000, 2004, and 2010 and Malawi's version of the The World Bank Living Standards Measurement Study (LSMS) - the Integrated Household Survey - was conducted in 2005 and 2010. Table 7 presents the number of children in the sample by birth year and by survey round and Table 1 in the Appendix presents the shares of the sample by survey round and birth year weighted using sample weights. Children without data on height, weight, age or sex are excluded from the sample. We use WHO standards and cut-offs (WHO, 1995), excluding children with extreme height or weight values as these are likely the result of measurement or data entry errors: height-for-age Z-scores below -5.0 or above 3.0 are not included nor are children with weight-for-height z-scores less than -4.0 or greater than 5.0.

Table 7: Sample structure and descriptives - children measured with height-for-age zscores between -5.0 and 3.0, by survey and round (unweighted numbers)

	DHS2000	DHS2004	DHS2010	IHS2005	IHS2010	Total
1995	420	0	0	0	0	420
1996	1,765	0	0	0	0	1,765
1997	1,957	0	0	0	0	1,957
1998	1,991	0	0	0	0	1,991
1999	2,085	107	0	380	0	2,572
2000	1,508	1,709	0	1,468	0	4,685
2001	0	1,596	0	1,367	0	2,963
2002	0	1,548	0	1,334	0	2,882
2003	0	1,957	0	1,540	0	3,497
2004	0	1,665	0	423	5	2,093
2005	0	16	364	0	304	684
2006	0	0	987	0	1,648	2,635
2007	0	0	1,013	0	1,764	2,777
2008	0	0	1,036	0	1,710	2,746
2009	0	0	982	0	1,485	2,467
2010	0	0	444	0	409	853
Total	9,726	8,598	4,826	6,512	7,325	36,987

Source: Malawi DHS and IHS surveys

The IHS and the DHS in Malawi are both designed to be nationally and regionally representative as well as representative of urban/rural regions. Statistics based on child anthropometrics should therefore be comparable in levels and trends for surveys conducted in the same year: stunting, severe stunting, wasting, and severe wasting. Table 8 presents these statistics by survey type and year and demonstrates that neither the levels nor the trends are comparable.[11]

While both surveys document a decreasing trend in stunting over time, the magnitude of the changes differ significantly across the DHS and IHS. The IHS data suggest a decrease of 2.2 percentage points annually between 2005 and 2010 while stunting in the DHS over the same period declined by 0.85 percentage points annually (between 2004 and 2010). Decreases are comparable over the same period in severe stunting. However, in the IHS, wasting increased during this period while the DHS suggests a small decrease. These discrepancies are also noted in Verduzco-Gallo et. al (2014). Differences in the cross-sectional levels are also considerable. For example, the DHS 2010 data suggests a stunting rate (national) of 49% and the IHS 2010 suggests the stunting rate was considerably lower: 29%. Comparisons with the Multiple Indicator Cluster Survey (MICS), conducted in 2006 and 2009, in Figures 5 and 6

[11] Statistics presented in Table 8 and subsequent tables are computed from the DHS and IHS data using the WHO 2006 guidelines on outlier-cleaned samples. Because the IHS sample only includes children 6-59 months of age, we drop all children under six months of age from the comparisons in the DHS surveys. We use survey weights in all comparisons.

suggest stunting rates closer to the DHS than the IHS. The Appendix includes further documentation on these points and presents and analyzes the differences in stunting rates across the DHS and IHS surveys according to gender, age of child (in months), urban or rural residence, household wealth, and region. We find that differences in the IHS are primarily driven by problems in the data from the Northern and Southern regions. Trends in the Central region appear comparable across the samples and we therefore use the data from the Central region as a robustness check for the DHS analyses.

Table 8: Share of Malawi children (national sample) stunted, wasted, severely stunted, severely wasted, by survey and year. Sample only includes children age 6 months and older (excludes children less than six months measured in the DHS)

	Mean	Linearized Std. Err.	[95% Conf. Interval]	
stunted				
DHS2000	0.575	0.008	0.559	0.592
DHS2004	0.550	0.008	0.534	0.566
DHS2010	0.490	0.010	0.470	0.510
IHS2005	0.420	0.009	0.402	0.437
IHS2010	0.293	0.009	0.275	0.310
severely stunted				
DHS2000	0.299	0.007	0.284	0.313
DHS2004	0.265	0.007	0.251	0.280
DHS2010	0.194	0.008	0.178	0.209
IHS2005	0.176	0.006	0.164	0.189
IHS2010	0.121	0.006	0.109	0.132
wasted				
DHS2000	0.052	0.003	0.045	0.058
DHS2004	0.045	0.003	0.039	0.051
DHS2010	0.033	0.004	0.026	0.040
IHS2005	0.018	0.002	0.013	0.023
IHS2010	0.032	0.003	0.026	0.038
severely wasted				
DHS2000	0.015	0.002	0.012	0.019
DHS2004	0.018	0.002	0.014	0.022
DHS2010	0.010	0.002	0.006	0.013
IHS2005	0.003	0.001	0.002	0.005
IHS2010	0.007	0.001	0.005	0.010

4 Identification Strategy

A child's exposure to the program is determined by the year and month in which he or she was born and his or her TA of residence. Our identification strategy exploits variation in treatment intensity across TAs.

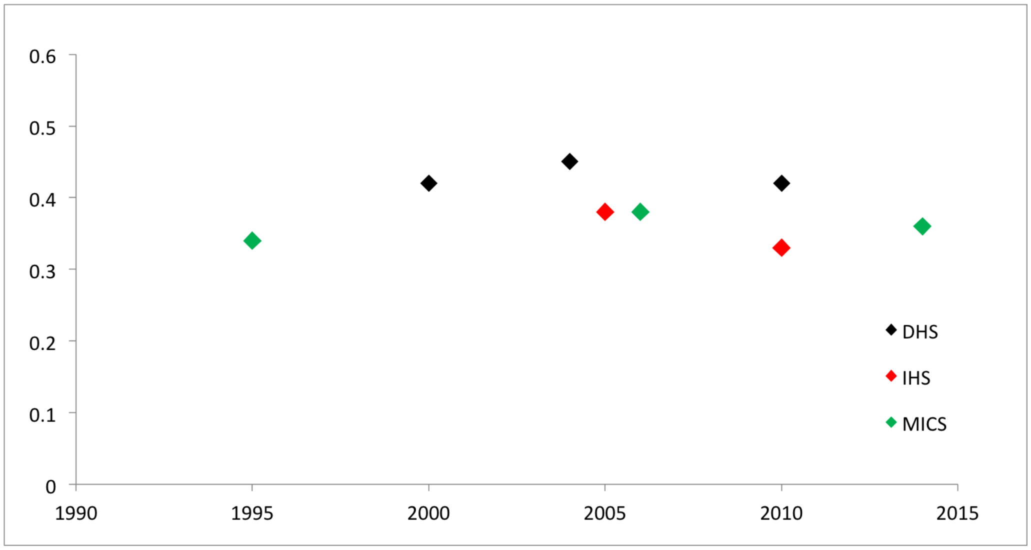

Figure 5: DHS, IHS, and MICS urban stunting trends for Malawi over time.

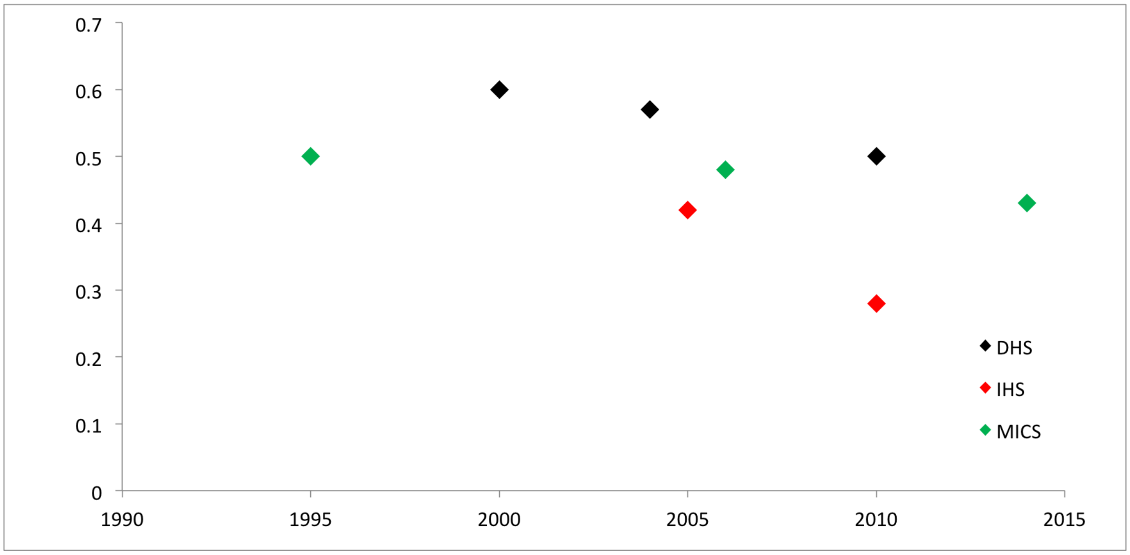

Figure 6: DHS, IHS, and MICS rural stunting trends for Malawi over time.

We identify sizable differences across TAs in coupon allocation both in terms of the vouchers allocated per square kilometer of maize production in the TA and in the mean per household allocation. Among TAs that received allocations, 2008-09 per household allocations (computed by taking the total number of vouchers and dividing by the number of households in the TA) range between 0.03 and 7.5, with a median of 1.3 coupons per household (mean is 1.36). This corresponds well with national-level figures which report that coupons were allocated to 2 million of Malawi's 2.7 million small farmers, suggesting a per household allocation statistic at the national level of 1.48 vouchers[12].

We use information on the Traditional Authority of residence in the time that the child was measured in the IHS surveys and GPS coordinates of the DHS cluster in the DHS surveys to match the household survey data with both the TA-level subsidy allocation data from the government logistics unit and TA-level data on pre-subsidy population, poverty, and production area[13].

The identifying assumption for the analysis is that once we control for TA and birth year fixed effects, allocation intensity is exogenous. That is, we assume that the allocation level (the number of FISP coupons allocated per capita at the TA level) is not correlated with pre-FISP trends across TAs in child height-for-age or weight-for-height z-scores. We also assume that TA-level allocation of subsidy coupons was not correlated with investments in other programs or services that drive improvements in child health during this period. We present evidence that these identifying assumptions are valid in the next section.

5 Results: Subsidy Effect on Child Anthropometric Outcomes

Our identification exploits variation in treatment across TAs and across cohorts. We run the following regression.

$$HAZ_{ijk} = c_1 + \alpha_{1j} + \beta_{1k} + R_l(I_jT_i)\gamma_1 + (C_jT_i)\delta_1 + X_i\delta_2 + \epsilon_{ijk} \tag{1}$$

Where HAZ_{ijk} is the height-for-age zscore of child i born in TA j in year k. T_i is a dummy variable indicating if the child was born before or after the 2006 harvest (the first post-FISP harvest), c_1 is a constant, β_{1k} is a birth year fixed effect, α_{1j} is a TA fixed effect, I_j is a measure of the intensity of treatment in the TA (measured in coupons per sqkm of maize cultivated at the TA level), X_i is a child-

[12]Lunduka et al. (2013) discuss whether the number of total farmers is 2.7 million as the National Statistical Office Claims or 3.4 million as claimed by the Ministry of Agriculture and argue for the 2.7 million number. Using the 3.4 million number would work out to a national per household allocation of 1.18 vouchers per household.

[13]In case place of measurement is endogenous, so that kids with better anthropometrics are more likely to be in households who relocated strategically to live in TAs with higher voucher allocations, a robustness check drops the small number of children from the analysis who were not born in the district where they were measured. Results are robust to dropping these children from the analysis.

specific vector of control variables, R_l is a region dummy (North, Central, South), that allows us to test the hypothesis that the subsidy effect over Malawi's three regions and C_j is a TA-specific vector of control variables.

We present results of regression estimates of equation (1) in Tables 9 and 10. Table 9 is our analysis of interest – we compare children born 1995-2005 (before FISP) with children born 2006-2010. Column (1) controls for the age of the child in months, age squared, the urban/rural status of the household, birth year, month of the year the child's anthropometric measurements were taken, and TA fixed effects. The estimated effect is that FISP led to an average increase of approximately 0.04 standard deviations in children's height-for-age z-scores in the Central Region of Malawi.

We add child, parent, and household controls in Column (2) shown in other studies to relate to child health outcomes including the household's access to improved sanitation, whether the child's mother and father are alive at the time of the survey, age and gender of the household head, the education level of the mother and whether the household has electricity, a radio, a television, a refrigerator, a bicycle, a motorcycle, and a car or truck. Column (3) adds the birth order of the child and the months that the child was breastfed.

This analysis and result relies on the assumption that there are no time-varying factors correlated with voucher allocations at the TA level. For this reason, Column (4) adds a control for TA population in 2005, a characteristic that could be associated with the allocation of other kinds of programs or allocations that could impact child health interacted with child birth year[14].

Table 10 is our parallel trends test; we compare two cohorts of children born before FISP began: children born 1995-2000 (and measured in 2000) and children born 2001-2005 (and measured in 2005). If height-for-age z-scores were increasing more rapidly in TAs that received more vouchers before the program began, these regressions would show positive coefficients on the interaction between the per household allocation rate and birth cohort. We do not see evidence of such pre-FISP trends in Table 10 in any specifications. The table presents the coefficient of the interaction between the per household coupon allocation and the child's cohort. The differences in differences estimates in the table include zero with small standard errors, providing some evidence that our identification assumption is valid; that is, that our results are not driven by differential trends across TAs that received higher and lower allocations of vouchers in a per household sense. Nor do we see differential trends by region. As in Table 9 we add additional child, household, and mother controls in Columns (2)-(5).

Analysis presented in the Appendix comparing levels and trends in the IHS and DHS suggests that

[14]We consider the potential problem of time-varying factors at the TA level in more detail in the next section.

VARIABLES	(1) Ht-for-Age Zscore	(2) Ht-for-Age Zscore	(3) Ht-for-Age Zscore	(4) Ht-for-Age Zscore
FISP vouchers per sqkm of maize (log)	-0.000919	-0.00638	-0.00937	-0.0268
	(0.0172)	(0.0167)	(0.0173)	(0.0193)
Central region*effect	0.0396**	0.0426**	0.0545***	0.0573***
	(0.0200)	(0.0195)	(0.0201)	(0.0217)
Southern region*effect	-0.0122	-0.00944	-0.00882	-0.0105
	(0.0193)	(0.0189)	(0.0194)	(0.0215)
Child gender	0.184***	0.186***	0.188***	0.212***
	(0.0221)	(0.0220)	(0.0233)	(0.0240)
TA FE	yes	yes	yes	yes
urban	yes	yes	yes	yes
birth year FE	yes	yes	yes	yes
month measured FE	yes	yes	yes	yes
child age in months	yes	yes	yes	yes
parent characteristics		yes	yes	yes
household characteristics		yes	yes	yes
Months child breastfed			yes	yes
Child birth order			yes	yes
TA population				yes
Observations	22,354	22,309	20,241	17,161
R-squared	0.162	0.173	0.186	0.187

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 9: Primary Result: Effect of FISP on child ht-for-age zscores: coefficients of the interactions between the child's birth cohort and the intensity of the subsidy allocation in the child's TA, DHS sample (1995-2010).

VARIABLES	(1) Ht-for-Age Zscore	(2) Ht-for-Age Zscore	(3) Ht-for-Age Zscore	(4) Ht-for-Age Zscore	(5) Ht-for-Age Zscore
FISP vouchers per sqkm of maize (log)	-0.00442	-0.00264	-0.0200	-0.0141	-0.0106
	(0.00740)	(0.00724)	(0.0144)	(0.0148)	(0.0175)
Central region*effect			0.0139	0.00742	0.00355
			(0.0176)	(0.0178)	(0.0197)
Southern region*effect			0.0235	0.0158	0.0123
			(0.0164)	(0.0167)	(0.0188)
Child gender	0.176***	0.178***	0.178***	0.176***	0.177***
	(0.0246)	(0.0246)	(0.0246)	(0.0260)	(0.0261)
TA FE	yes	yes	yes	yes	yes
birth year FE	yes	yes	yes	yes	yes
month measured FE	yes	yes	yes	yes	yes
urban	yes	yes	yes	yes	yes
parent characteristics		yes	yes	yes	yes
child age in months	yes	yes	yes	yes	yes
household characteristics		yes	yes	yes	yes
Months child breastfed				yes	yes
Child birth order				yes	yes
TA population					yes
Observations	17,642	17,597	17,597	15,928	15,392
R-squared	0.168	0.180	0.180	0.194	0.194

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 10: Parallel trends test, DHS sample (1995-2004). Effect of FISP on child health: coefficients of the interactions between the child's birth cohort and the intensity of the subsidy allocation in the child's TA.

VARIABLES	(1) Ht-for-Age Zscore	(2) Ht-for-Age Zscore	(3) Ht-for-Age Zscore
Parallel trends test			-0.00789
			(0.00948)
FISP vouchers per sqkm of maize (log) * born after May 2006	0.0246**	0.0226**	
	(0.00965)	(0.00965)	
DHS survey	-0.370***	-0.448***	
	(0.0491)	(0.0553)	
TA FE	yes	yes	yes
birth year FE	yes	yes	yes
child age in months	yes	yes	yes
urban	yes	yes	yes
child gender	yes	yes	yes
month measured FE	yes	yes	yes
parent characteristics		yes	yes
household characteristics		yes	yes
Observations	13,263	13,251	8,881
R-squared	0.143	0.154	0.160

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 11: Primary Result: Effect of FISP on child ht-for-age zscores: coefficients of the interactions between the child's birth cohort and the intensity of the subsidy allocation in the child's TA, pooled IHS and DHS sample (1995-2010), Central Region of Malawi only.

we can use the IHS data in the Central Region as an additional source of information to test for an effect of FISP. Table 11 presents estimates of Equation (1) for the Central Region only, pooling all rounds of the DHS and IHS data for Malawi. Column (3) tests for pre-FISP parallel trends for this pooled DHS and IHS sample restricted to the Central Region. Results are similar in magnitude and significance with results presented in Table 9 using the full DHS sample.

5.1 Birth Year Estimations

In order to assess for which birth years the project had the most impact we perform a more granular analysis, dropping the cohort framework and using interaction terms between birth year and intensity of treatment. We focus on the Central region.

We estimate the following equation for the Central Region, pooling all IHS and DHS data to increase statistical power:

$$HAZ_{ijk} = c_1 + \alpha_{1j} + \beta_{1k} + \sum_{l=2}^{16}(P_j * d_{il})\gamma_{1l} + (C_j T_i)\delta_1 + \epsilon_{ijk} \quad (2)$$

Where d_{il} is a dummy that indicates the year of individual i's birth so each γ_{1l} is the estimate of the program on children born in a given year. Our hypothesis is that children born 1995-2005 did not benefit from FISP, so γ_{1l} should be 0 for $d_{il} < 2006$ and increase for $d_{il} \geq 2006$. Note that while survey rounds may be treated as representative of children less than 60 months as a group, observations from a given year are not representative of children born in that year; see Figure 7 for a histogram of ages (in months) by birth year, in the sample.

The top panel in Figure 8 plots the coefficients of the interaction of birth year with intensity of the subsidy allocation in the TA where the child was measured. Vertical lines plot the 95% confidence interval. These coefficients stay close to zero - fluctuating just above and below zero - until 2006 when they shift up approximately 0.02 standard deviations. This provides additional evidence that FISP had no effect on children's heights who were not exposed to it (who were born before it was implemented) and had a small positive effect on children born after it was implemented in 2005/06. All coefficients after 2005 are significantly different from zero except in 2007. The estimation plotted in Figure 8 suggests that the identification strategy is appropriate and that the program had an effect. The bottom panel presents the number of measured children born in each year in the pooled DHS and IHS Central Region sample. Table 12 presents the results of the estimations plotted in Figure 8.

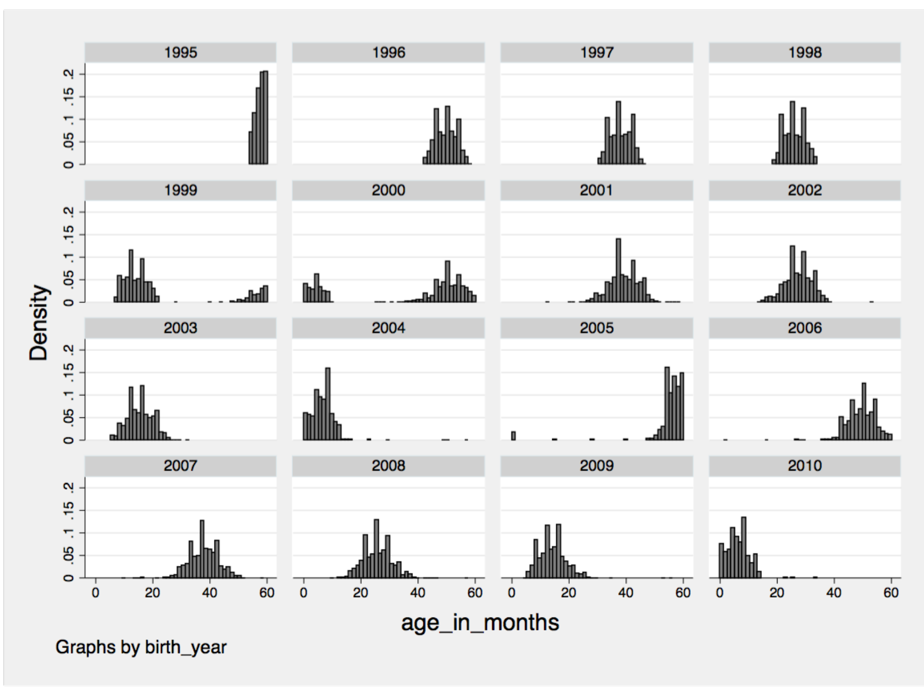

Figure 7: Histograms of the age in months (unweighted) represented in the data, by birth year.

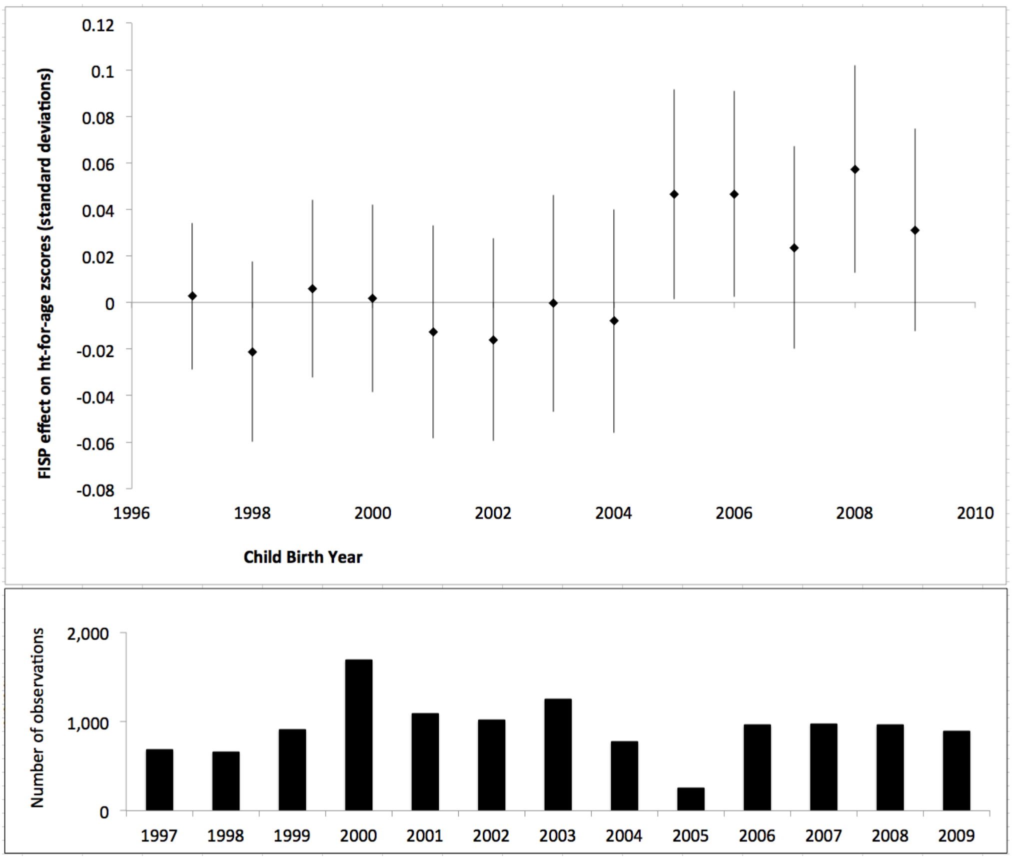

Figure 8: Top panel plots the coefficients of the interaction of birth year with intensity of the subsidy allocation in the TA where the child was measured. These are the coefficients from Table 12, Column (4). Vertical lines plot the 95% confidence interval. Bottom panel presents the number of measured children born in each year. Pooled IHS and DHS sample, Central Region only.

VARIABLES	(1) Ht-for-Age Zscore	(2) Ht-for-Age Zscore	(3) Ht-for-Age Zscore	(4) Ht-for-Age Zscore
2009*FISP vouchers per sqkm of maize (log)	0.0273	0.0281	0.00289	0.0299
	(0.0371)	(0.0368)	(0.0245)	(0.0220)
2008*FISP vouchers per sqkm of maize (log)	0.0168	0.0190	0.0354	0.0569***
	(0.0263)	(0.0255)	(0.0262)	(0.0212)
2007*FISP vouchers per sqkm of maize (log)	0.0173	0.0177	-0.00616	0.0223
	(0.0274)	(0.0276)	(0.0256)	(0.0218)
2006*FISP vouchers per sqkm of maize (log)	0.0318	0.0233	0.0204	0.0444**
	(0.0247)	(0.0244)	(0.0272)	(0.0220)
2005*FISP vouchers per sqkm of maize (log)	0.00362	0.00423	0.0349	0.0460*
	(0.0267)	(0.0266)	(0.0323)	(0.0236)
2004*FISP vouchers per sqkm of maize (log)	-0.0182	-0.0152	0.00136	-0.00678
	(0.0258)	(0.0248)	(0.0318)	(0.0228)
2003*FISP vouchers per sqkm of maize (log)	-0.00426	0.000943	-0.0180	0.00211
	(0.0238)	(0.0224)	(0.0202)	(0.0216)
2002*FISP vouchers per sqkm of maize (log)	-0.0256	-0.0238	-0.0259	-0.0164
	(0.0289)	(0.0271)	(0.0289)	(0.0222)
2001*FISP vouchers per sqkm of maize (log)	-0.0362	-0.0309	0.00118	-0.0108
	(0.0240)	(0.0234)	(0.0232)	(0.0198)
2000*FISP vouchers per sqkm of maize (log)	-0.00232	-0.00227	-0.00452	0.00204
	(0.0203)	(0.0199)	(0.0224)	(0.0187)
1999*FISP vouchers per sqkm of maize (log)	0.00881	0.00608		0.00346
	(0.0203)	(0.0205)		(0.0195)
1998*FISP vouchers per sqkm of maize (log)	-0.0208	-0.0214		-0.0226
	(0.0156)	(0.0144)		(0.0149)
1997*FISP vouchers per sqkm of maize (log)	0.00533	0.00426		0.000604
	(0.0150)	(0.0152)		(0.0153)
TA FE	yes	yes	yes	yes
birth year FE	yes	yes	yes	yes
urban resident	yes	yes	yes	yes
parent characteristics		yes		yes
household characteristics		yes		yes
Observations	7,916	7,906	5,025	12,929
R-squared	0.145	0.163	0.158	0.138

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 12: Effect of FISP on child health: coefficients of the interactions between the child's birth cohort and the intensity of the subsidy allocation in the child's TA for the Central Region; full 1995-2010 DHS and IHS sample

6 Discussion

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Appendix

Demographic Health Surveys (DHS) were conducted in Malawi in 2000, 2004, and 2010. Malawi's version of the The World Bank Living Standards Measurement Study (LSMS) - the Integrated Household Survey - was conducted in 2005 and 2010. Given that both surveys are designed to be nationally and regionally representative as well as representative of urban/rural regions, statistics based on child anthropometrics should be comparable in levels and trends: stunting, severe stunting, wasting, and severe wasting. Table 8 in the main text presents these statistics by survey type and year.[15]

The DHS and IHS surveys are both conducted by the National Statistical Office of Malawi. USAID provides the financial and technical assistance for the Malawi Demographic and Health Surveys and the World Bank provides financial and technical assistance for the IHS surveys.

Stunting and severe stunting rates differ significantly by survey. The IHS measures suggest a decrease of 2.2 percentage points annually between 2005 and 2010 while stunting in the DHS over the same period declined by 0.85 percentage points annually (between 2004 and 2010). Decreases are comparable over the same period in severe stunting. However, in the IHS, wasting increased during this period while the DHS suggests a small decrease. These discrepancies are also noted in Gallo et. al (2014). Differences in the cross-sectional levels are also considerable. For example, the DHS 2010 data suggests a stunting rate (national) of 49% and the IHS 2010 suggests the stunting rate was considerably lower: 29%. Comparisons with the Multiple Indicator Cluster Survey (MICS), conducted in 2006 and 2009 in the main text suggest stunting rates closer to the DHS than the IHS.

This appendix presents and analyzes the differences in stunting rates across the DHS and IHS surveys according to gender, age of child (in months), urban or rural residence, household wealth, and region. We find that differences in the IHS are primarily driven by differences in the North and South. Trends in the Central region appear comparable across the samples. Rural children are closing the gap with urban children more quickly in the IHS/LSMS surveys than in the DHS surveys. We find no evidence that trends in surveys differ by child gender.

Gender

Table 13 presents stunting, severe stunting, wasting, and severe wasting rates by child gender across surveys. The expected relationship is present in all surveys and survey years; girls are less likely to be stunted or severely stunted than boys – in general about five percent less likely, across surveys and years.

We also run a regression to test for special patterns in stunting and wasting rates by gender across

[15] Statistics presented in Table 8 and subsequent tables are computed from the DHS and IHS data files using the WHO 2006 guidelines on outlier-cleaned samples. Because the IHS sample only includes children 6-59 months of age, we drop all children under six months of age from the comparisons in the DHS surveys. We use survey weights in all comparisons.

Table 13: Share of male and female Malawi children (national sample) stunted, wasted, severely stunted, severely wasted, by survey and year. Sample only includes children age 6 months and older (excludes children less than six months measured in the DHS)

	Female mean	SE	Male mean	SE
Stunted				
DHS2000	0.559***	(0.010)	0.593	(0.011)
DHS2004	0.522***	(0.011)	0.579	(0.010)
DHS2010	0.455***	(0.013)	0.527	(0.014)
IHS2005	0.390***	(0.011)	0.451	(0.011)
IHS2010	0.261***	(0.010)	0.324	(0.013)
Severely stunted				
DHS2000	0.277***	(0.009)	0.321	(0.010)
DHS2004	0.235***	(0.009)	0.297	(0.010)
DHS2010	0.162***	(0.010)	0.227	(0.012)
IHS2005	0.162***	(0.007)	0.191	(0.008)
IHS2010	0.102***	(0.007)	0.140	(0.010)
Wasted				
DHS2000	0.052	(0.004)	0.051	(0.004)
DHS2004	0.040*	(0.004)	0.051	(0.005)
DHS2010	0.034	(0.005)	0.032	(0.004)
IHS2005	0.015	(0.002)	0.021	(0.004)
IHS2010	0.028*	(0.004)	0.035	(0.004)
Severely wasted				
DHS2000	0.015	(0.003)	0.016	(0.002)
DHS2004	0.017	(0.003)	0.019	(0.003)
DHS2010	0.010	(0.003)	0.009	(0.002)
IHS2005	0.002	(0.001)	0.005	(0.001)
IHS2010	0.006	(0.002)	0.008	(0.002)

*** p<0.01, ** p<0.05, * p<0.1

the surveys. Results in Table 14 suggest the following:

1. Stunting rates are lower (compared with the 2000 DHS) in the 2005 IHS and the 2010 DHS and IHS. The decrease between the 2000 DHS and the 2010 DHS is relatively modest, a national reduction of about 6.5%. The decrease is nearly four times that for the 2010 IHS, about 26% reduction.

2. Severe stunting also decreases (this time in all survey rounds compared with the DHS 2000) but again, the 18% reduction in the 2010 IHS is double the drop in the 2010 DHS (9%).

3. Wasting and severe wasting also decrease but the decreases are smaller and more comparable across the surveys.

4. Girls overall have lower rates of stunting (3% less than boys) and severe stunting (4% less).

5. Little evidence that any survey round has particularly different trends based on child gender. (Girls' rates in 2010 DHS are 3% lower than in any other survey but the significance is weak).

Stunting rates by months of age

Generally, stunting is lowest in the youngest children and increases until about two years of age. After two years of age the stunting rate tends to plateau.

Once we drop children under the age of six months from the DHS surveys the mean age in months across the surveys is similar, ranging from 31.24 (0.16) months in DHS 2000 to 32.87 (0.18) months in IHS 2010.

Figures 9, 10, and 11 present stunting rates by child months for the Northern, Central, and Southern regions of Malawi, respectively. The IHS2010 round in the North exhibits a different pattern than most other survey rounds.

Urban/Rural

Note that the urban share of the sample is small. Table 15 presents the number of urban and rural observations by survey round. Table 16 presents stunting, severe stunting, wasting, and severe wasting rates by urban and rural samples across surveys. The expected relationship is present in all DHS surveys; urban children are less likely to be stunted or severely stunted than rural children. The magnitude of the difference is large – between 11% and 13% depending on the DHS survey round. The IHS surveys exhibit no statistical difference between urban and rural stunting or severe stunting rates. Both rural and urban stunting rates are significantly lower than in the IHS surveys than in the DHS. The magnitude of the difference between urban and rural areas in the IHS surveys is about 4% (stunting rate) but the difference is not statistically significant. Figures 5 and 6 in the main text plot these differences over time.

Table 14: Linear probability model regression of stunting, severe stunting, wasting, and severe wasting rates on survey round, child gender, and interaction between survey round and child gender.

	(1)	(2)	(3)	(4)
VARIABLES	Stunted	Severely stunted	Wasted	Severely wasted
year_num = 2, DHS2004	-0.0149	-0.0236*	0.000734	0.00411
	(0.0152)	(0.0141)	(0.00628)	(0.00412)
year_num = 3, DHS2010	-0.0657***	-0.0933***	-0.0199***	-0.00666*
	(0.0178)	(0.0153)	(0.00591)	(0.00343)
year_num = 4, IHS2005	-0.135***	-0.123***	-0.0309***	-0.0118***
	(0.0154)	(0.0131)	(0.00570)	(0.00269)
year_num = 5, IHS2010	-0.262***	-0.177***	-0.0152**	-0.00735**
	(0.0166)	(0.0137)	(0.00608)	(0.00307)
gen = 1, female	-0.0328***	-0.0434***	0.000676	-0.000711
	(0.0123)	(0.0112)	(0.00531)	(0.00319)
DHS2004 * female	-0.0227	-0.0188	-0.0120	-0.00197
	(0.0185)	(0.0164)	(0.00792)	(0.00549)
DHS2010 * female	-0.0377*	-0.0215	0.00154	0.00249
	(0.0223)	(0.0182)	(0.00811)	(0.00519)
IHS2005 * female	-0.0257	0.0140	-0.00668	-0.00196
	(0.0173)	(0.0146)	(0.00672)	(0.00359)
IHS2010 * female	-0.0282	0.00932	-0.0107	-0.00230
	(0.0183)	(0.0153)	(0.00787)	(0.00408)
Observations	34,883	34,883	35,437	35,437
R-squared	0.049	0.028	0.005	0.003

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 15: number of urban and rural observations, by survey round. Sample only includes children age 6 months and older (excludes children less than six months measured in the DHS)

	DHS2000	DHS2004	DHS2010	IHS2005	IHS2010	Total
rural	7,087	6,992	4,039	5,825	6,212	30,155
urban	1,632	820	444	692	1,140	4,728
Total	8,719	7,812	4,483	6,517	7,352	34,883

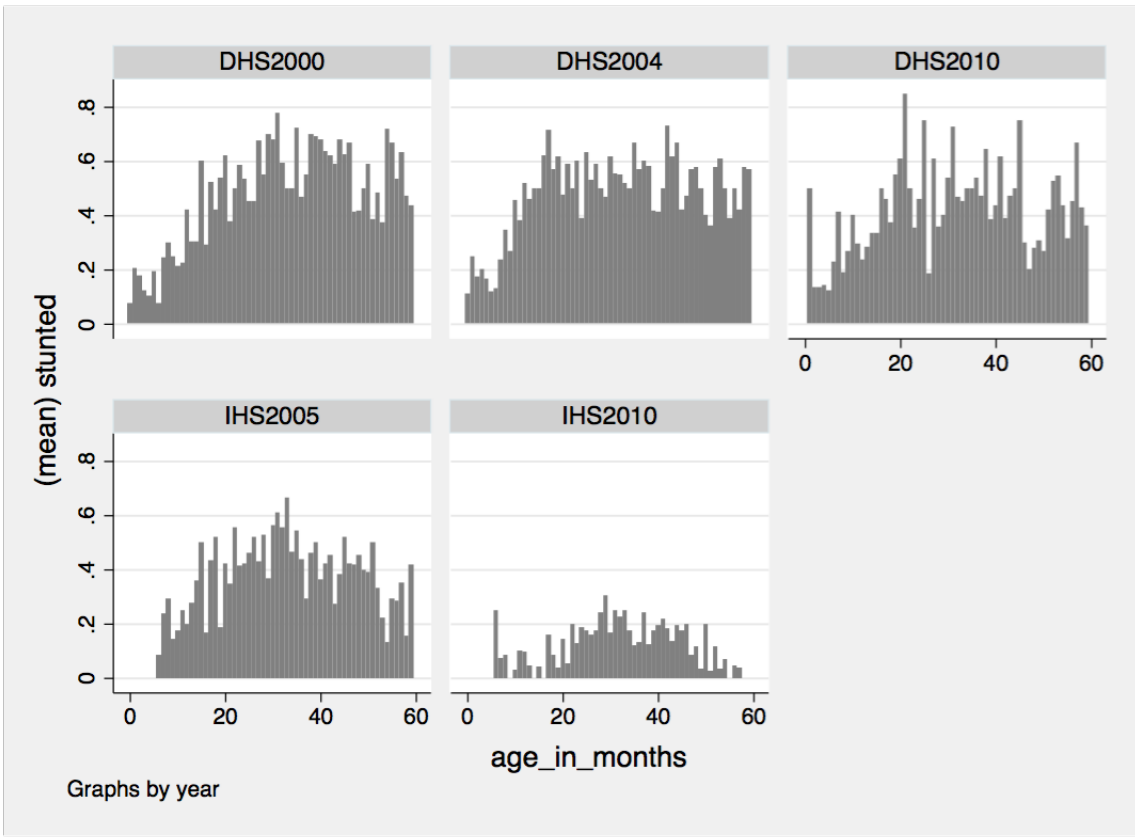

Figure 9: Northern Region stunting rates in the data by months of age, across survey rounds.

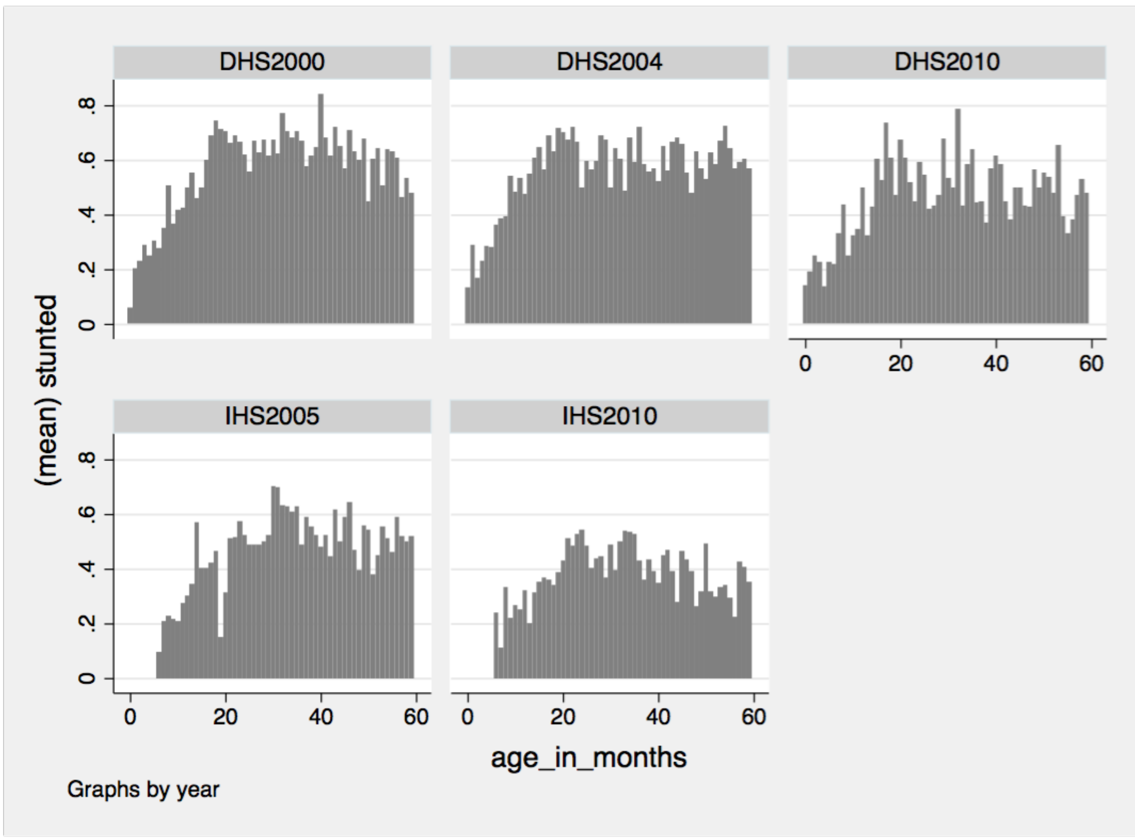

Figure 10: Central Region stunting rates in the data by months of age, across survey rounds.

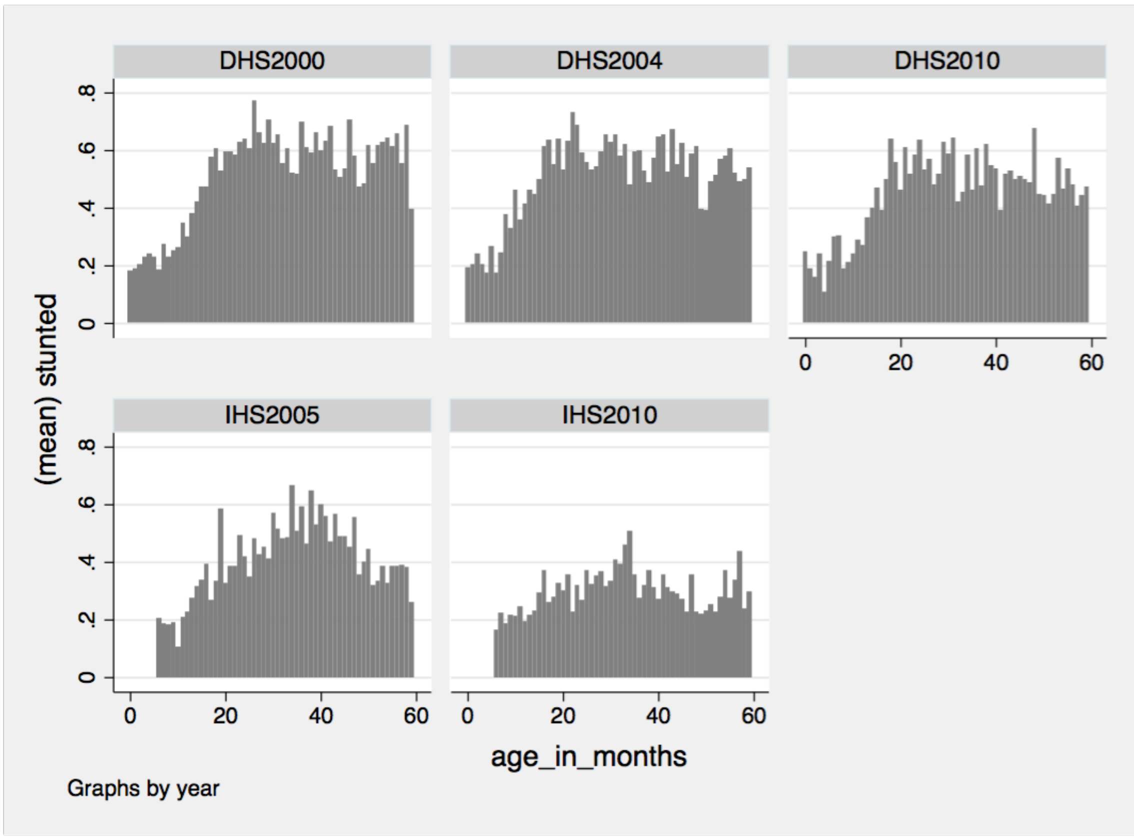

Figure 11: Southern Region stunting rates in the data by months of age, across survey rounds.

Table 16: Share of rural and urban Malawi children (national sample) stunted, wasted, severely stunted, severely wasted, by survey and year. Sample only includes children age 6 months and older (excludes children less than six months measured in the DHS)

	Rural mean	SE	Urban mean	SE
Stunted				
DHS2000	0.599***	(0.008)	0.425	(0.025)
DHS2004	0.566***	(0.008)	0.445	(0.027)
DHS2010	0.503***	(0.010)	0.417	(0.030)
IHS2005	0.424	(0.010)	0.384	(0.025)
IHS2010	0.280	(0.011)	0.327	(0.031)
Severely stunted				
DHS2000	0.317***	(0.008)	0.183	(0.018)
DHS2004	0.276***	(0.008)	0.198	(0.021)
DHS2010	0.200***	(0.008)	0.154	(0.025)
IHS2005	0.178	(0.007)	0.156	(0.019)
IHS2010	0.107	(0.008)	0.133	(0.021)
Wasted				
DHS2000	0.055**	(0.003)	0.029	(0.009)
DHS2004	0.045	(0.003)	0.047	(0.008)
DHS2010	0.034*	(0.004)	0.024	(0.008)
IHS2005	0.018	(0.003)	0.016	(0.006)
IHS2010	0.033***	(0.004)	0.007	(0.003)
Severely wasted				
DHS2000	0.016	(0.002)	0.009	(0.004)
DHS2004	0.017	(0.002)	0.021	(0.006)
DHS2010	0.010	(0.002)	0.007	(0.004)
IHS2005	0.003	(0.001)	0.002	(0.002)
IHS2010	0.007	(0.002)	0.002	(0.002)

*** p<0.01, ** p<0.05, * p<0.1

Table 17: Linear probability model regression of stunting, severe stunting, wasting, and severe wasting rates on survey round, child urban or rural residence, and interaction between survey round and child urban or rural residence.

VARIABLES	(1) Stunted	(2) Severely stunted	(3) Wasted	(4) Severely wasted
year_num = 2, DHS2004	0.0215	0.0153	0.0183	0.0124*
	(0.0370)	(0.0270)	(0.0118)	(0.00692)
year_num = 3, DHS2010	-0.00311	-0.0273	-0.00433	-0.00213
	(0.0400)	(0.0304)	(0.0120)	(0.00545)
year_num = 4, IHS2005	-0.0302	-0.0217	-0.0122	-0.00661
	(0.0364)	(0.0269)	(0.0107)	(0.00453)
year_num = 5, IHS2010	-0.0844**	-0.0372	-0.0222**	-0.00649
	(0.0411)	(0.0302)	(0.00892)	(0.00432)
rural = 1	0.178***	0.135***	0.0266***	0.00776*
	(0.0272)	(0.0194)	(0.00928)	(0.00456)
DHS2004 * rural	-0.0561	-0.0563*	-0.0287**	-0.0117
	(0.0387)	(0.0291)	(0.0127)	(0.00758)
DHS2010 * rural	-0.0931**	-0.0881***	-0.0165	-0.00423
	(0.0422)	(0.0325)	(0.0131)	(0.00623)
IHS2005 * rural	-0.138***	-0.110***	-0.0247**	-0.00649
	(0.0385)	(0.0288)	(0.0115)	(0.00507)
IHS2010 * rural	-0.221***	-0.155***	0.00273	-0.00170
	(0.0430)	(0.0318)	(0.0101)	(0.00504)
Observations	34,883	34,883	34,258	34,258
R-squared	0.051	0.029	0.005	0.003

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

We also run a regression to test for special patterns in stunting and wasting rates by urban/rural residence across the surveys. Results in Table 17 suggest the following:

1. Overall, children living in rural areas are more likely to be stunted, severely stunted, wasted, and severely wasted.

2. Evidence in the 2010 DHS and the 2010 IHS suggest that rural children are improving and closing the gap with urban children in stunting and severe stunting rates but the magnitude of the change differs significantly with a nine percent reduction in the 2010 DHS (compared with 2000) and a 22 percent reduction in the 2010 IHS. The 2005 IHS also shows a significant improvement (nine percent) in rural children (relative to their urban counterparts). Similar trends (positive changes in the 2005 IHS and the 2010 DHS and IHS surveys).

Wealth

Table 19 presents the estimated likelihood of owning each of a set of assets and of having electricity in the household, by survey round. DHS households are more likely (in 2004 and 2010) to have electricity and DHS households in 2010 are more likely to have a bicycle and a television. Overall, households in the DHS samples are more likely to hold material assets assessed in the surveys and to have electricity in the home; in other words, the DHS households are likely to be wealthier according to these proxies.

Table 18 presents stunting and severe stunting rates by survey for household ownership of a radio, an asset owned by approximately 56% of households (pooled surveys). Children living in households in the DHS surveys without a radio were significantly more likely to be stunted than children in households with a radio. This relationship does not hold for the 2010 DHS.

Table 18: Share of Malawi children in households with radio and without (58% of households reported ownership pooled surveys) stunted, wasted, severely stunted, severely wasted, by survey and year. Sample only includes children age 6 months and older (excludes children less than six months measured in the DHS)

	No radio in hh	SE	With radio	SE
Stunted				
DHS2000	0.641***	0.010	0.531	0.012
DHS2004	0.600***	0.011	0.524	0.010
DHS2010	0.514**	0.015	0.474	0.013
IHS2005	0.438*	0.013	0.408	0.010
IHS2010	0.296	0.011	0.289	0.010
Severely stunted				
DHS2000	0.350***	0.010	0.263	0.009
DHS2004	0.312***	0.012	0.241	0.008
DHS2010	0.207	0.012	0.185	0.010
IHS2005	0.194***	0.009	0.165	0.007
IHS2010	0.125	0.008	0.116	0.007
Wasted				
DHS2000	0.067***	0.006	0.041	0.003
DHS2004	0.048	0.005	0.044	0.004
DHS2010	0.037	0.006	0.030	0.005
IHS2005	0.017	0.003	0.019	0.003
IHS2010	0.034	0.004	0.029	0.004
Severely wasted				
DHS2000	0.019	0.003	0.013	0.002
DHS2004	0.019	0.004	0.017	0.002
DHS2010	0.010	0.003	0.009	0.002
IHS2005	0.003	0.001	0.004	0.001
IHS2010	0.008	0.002	0.006	0.002

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 19: Linear probability model regression of household having electricity, owning a radio, television, refrigerator, bicycle, motorcycle, and car or truck.

VARIABLES	(1) Electricity	(2) Radio	(3) TV	(4) Fridge	(5) Bike	(6) Motorcycle	(7) Car or truck
year_num = 2, DHS2004	0.0140*	0.0656***	0.0275***	0.0199***	-0.0363***	-0.00293	-0.000754
	(0.00771)	(0.0131)	(0.00491)	(0.00279)	(0.0140)	(0.00250)	(0.00358)
year_num = 3, DHS2010	0.0384***	0.0126	0.0860***	0.0289***	0.0446***	0.00249	-0.00213
	(0.00987)	(0.0149)	(0.00866)	(0.00435)	(0.0156)	(0.00343)	(0.00394)
year_num = 4, IHS2005	0.00828	0.0143	0.0167***	0.0148***	-0.0646***	-0.00660***	-0.00567*
	(0.00776)	(0.0127)	(0.00440)	(0.00265)	(0.0130)	(0.00218)	(0.00322)
year_num = 5, IHS2010	0.00410	-0.118***	0.0504***	0.0204***	-0.0558***	-0.00611***	-0.00750***
	(0.00696)	(0.0132)	(0.00540)	(0.00241)	(0.0132)	(0.00211)	(0.00290)
Observations	34,862	34,875	34,863	34,883	34,878	34,867	34,868
R-squared	0.002	0.019	0.013	0.004	0.004	0.001	0.001

Region

Table 20 presents stunting, severe stunting, wasting, and severe wasting rates by region for each IHS and DHS survey round. The DHS and IHS both suggest a decrease in stunting rates across regions between 2004/05 and 2010. The magnitude of this decrease differs considerably between the IHS and DHS and depends on the region. The North and the South exhibit different trends across the surveys (IHS vs DHS) while the Central region exhibits comparable trends but different levels.

- North: The DHS picks up a 6% decrease in stunting in the North; the IHS records a 26% decrease. Severe stunting decreases in the DHS by 7% and by 16% in the IHS.
- Central: 10% decrease in stunting in both surveys and 10-11% decrease in severe stunting in both.
- South: 3% decrease in stunting in the DHS and a 12% decrease in the IHS. Changes in the severe stunting rate are comparable across surveys.

Table 20: Share of Malawi children in Northern, Central, and Southern regions stunted, wasted, severely stunted, severely wasted, by survey and year. Sample only includes children age 6 months and older (excludes children less than six months measured in the DHS)

	North	SE	Central	SE	South	SE
Stunted						
DHS2000	0.53	(0.02)	0.62	(0.01)	0.55	(0.01)
DHS2004	0.51	(0.02)	0.59	(0.01)	0.53	(0.01)
DHS2010	0.45	(0.02)	0.49	(0.02)	0.50	(0.01)
IHS2005	0.38	(0.02)	0.46	(0.01)	0.39	(0.01)
IHS2010	0.12	(0.01)	0.37	(0.01)	0.27	(0.01)
Severely stunted						
DHS2000	0.24	(0.02)	0.36	(0.01)	0.26	(0.01)
DHS2004	0.24	(0.02)	0.29	(0.01)	0.25	(0.01)
DHS2010	0.17	(0.02)	0.19	(0.01)	0.20	(0.01)
IHS2005	0.17	(0.01)	0.20	(0.01)	0.15	(0.01)
IHS2010	0.01	(0.00)	0.17	(0.01)	0.11	(0.01)
Wasted						
DHS2000	0.04	(0.01)	0.05	(0.01)	0.06	(0.00)
DHS2004	0.05	(0.01)	0.04	(0.00)	0.05	(0.00)
DHS2010	0.01	(0.00)	0.04	(0.01)	0.03	(0.01)
IHS2005	0.02	(0.00)	0.02	(0.00)	0.02	(0.00)
IHS2010	0.02	(0.00)	0.04	(0.01)	0.03	(0.00)
Severely wasted						
DHS2000	0.01	(0.00)	0.01	(0.00)	0.02	(0.00)
DHS2004	0.02	(0.01)	0.01	(0.00)	0.02	(0.00)
DHS2010	0.00	(0.00)	0.01	(0.00)	0.01	(0.00)
IHS2005	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)
IHS2010	0.00	(0.00)	0.01	(0.00)	0.01	(0.00)

*** p<0.01, ** p<0.05, * p<0.1