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# Does Ethiopia's Productive Safety Net Program Improve Child Nutrition?

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We study the link between Ethiopia's Productive Safety Net Program (PSNP) and short-run nutrition outcomes among children age 5 years and younger. We use 2006 and 2010 survey data from Northern Ethiopia to estimate parameters of an exogenous switching regression. This allows us to measure the differential impacts of household characteristics on weight-for-height Z-score of children in member and non-member households in PSNP. We find that the magnitude and significance of household covariates differ in samples of children from PSNP and non-PSNP households. Controlling for a set of observable features of children and households we find that children in member households have weight-for-height Z-scores that are 0.55 points higher than those of children in non-member households. We conclude that the PSNP is providing positive short-term nutritional benefits for children, especially in those households that are able to leverage underemployed female labor.

Key words: anthropometrics, Ethiopia, food security, nutrition, safety net

JEL codes: I15, I38

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## 1. Introduction

In this paper, we use data from Northern Ethiopia to study the links between a social protection program and child nutrition.[1] Child malnutrition is one of the many challenges that pose a threat to economic growth in developing countries. It undermines educational attainment, lowers non-cognitive skills, leads to low labor productivity during adulthood, and diverts attention and resources away from other development objectives (Kimhi, 2003; World Bank, 2010; Save the Children, 2012; Dercon and Sanchez, 2013). Ultimately, under-nutrition during childhood can lead to intergenerational poverty (World Bank, 2010). To tackle the problem of malnutrition in poor nations, a number of targeted interventions have emerged. These include school feeding programs and micro-nutrient and vitamin supplementation programs for women and young children (Save the Children, 2012). A broader approach is the provision of food aid. Ethiopia has a long history of receiving food aid (Gilligan et al., 2008), yet the country's record of child malnourishment remains poor and rates of malnutrition are among the highest in Africa (Christiaensen and Alderman, 2004). In 2005, the government of Ethiopia established the largest social protection program in Sub-Saharan Africa to date, aside from South Africa. The Productive Safety Net Program (PSNP) builds on a previous emergency food aid program and includes as components food-for-work (FFW) and cash-for-work (CFW) as well as direct support through free food. However, the PSNP differs from Ethiopia's previous interventions by providing individual member households a guaranteed source of income for at least five consecutive years (2005-2009), and in a majority of cases guaranteed income for an additional five years (2010-2014) (Government of Ethiopia, 2009).

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[1] We use the terms "health" and "nutrition" interchangeably here.

To examine the impacts of the PSNP on child nutrition, we use anthropometric data collected in the Tigray region among children five years and younger in 2006 and 2010. Our outcome indicator is weight-for-height Z-score (WHZ), a short-term indicator which we construct using the WHO's newly developed child growth standard. Two research questions motivate the analysis. First, we ask whether the determinants of WHZ differ between the population of children in PSNP households and those in non-PSNP households. Second, we test whether PSNP membership was associated with subsequently higher Z-scores for children in beneficiary households. Importantly, we move beyond the traditional approach to measuring a potential impact "with" and "without" an intervention, and search for underlying conditioning mechanisms that may be driving differences in nutrition outcomes in the PSNP and non-PSNP samples. Such a refocusing of effort for impact evaluation has been most clearly articulated by Deaton (2010). We find, for example, that a household's supply of female labor is one such factor that conditions nutritional response to food-for-work opportunities.

Past studies focusing on the relationship between food aid and child nutrition in Ethiopia have suggested a positive impact of food aid on weight-for-height (Quisumbing, 2003) and linear growth (Yamano et al., 2005). These earlier studies relied on data collected between 1994 and 1996, well before the start of the PSNP. Our study updates and complements this previous work using data collected after the introduction of the PSNP. Further, we use the new WHO growth standard, which provides the most accurate measure of child health in Ethiopia to date.

We use an exogenous switching regression framework to answer our research questions. Findings reveal that the determinants of short-run anthropometric outcomes differ between member and non-member households. In particular, the supply of female labor seems to matter for promoting child health in member households. We also find that while nutrition outcomes are better for female children in our sample of member households, vis-à-vis their non-PSNP cohorts, male children appear to do better in non-member households. We use our regression results to examine difference in WHZ in member and non-member households, finding an average difference in WHZ of approximately 0.55 points, or roughly 31 percent of a standard deviation.  We also measure program treatment effects under a set of counterfactual conditions in which we equate the nutrition returns to characteristics of member and non-member households. Those results suggest that, after controlling for the differences in the profiles of member and non-member households, children in member households had 97 percent higher WHZ, on average, than children in non-member households. We conclude that short-run nutrition outcomes, as measured by WHZ, have been responsive to PSNP membership and associated interventions.

## 2. Theoretical Framework

At the outset, it is necessary to clarify key temporal considerations for our analysis because we have available both short-run and long-run nutritional indicators but are only well-positioned to measure program impacts arising in the recent wake of PSNP enrollment. Clearly, given a long enough observational history, it would be possible to isolate the long-term impacts of PSNP membership on child health, as expressed through a long-term indicator such as height-for-age Z-score (HAZ). In our case, however, we strongly believe that HAZ is highly correlated with household status at the start of the PSNP, and therefore negatively correlated with program participation. Indeed, cursory examination of the data confirms that average HAZ is lower among PSNP members than non-members. In the absence of a realistic opportunity to separately identify the drivers of long-run malnutrition and program participation predicated on poverty, we set aside the notion of linking the PSNP to long-term nutrition outcomes.

Instead, we focus our attention on WHZ, the more immediate nutrition indicator, as this is more likely to be sensitive to short-term program impacts and less likely to be contaminated by initial conditions influencing program enrollment. From a short-run perspective, a program such as Ethiopia's PSNP can affect a child's short-run nutritional status through multiple channels. First, if the program involves distribution of food (as in the case of the FFW and free food program components of the PSNP), it may directly increase household's short-run food availability, with potential immediate benefits to mothers and children (Yamano et al., 2005). Second, in cases where the program provides wages or cash transfers, a household's income will rise, thereby improving the household's ability to purchase food and nutrition-enhancing items (Alderman et al., 2006). Nevertheless, while a positive nutritional impact from a rise in income seems possible and even likely, the degree to which such transfers might boost nutrition depends upon several factors. These include the overall magnitude of the increase in income, the marginal propensity to consume calories or other health and nutrition goods and services out of cash income, and the extent to which actual expenditures are transformed into positive increments in health and nutrition. On the other hand, a work program that requires households to provide labor could have negative implications for a child's nutritional status by shifting effort away from health provisioning. Whether a work program has deleterious impacts depends on the labor situation of the household, especially female members of the household. To the extent a household has "surplus" labor, and hence a low opportunity cost of effort, work opportunities may not displace nutrition-producing activities. However, if household labor is scarce, if the overall nutritional demands of work are high, or if off-farm work leads household members to redirect labor away from activities that produce adult and child nutrition, negative impacts may arise. In short, since labor is an input to child health, but public works programs require labor contributions from household members, such programs introduce the potential for an income-nutrition tradeoff.

To better understand the conceptual and temporal linkages between the PSNP and child health, we begin by developing a multi-period dynamic model of household production and consumption in which household health evolves as a stock. As a simple starting point, we assume a unitary household in which household members make decisions, including those that affect child nutrition, jointly. The representative household maximizes a discounted stream of utility, defined over consumption, subject to the technology of production and the evolution in stocks of human and physical capital. The problem can be written as:

$$\text{Max} \sum_{t=0}^{T} \beta^{t} U(C_t) \qquad [1]$$

$$\text{Subject to} \quad C_t = I_t - S_t \qquad [2]$$

$$\bar{L}_b = L_{tb}^{G} + L_{tb}^{o} + L_{tb}^{F} + L_{tb}^{H} \qquad [3]$$

$$\bar{L}_d = L_{td}^{G} + L_{td}^{F} + L_{td}^{H} \qquad [4]$$

$$Q_t = q\left( L_{tb}^{G}, L_{td}^{G}, A_t, \eta \right) \qquad [5]$$

$$I_t = P_t Q_t + w_t^{o} L_{tb}^{o} + w_t^{F} L_{tb}^{F} + w_t^{F} L_{td}^{F} \qquad [6]$$

$$A_t = (1+r) A_{t-1} + S_t \qquad [7]$$

$$H_t = h\left(L_{tb}^{H}, L_{td}^{H}, C_t\right) + H_{t-1} \qquad [8]$$

where $C_t$ is a vector containing consumption of food, manufactured goods and health; $I_t$ is the income of the household; and $S_t$ represents savings. Equations [3] and [4] represent labor constraints for each gender category where subscripts *b* and *d* refer to male and female labor, respectively. $\bar{L}$ is the total labor endowment; $L_t^G$, $L_t^o$, $L_t^F$ and $L_t^H$ represent labor allocated to agricultural production, off-farm work, food-for-work (FFW) and health, respectively. Gender disaggregation of the labor force endowment is important because household health outcomes may vary depending on whether new activities require the (re)allocation of male or female labor. Since off-farm employment is generally unavailable or greatly limited for women in Tigray, we assume in equation [4] that female labor cannot be allocated to off-farm employment. $Q_t$ is an agricultural production function which is increasing in labor and stock of land and non-land productive assets ($A_t$) and decreasing in production risk ($\eta$); $P_t$ refers to the price of a composite agricultural product; $w_t^o$ and $w_t^F$ are wages from off-farm employment and food-for-work, respectively.

The dynamic system is governed by two equations of motion, one for physical capital (equation [7]) and one for human capital (equation [8]). $A_t$ appreciates at the rate *r* and can be augmented through savings. Of course, the stock of land may depreciate from degradation and the stock of animals may depreciate from disease. The household's stock of human capital is represented as an aggregate index of health, $H_t$, which evolves subject to previous health status ($H_{t-1}$) and improvements in health generated through the health production function [h (•)]. We assume the health production function is concave in its arguments and depends on the labor allocated to health (child care) and the current level of consumption ($C_t$). In subsequent modeling, we consider child health to be part of $H_t$.

Substitution of equation [5] into equation [6]; equation [6] into equation [2] and equation [2] into the objective function yields the following fixed-horizon optimization problem:

$$\mathrm{Max}\sum_{t=0}^{T} \beta^{t}\ U[P_t(q(L_{tb}^G, L_{td}^G, A_t,\ \eta)) +\ w_t^o L_{tb}^o +\ w_t^F\ L_{tb}^F +\ w_t^F\ L_{td}^F - S_t]$$

Subject to: $\bar{L}_b = L^G_{tb} + L^o_{tb} + L^F_{tb} + L^H_{tb}$ [9]

$$\bar{L}_d = L^G_{td} + L^F_{td} + L^H_{td} \qquad [10]$$

$$A_t - A_{t-1} = r\,A_{t-1} + S_t \qquad [11]$$

$$H_t - H_{t-1} = h\,(L^H_{tb}, L^H_{td}, C_t) \qquad [12]$$

The choice variables in the problem are $L^G_{tb}$, $L^G_{td}$, $L^o_{tb}$, $L^F_{tb}$, $L^F_{td}$ and $L^H_{tb}$ $L^H_{td}$ while the state variables are $A_t$ and $H_t$. We assume that initial conditions for the state variables are given as A (0) =$A_0$ and H (0) =$H_0$ where $A_0=\bar{A}>0$ and $H_0=\bar{H}>0$. With a fixed terminal time T, transversality conditions for the state variables (with initial values $\bar{A}$ and $\bar{H}$) imply that the values of physical and human capital may vary at the terminal time depending on the shadow values of increments to these stocks compared with the cost of further improvements.

Accounting for the constraints on the choice variables, the dynamic Lagrangian associated with the problem is:

$$\begin{aligned}\mathcal{L} = {} & \beta^t\, U[P_t(q(L^G_{ta}, L^G_{tb}, A_t, \eta)) + w^o_t L^o_{tb} + w^F_t L^F_{tb} + w^F_t L^F_{td} - S_t] + \theta_t(r\,A_{t-1} + S_t) \\ & + \delta_t[h\,(\bar{L}_b - L^G_{tb} - L^o_{tb} - L^F_{tb}, \bar{L}_d - L^G_{td} - L^F_{td}, C_t)] \\ & + \lambda_t(\bar{L}_b - L^G_{tb} - L^o_{tb} - L^F_{tb} - L^H_{tb}) + \gamma_t(\bar{L}_d - L^G_{td} - L^F_{td} - L^H_{td}) \qquad [13]\end{aligned}$$

The first-order necessary conditions (FOC) with respect to labor allocated to health and FFW for male labor are given by equation [14] and equation [15].

$$\frac{\partial \mathcal{L}}{\partial L^F_{tb}} = \beta^t \frac{\partial U}{\partial C_t}\frac{\partial C_t}{\partial L^F_{tb}} + \delta_t \frac{\partial h}{\partial L^F_{tb}} - \lambda_t = 0 \longrightarrow \beta^t \frac{\partial U}{\partial C_t} w^F_t + \delta_t \frac{\partial h}{\partial L^F_{tb}} - \lambda_t = 0$$

$$\longrightarrow \lambda_t = \beta^t \frac{\partial U}{\partial C_t} w^F_t + \delta_t \frac{\partial h}{\partial L^F_{tb}} \qquad [14]$$

$$\frac{\partial \mathcal{L}}{\partial L^H_{tb}} = \delta_t \frac{\partial h}{\partial L^H_{tb}} - \lambda_t = 0 \longrightarrow \lambda_t = \delta_t \frac{\partial h}{\partial L^H_{tb}} \qquad [15]$$

Analogously, the FOC with respect to the choice variables of interest (labor allocated to health and FFW) for female labor are presented in equation [16] and equation [17].

$$\gamma_t = \beta^t \frac{\partial U}{\partial C_t} w_t^F + \delta_t \frac{\partial h}{\partial L_{td}^F} \qquad [16]$$

$$\gamma_t = \delta_t \frac{\partial h}{\partial L_{td}^H} \qquad [17]$$

Solving equations [14] and [15] for male labor and equations [16] and [17] for female labor results in a pair of equations that illustrate the potential connections between a program like Ethiopia's PSNP and nutrition outcomes:

$$\beta^t \frac{\partial U}{\partial C_t} w_t^F + \delta_t \frac{\partial h}{\partial L_{tb}^F} = \delta_t \frac{\partial h}{\partial L_{tb}^H} \longrightarrow \delta_t \frac{\partial h}{\partial L_{tb}^F} = \delta_t \frac{\partial h}{\partial L_{tb}^H} - \beta^t \frac{\partial U}{\partial C_t} w_t^F \qquad [18]$$

$$\beta^t \frac{\partial U}{\partial C_t} w_t^F + \delta_t \frac{\partial h}{\partial L_{td}^F} = \delta_t \frac{\partial h}{\partial L_{td}^H} \longrightarrow \delta_t \frac{\partial h}{\partial L_{td}^F} = \delta_t \frac{\partial h}{\partial L_{td}^H} - \beta^t \frac{\partial U}{\partial C_t} w_t^F \qquad [19]$$

Equations [18] and [19] show that PSNP can either increase or decrease health production and hence have either a positive or negative effect on child nutrition. A decline in health may occur if labor allocated to health provisioning falls in response to a reallocation of labor to other activities, thereby reducing health production by an amount more than the health improvements provided by income arising from the competing activity. On the other hand, an improvement in health could result from an increase in FFW income if it does not require substantial "cost" in terms of reallocation of labor from health production. Because labor market rigidities preclude off-farm work for women, one might expect the shadow value of female labor to be artificially low inside the household. In such a setting, a FFW program that makes use of female labor provides a potential means to generate gains for the household by reallocating small quantities of female labor. Hence, the household's supply of female labor may influence the marginal nutrition benefit of a FFW program, providing a mechanism by which program impacts might differ across otherwise similar households.

Whether, on net, FFW has a short-run positive or negative effect on child health depends on the deleterious effects of the reallocation of labor, the household's labor endowment, the size of the public works payment, and the marginal impact of this payment on child nutrition and health. If a household uses the payment on health production (either in terms of consuming food or consuming health and medical attention) children in PSNP households may enjoy better health than those in non-PSNP households, even when FFW labor requirements crowd out some agricultural or home activities. In this case, the benefit from PSNP may outweigh the deleterious effect of reallocation of labor. If, on the other hand, the household uses public works income for purposes unrelated to child health, this potentially undermines health production by displacing labor from health production without a compensatory expenditure on health provisioning. Moreover, the outcome may critically depend on whether it is male or female labor that is devoted to FFW, and whether that labor is relatively scarce in the household. The overall impact is, *a priori*, ambiguous.

Based on the theoretical framework, we pose two hypotheses. First, the model shows a clear potential link between labor allocation to the PSNP and health outcomes. We therefore hypothesize that nutritional outcomes will differ between households that are members of the PSNP and those that are not. Second, we hypothesize that children residing in PSNP households will have better nutritional outcomes because the opportunity cost of allocating labor to public works is likely to be low and the nutritional or cash income benefits obtained from participating in the program are likely to be high.

Our subsequent investigation makes use of data observed over two periods to reveal empirical regularities between WHZ and membership in the PSNP.[2]

## 3. Study Context and Data

(a) *Child malnutrition in Ethiopia*

It has long been recognized that under-nutrition is the major cause of child mortality (World Bank, 2011). In Ethiopia, child malnutrition contributed to an estimated 57 percent of under-five mortality as of 2001 (Mekonnen et al., 2005), with boys having higher mortality rate than girls (WHO, 2011). Between 2000 and 2011, the country ranked third in Africa in terms of high under-five mortality, after Nigeria and the Democratic Republic of Congo (WHO, 2013). A recent estimate of the country's malnutrition status indicates that 44.2, 10.1 and 29.2 percent of children under five years of age were stunted, wasted and underweight in 2011 (WHO, 2013). [3] Compared to data from 2005 (WHO, 2012), these rates have improved somewhat (by 6.5, 2.2 and 5.4 points for stunting, wasting and underweight), although improvements have not been sufficient for Ethiopia to reach the Millennium Development Goals (World Bank, 2011).

(b) *The Productive Safety Net Program*

The Productive Safety Net Program (PSNP) is a development-oriented social protection program launched in Ethiopia in 2005. It was introduced by joint efforts of the

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[2] As argued elsewhere, we do not include a longer-term measure of malnutrition (e.g. height-for-age) in this study primarily because a long-term indicator is not likely to pick up the short-term benefits of the PSNP as measured at the time of the study. Instead, height-for-age scores are more likely to reflect underlying levels of deprivation in the sample, and for this reason are likely to be positively correlated with PSNP eligibility.

[3] A child is considered stunted, wasted or underweight if the calculated Z-score for height-for-age, weight-for-height and weight-for-age, respectively, is 2 standard deviations below the median of a reference population. The Z-score is calculated as: $Z = \frac{\text{observed value} - \text{median reference value}}{\text{standard deviation of reference population}}$.

Government of Ethiopia and donors in an attempt to provide a long-term solution to the chronically food insecure households found in chronically food insecure regions of the country. It aims to cover more than 263 *weredas* (districts) and 1.6 million households in five major regions of the country, namely Tigray, Amhara, Oromiya and SNNP (Legovini, 2006, Gilligan *et al*., 2009; Porter and Dornan, 2010; Nega *et al*., 2010). While the program builds on the experiences of the earlier emergency relief program, it has distinct characteristics in its long term nature. It provides a predictable amount of transfers (cash or food) for a predictable period of time (at least five years) (Bishop and Hilhorst, 2010). Able-bodied adults are required to work five days per month in community infrastructure development in return for food (mainly wheat and cooking oil) or cash. Elderly, disabled, sick or mentally challenged individuals; pregnant and lactating women; and orphaned teenagers receive free food or cash without a work requirement. The former is the public work (food-for-work or cash-for-work) component and the latter is the direct support component (Sharp et al., 2006).

Program eligibility depends on whether a household is found in one of the chronically food insecure *weredas*; whether it faced food gaps or received food aid within three years of the start of the program; whether it faced severe shocks that led to substantial asset depletion; or whether the household had no other source of support (e.g. from family or other social protection programs). Food security task forces and councils formed at the *tabia* and *wereda* levels select eligible households in the program (Government of Ethiopia, 2009). Eligible households are then registered as members of the program for a consecutive five year period (first phase) and possibly for an additional five years (second phase). [4]

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[4] Households that participate in the public works component of the PSNP do not necessarily participate in the community asset development component.

Along with the Other Food Security Program (OFSP) that provides credit and extension service, the PSNP aims to allow households to accumulate assets and prevent likely asset depletion due to severe shocks. Further, it is expected that the program directly fills the food gap for food insecure households. The program attempts to graduate successful participants that show sufficient improvement in food security status and asset accumulation out of the program (Government of Ethiopia, 2009).

### (c) *Study site and data*

Data for this study come from household surveys collected in Tigray region. Located in Northern Ethiopia, Tigray is typically characterized by high exposure to recurrent drought and famine (Hagos, 2003). Further, most households have limited access to credit and off-farm opportunities (Bezu and Holden, 2008). The malnutrition status of children under five in Tigray is among the worst in the country. In 2000, 61.3% of children were stunted in the region, the second largest percentage in the nation after the Amhara region (62.9%). During the same period, the percentages of wasted and underweight children were 12.9 and 42.3, respectively (WHO, 2012).

Our data were collected in 2006 and 2010. The data are part of a follow up survey that initially visited 400 households in 1998 and then revisited them in 2001 and 2003. The initial sample contained 16 villages that were representative of the region in terms of agro-climatic conditions, agricultural potential, population density and market access. Sample households were randomly selected within villages (Hagos, 2003). Survey data in 2006 and 2010 included child anthropometric measures for the first time. The 2010 data further contains height and weight of the parents and an additional 119 households from two different villages. The survey used a multipurpose questionnaire containing topics on household characteristics; asset ownership (livestock, land and physical assets); membership in the PSNP; income from agriculture and non-agriculture sources;

exposure to shocks and anthropometric measures for children and parents.[5] In addition, a village questionnaire was administered in all villages.

We generated Z-score values for weight-for-height of children under five using WHO's latest child growth standard (2006). The newly developed growth standard incorporates the growth pattern of children with different ethnic and cultural backgrounds which makes it suitable for data coming from developing countries. This is unlike the earlier National Center for Health Statistics (NCHS)/WHO growth standard (O'Donnell *et al*., 2008). The Z-score values reflect the standard deviation from the median height or weight of WHO's well-nourished reference population (with same age and gender).[6] Anthropometric surveys of children typically suffer from problems of missing data or mismeasurement. After removing missing and outlier observations, our sample includes 383 children less than five years of age, 187 for 2006 and 196 for 2010. Only 37 of these children were included in both surveys, so we treat each round as a separate representative sample.

Table 1 presents the proportions of malnourished children by age category, gender and membership in the PSNP. Acute malnutrition (wasting), which is indicated by low WHZ, seems to be more of a problem for children above two years. In our sample, approximately 15 percent of children below two years and 19 percent of children above two years are wasted (WHZ<-2.0). Overall, 18 percent of children in our sample are wasted. In terms of sex, our sample indicates a greater share of boys with WHZ scores lower than 2 standard deviations below the reference population (see Table 1). This is in

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[5] Parent's heights and weights were measured only in the 2010 survey. This precludes us from using these variables in the empirical analysis.

[6] We used the WHO's STATA package (2011) to compute Z scores. When biologically implausible values are encountered, these are recoded to missing. In our dataset, 11 per cent of WHZ scores exceeded the WHO cutoff values.

line with the study by Christiaensen and Alderman (2004) who found that boys were more malnourished than girls in Ethiopia. Table 1 also shows the percentages of children who are malnourished within households that are members and non-members in the PSNP. The proportion of wasted children in member households (16%) is lower than in non-member households (23%).

Table 2 summarizes average WHZ among children in PSNP and non-PSNP households. Short-term nutritional status worsened in both groups between 2006 and 2010, declining from 0.17 in 2006 to -0.66 in 2010. Figure 1 illustrates the pattern.[7] On average, children in PSNP households exhibited higher WHZ than children in non-beneficiary households. Figure 2 compares the Z-score distributions for members and non-members. Cumulative density functions for WHZ are plotted in Figure 3. These underscore that the distribution for PSNP households is shifted to the right, and dominates the non-PSNP distribution at nearly all points.

## 4. Empirical Strategy

Our main focus in this paper is to examine differences in the nutritional outcome of children in households that are members in the PSNP and those that are not. We first examine the differences in the determinants of WHZ within PSNP and non-PSNP households. Then, we measure the impact of the PSNP on member households' child nutrition outcome. Membership in the PSNP is beyond the control of households, which makes an exogenous switching regression suitable for our purposes.[8]

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[7] The worsening of WHZ occurred for both member and non-member households.

[8] Following Duflo (2003), we focus on membership, rather than participation. We tested exogeneity of membership in two ways. First, following a similar approach used by Yamano et al. (2005) we employed 2SLS using the deflated village average income from FFW in 1998 as our identifying instrument for PSNP membership. Although the instrument was weak, the test recommended rejecting the hypothesis that membership

The theoretical framework suggests labor reallocation decisions of member households may differ from non-member households. An implication is that child health may differ in member and non-member households. A Chow test in our sample rejects the null hypothesis of coefficient equality for members and non-members (at a 0.1% test level). This confirms that an exogenous switching regression, which allows coefficient estimates to differ across the sub-samples, is appropriate. Estimating separate slope coefficients for the two groups also enables us to measure the differential impacts of child and household covariates on the outcome variable of interest.

Using the child as the unit of analysis, the regression models for the two groups are defined as follows:

$$Z_{Mi} = \beta_0 + \beta_1' X_{Mi} + \beta_2' X_{Mh} + \beta_3' A_{Mh} + \beta_4 T + \varepsilon_{Mi} \qquad [20]$$

$$Z_{Ni} = \gamma_0 + \gamma_1' X_{Ni} + \gamma_2' X_{Nh} + \gamma_3' A_{Nh} + \gamma_4 T + \varepsilon_{Ni} \qquad [21]$$

where subscripts *M* and *N* for the dependent and the explanatory variables represent PSNP membership and non-membership. Subscript *i* denotes child level variables and subscript *h* denotes household level variables. $Z_i$ denotes anthropometric measures of the child (weight-for-height Z-score) ; $X_i$ is a vector of child characteristics (gender and age of the child); $X_h$ is a vector of household characteristics (age, gender and education of the household head; number of female and male adult labor; number of other siblings under five); $A_h$ refers to a vector of productive assets (including land area and livestock holdings); $T$ is a year dummy variable ($T = 1$ if the year is 2010 and zero if the year is 2006); and $\varepsilon_i$ is an error term with expected value of zero. In the estimation, $\varepsilon_{Mi}$ and $\varepsilon_{Ni}$ are assumed to be uncorrelated with unobservable factors affecting membership in

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is endogenous in the Z-score regression. Second, we used the same instrument in an endogenous switching regression, subsequently checking the significance of the correlation between the error term in the membership equation and the error term in the Z-score regression. The estimated coefficient was not statistically different from zero, again suggesting that PSNP membership is exogenous to nutrition outcomes.

PSNP, a requirement in an exogenous switching regression model (Maddala, 1983). In order to control for time-invariant unobservable characteristics, we use household fixed effects. White's hetroskedasticity corrected standard errors are clustered by *wereda*

In order to directly examine if membership in PSNP contributed to child nutrition, we use two approaches. First, we use predictions from the separate regressions and test differences in predicted outcomes between members and non-members. Kernel density graphs, Kolmogorov Smirnov tests and t-tests were applied. Second, we adopt the approach of Kassie et al. (2014) who compute treatment effects after carrying out an exogenous switching regression. In our case this involves generating the average value of the observed outcome (WHZ) for PSNP and non-PSNP sub-samples, as well as those derived under plausible counterfactual conditions. A reasonable counterfactual for PSNP member households is one in which the nutrition outcomes of children reflect the aggregated effects of the observed household characteristics but the marginal nutrition effects for each characteristic observed in the non-member sample regression. Average treatment on the treated (ATT) is then computed as the difference between the average of the observed WHZs and the average of the constructed counterfactual WHZs.

## 5. Results

Prior to examining the impact of PSNP on child health, we first discuss the factors that influence the weight-for-height Z-score of children in PSNP and non-PSNP households.

### *(a) Determinants of weight-for-height Z-score*

Tables 3 and 4 report the determinants of children's WHZ in member and non-member households. The parameter estimates in the regressions measure the short-term nutritional status of children (WHZ) attributable to the explanatory variables within the two groups. Models 1A, 1B and 1C contain results for member households and Models 2A, 2B and 2C show results for non-member households. Models 1B and 2B include the number of other under five children in the household. Models 1C and 2C disaggregate the number of other under five children by gender. As the theoretical model predicts, the set of covariates that explain variation in WHZ differ in the PSNP and non-PSNP sub-samples.

Findings suggest that a higher WHZ for older children in member households while the age of a child does not seem to matter in non-member households. Gender of a child has an impact on WHZ in non-member households. Results indicate that boys in non-member households have 0.89-1.88 higher WHZ than girls, on average. Non-member households seem to favor boys than girls in the distribution of food within the households. On the other hand, the estimate in Model 1C and signs in Models 1A and 1B show that in member households girls have better WHZ outcomes, on average, than boys. This finding is similar to those from a study by Webb and Block (2004) showing higher WHZ for girls than boys in Indonesia. Using a sample of Ethiopian children, Outes and Porter (2013) also find that girls have higher catchup growth than boys in terms of height-for-age Z-score.

Female headship seems to be negatively associated with WHZ in non-member households. This may indicate that female-headed households are resource poor and hence less able to generate health improvements than male-headed households. The point estimate for this variable is not statistically significant in the member sample, probably because female-headed households benefit more and are more able to provide food for children. As the age of non-member households head increases by one year, short term health outcome (WHZ) decreases by 0.28-0.32 (significant at 1% level). This potentially relates to the decline in the ability to foster children's better nutritional outcome as one gets old. In the regression for member households, we find no evidence that household head age is correlated with WHZ.

Results show that children in non-member households with uneducated household heads have higher WHZ, ceteris paribus. This is contrary to findings in previous studies such as Lavy et al. (1996) and Christiaensen and Alderman (2004). Our results are on the other hand similar with Webb and Block (2004) who argue that responses to education vary depending on whether one considers short-term or long-term nutrition indicator. In member households, coefficient estimates for household head education are not statistically significant.

In member households one additional female worker is associated with 1.09-1.31 higher WHZ, on average. A plausible explanation is that member households with greater number of adult female labor are in a better situation to allocate labor to the public works in the PSNP as well as health production. This is in line with our theoretical model which states that the increase in income from FFW can bring positive health outcome if labor reallocation from health production is not costly. It seems like FFW is particularly important for mobilizing idle female labor while males may have better off-farm opportunities without access to FFW. Put differently, FFW enhances value of the female labor force in the household and this leads to more investment in child health through their FFW income. Endowment of labor does not seem to matter in determining child nutrition in non-member households (see Table 4).

Children who have greater number of siblings under the age of five seem to have higher WHZ in both member and non-member households (see Models 1B and 2B in Tables 3 and 4, respectively). The marginal effect is higher for non-member households (0.76) than member households (0.52). As can be seen in Models 1C and 2C, effects differ depending on whether the siblings are boys or girls. The number of brothers positively affects WHZ in non-member households while number of sisters is positively linked with higher WHZ in member households. This is in line with our results on gender which show that members favor girls and non-members favor boys in health production.

One can observe that WHZ has generally declined for all households between 2006 and 2010. This is possibly due to the high food prices experienced in 2008 (Gilligan et al., 2009b). Findings are consistent with Gilligan et al. (2009b) who studied the prevalence of wasting in Amhara region from 2005 and 2008. Thomas et al. (1996) also found that higher food prices led to a significant decline in the short-run health indicator in Cote d'Ivoire. However, the point estimate for the year indicator is significantly different from zero only in the regression for member households.

### *(b) Impact of PSNP on weight-for-height Z-score*

Is the average WHZ higher for children living in member households than for those in non-member households? Table 5 summarizes the result for a two sample t-test between the predicted values of the separate regressions for the two groups.[9] Results indicate that the average predicted WHZ is significantly higher for children in PSNP households than their non-PSNP cohorts. A two-sample Kolmogorov-Smirnov test for equality of distribution functions for member and non-member households reveals a statistically significant difference in the conditional distributions (p-value=0.06) (see Table 5).

Table 6 presents results for treatment effects of membership. Cells 1 and 5 contain observed WHZ for children of PSNP and non-PSNP households. Cell 2 shows the counterfactual condition for members, i.e. the WHZ value that would have been obtained had members' responses to observed characteristics been the same as that of non-

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[9] We use models 1A and 2A to derive predicted values and compute treatment effects.

members. Similarly, cell 4 shows the counterfactual value for non-members. Findings reveal that average treatment effect on the treated (ATT) is positive and significant at a 1% level (cell 3). This implies that average WHZ for members is higher than it would have been if the marginal return to their characteristics had been the same as for non-members. Results also show that average treatment effect on the untreated (ATU) is statistically insignificant (cell 6). The heterogeneity effects, which are shown in cells 7 and 8, indicate that unobserved factors also contribute to the differences in WHZ between member and non-member households. In general, results show that nutrition outcomes have been responsive to PSNP membership in the short run.

## 6. Conclusion

Using 2006 and 2010 survey data from Northern Ethiopia, we investigated whether the determinants of short-run nutrition outcomes, as measured by weight-for-height, differ between PSNP and non-PSNP households. We also examined whether the PSNP has improved child nutrition in households benefiting from the program. Findings indicate that both the magnitude and significance of covariates influencing WHZ differ across the member and non-member samples. We find that female labor supply is positively correlated with WHZ in member households but exhibits no correlation with WHZ in non-member households. We conclude that there is no observable income-nutrition tradeoff when “underutilized” female labor is allocated to a FFW program. Although this result is highly-specific to Ethiopia, given its low baseline female labor force participation rate, it nevertheless underscores the potential for FFW programs to improve, not jeopardize, the short-run nutrition outcomes of children. . We find that girls are better nourished in member households and boys have higher average WHZ in non-member households. This result, its causes and implications warrant further study.

Results from predictions after exogenous switching regressions show that children in member households have higher WHZ than those in non-member households. We also measured the treatment effect by comparing mean of actual WHZ and counterfactual WHZ constructed from the regression. Results confirm that the PSNP has positively influenced short-term nutrition of children.

Our findings contribute to the impact evaluation literature in two ways. First, we demonstrated not only the existence of a short-run PSNP impact on child nutrition, but also cast light on one potential mechanism that seems to drive the result. As Deaton (2010) argues, uncovering the factors that explain why an impact exists is a necessary task to inform policy. In this paper we have suggested one way to do so, providing evidence that female labor supply, which is an input to the FFW component of the PSNP, influences the marginal benefit of membership.

One of the key policy implications that emerge from our findings, therefore, is that employment opportunities for women not only improve their incomes, but also improve child nutrition in the short run. Whether long-term nutrition impacts can be generated through continued participation in the program remains an important, but unanswered question.

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Table 1. Percentages of wasted children by gender, age and household PSNP status

| | Percentage of children wasted (WHZ < -2) | # Obs. |
|---|---|---|
| Gender of child | | |
| Girls | 17.5 | 194 |
| Boys | 19.0 | 189 |
| Age of child | | |
| 0-24 Months | 16.4 | 134 |
| 25-60 Months | 19.3 | 249 |
| Membership in PSNP | | |
| PSNP=1 | 15.5 | 239 |
| PSNP=0 | 22.9 | 144 |
| All children | 18.3 | 383 |
| Note: 2006 and 2010 data combined | | |

Table 2. Mean weight-for height Z-score by year and membership in PSNP

| | | All | Members | Non-members | t-test |
|---|---|---|---|---|---|
| Average Weight-for-height Z-score(WHZ) | All years | -0.25 (383) | -0.05 (239) | -0.60 (144) | 2.53 |
| | 2006 | 0.17 (187) | 0.30 (127) | -0.10 (60) | 1.25 |
| | 2010 | -0.66 (196) | -0.45 (112) | -0.95 (84) | 1.77 |

Number of observations in parentheses.

Table 3. Determinants of weight-for-height Z-score (WHZ) of children in member households

| | Model 1A | Model 1B | Model 1C |
|---|---|---|---|
| Sex of child (1=female, 0=male) | 0.51 | 0.50 | 1.23 |
| | (0.36) | (0.38) | (0.45)** |
| Age of child(in months) | -0.02 | -0.02 | -0.02 |
| | (0.01)* | (0.01)** | (0.01)** |
| Female headed household | -0.87 | -0.75 | -0.56 |
| | (0.53) | (0.59) | (0.58) |
| Age of Household Head | -0.01 | -0.01 | 0.01 |
| | (0.04) | (0.03) | (0.03) |
| Education of Household Head | -0.64 | -0.85 | -1.09 |
| | (0.70) | (0.70) | (0.66) |
| Number of adult female labour | 1.17 | 1.09 | 1.31 |
| | (0.33)*** | (0.33)*** | (0.35)*** |
| Number of adult male labour | -0.06 | -0.13 | -0.01 |
| | (0.33) | (0.31) | (0.26) |
| Tropical Livestock Unit current | -0.26 | -0.21 | -0.23 |
| | (0.16) | (0.18) | (0.20) |
| Land area owned in Tsimdi | 0.10 | 0.17 | 0.17 |
| | (0.16) | (0.12) | (0.11) |
| Year Dummy (1=2010, 0=2006) | -0.64 | -0.55 | -0.67 |
| | (0.32)* | (0.24)** | (0.24)** |
| Number of other children | | 0.51 | |
| | | (0.23)** | |
| Number of other female children | | | 0.84 |
| | | | (0.22)*** |
| Number of other male children | | | -0.04 |
| | | | (0.21) |
| Constant | 0.22 | -0.16 | -1.64 |
| | (1.73) | (1.63) | (1.62) |
| Observations | 239 | 239 | 239 |
| Number of Household ID | 129 | 129 | 129 |
| R-squared | 0.17 | 0.20 | 0.22 |
| Household fixed effect | Yes | Yes | Yes |

Robust standard errors clustered by *wereda* in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 4. Determinants of weight-for-height Z-score (WHZ) of children in non-member households

| | Model 2A | Model 2B | Model 2C |
|---|---|---|---|
| Sex of child (1=female, 0=male) | -0.96 | -0.89 | -1.88. |
| | (0.36)** | (0.36)** | (0.87)* |
| Age of child(in months) | 0.00 | -0.00 | 0.00 |
| | (0.01) | (0.00) | (0.00) |
| Female headed household | -5.49 | -4.83 | -5.41 |
| | (0.62)*** | (0.67)*** | (1.54)*** |
| Age of Household Head | -0.32 | -0.30 | -0.28 |
| | (0.10)*** | (0.09)*** | (0.07)*** |
| Education of Household Head | -1.99 | -1.72 | -1.73 |
| | (0.62)*** | (0.62)** | (0.70)** |
| Number of adult female labour | -0.52 | -0.44 | -0.65 |
| | (0.36) | (0.32) | (0.47) |
| Number of adult male labour | -0.19 | -0.31 | -0.09 |
| | (0.46) | (0.47) | (0.49) |
| Tropical Livestock Unit current | 0.20 | 0.18 | 0.16 |
| | (0.25) | (0.26) | (0.25) |
| Land area owned in Tsimdi | 0.15 | 0.05 | 0.08 |
| | (0.17) | (0.11) | (0.19) |
| Year Dummy (1=2010, 0=2006) | -0.89 | -0.55 | -0.97 |
| | (0.60) | (0.55) | (0.74) |
| Number of other children | | 0.76 | |
| | | (0.40)* | |
| Number of other female children | | | -0.10 |
| | | | (0.86) |
| Number of other male children | | | 1.14 |
| | | | (0.48)** |
| Constant | 16.06 | 14.82 | 14.61 |
| | (3.78)*** | (3.35)*** | (3.49)*** |
| Observations | 144 | 144 | 144 |
| Number of Household ID | 79 | 79 | 79 |
| R-squared | 0.39 | 0.42 | 0.45 |
| Household fixed effect | Yes | Yes | Yes |

Robust standard errors clustered by *wereda* in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 5.Kolmogorov-Smirnov test and t-test on predicted values for members and non-members

| | Kolmogorov-Smirnov test | | T-test | | # Obs |
|---|---|---|---|---|---|
| Group | D | P-value | Mean | t-value | |
| Members | -0.01 | | -0.05 | | 239 |
| Non-members | 0.15 | | -0.60 | | 144 |
| Combined | 0.15 | 0.03 | -0.25 | 2.90 | 383 |

Table 6.Treatment effects-average weight-for-height Z-score

| Groups | Member households' response to characteristics | Non-member households' responses to characteristics | Treatment effects<br>(Column 2- column 3) |
|---|---|---|---|
| Member households' characteristics | [1] -0.05 | [2] -1.43 | [3] 1.38 (0.27) *** |
| Non-member households' characteristics | [4] -0.64 | [5] -0.60 | [6] -0.04 (0.40) |
| Heterogeneity effects<br>(Row 2- row 3) | [7] 0.59 (0.13) *** | [8] -0.84 (0.42)** | |

Standard errors in parenthesis
** significant at 5% and *** significant at 1%

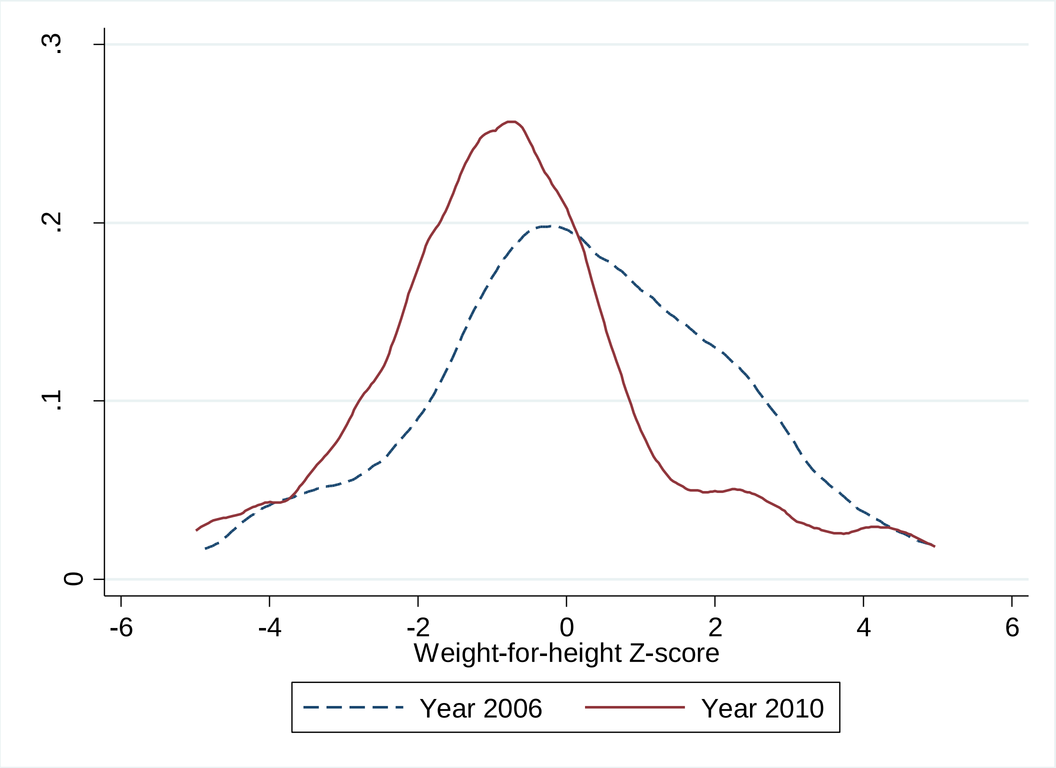

Figure 1. Distribution of WHZ, by year

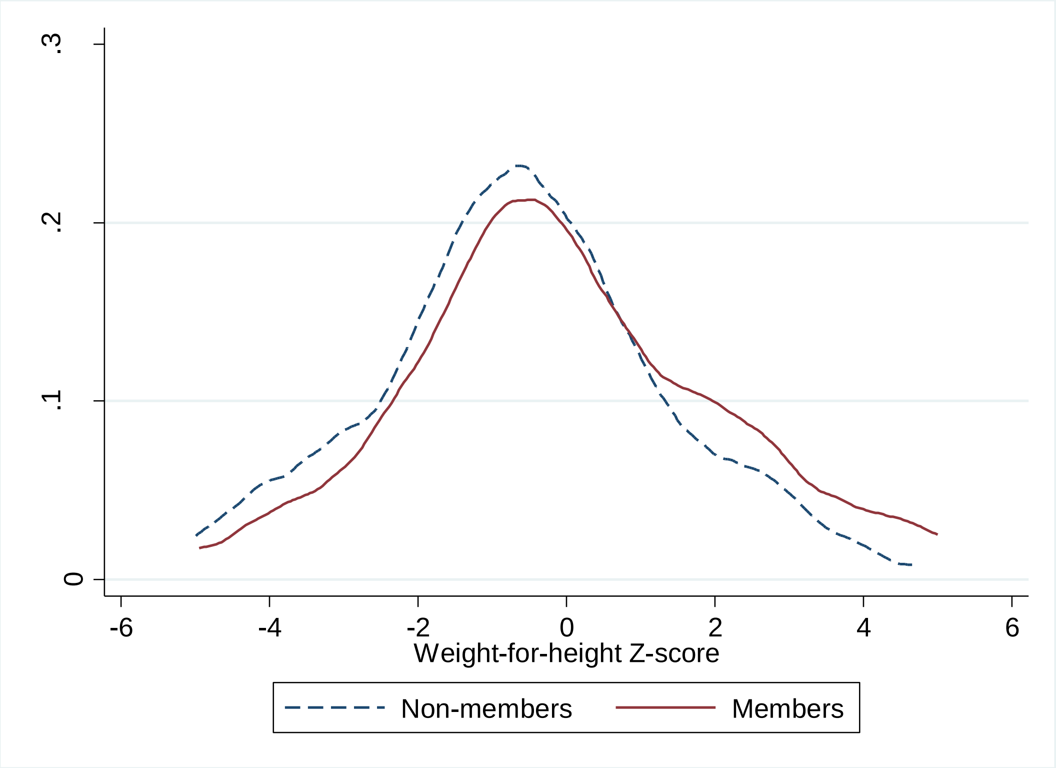

Figure 2. Distribution of WHZ by PSNP status

Figure 3. Cumulative density function of WHZ by PSNP status