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## How Does Ethiopia's Productive Safety Net Program Affect Livestock Accumulation and Children's Education?

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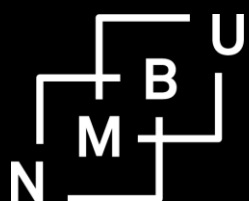
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# How Does Ethiopia's Productive Safety Net Program Affect Livestock Accumulation and Children's Education?

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Centre for Land Tenure Studies

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## **How Does Ethiopia's Productive Safety Net Program Affect Livestock Accumulation and Children's Education?\***

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## **Abstract**

We use panel data from Northern Ethiopia to investigate the welfare impact of Ethiopia's Productive Safety Net Program. We assess whether the program raised livestock asset levels and children's education among participant households. Using treatment effects models, we find that participants in the public work component invested more in livestock and children's education than non-participant households after controlling for selection into the program. Participation in the program helps to protect beneficiaries from sacrificing their children's education in response to shocks. Our conclusion remains the same when we control for the extent of down sale of livestock to avoid graduation from the program.

**Keywords:** Social protection, safety net, asset accumulation, education, Ethiopia, Africa

## **1 Introduction**

This paper examines the effect of a social protection program on asset accumulation behavior of rural households in Northern Ethiopia. Ethiopia has been heavily dependent on emergency food aid programs for more than a decade (Gilligan et al., 2008). Recurrent droughts and food shortages in the country were the main reasons causing appeals for relief interventions (Jayne et al., 2001). The country's emergency food aid recipients have been chronically food insecure and were unable to feed themselves even in good years. As a result, there was a need to provide long term assistance to these households (Nega et al., 2010). To this end, the government of Ethiopia (with joint effort of donors) launched a large scale social protection program in 2005, namely the Productive Safety Net Program (PSNP). It is different from the previous program as it provides predictable transfers to eligible households for a predictable period of time (Gilligan et al., 2008; Gilligan et al., 2009; Andersson et al., 2011; Government of Ethiopia, 2009; Bishop and Hilhorst, 2010). The program has two components: public works involving food-for-work and cash-for-work as well as direct support providing free food and cash. The main objectives of the PSNP are to reduce the food deficit of households, promote asset accumulation and prevent asset depletion (Government of Ethiopia, 2009).

We use panel data from Northern Ethiopia, Tigray region, to investigate whether the public work component of the PSNP allowed investment in two types of assets: livestock and children's education. To control for endogenous selection, we employ treatment effects model and estimate the average treatment effects on beneficiary households.

A growing body of literature examines the welfare implications of workfare programs operating at scale such as the PSNP. Earlier studies of the impacts of Ethiopia's PSNP suggest that PSNP increased consumption (Gilligan et al., 2009), improved tree holdings and had no effect on livestock holding (Andersson et al., 2011), decreased labor allocated to farm work (Siyoun, 2012), improved food security status and raised livestock holdings (Berhane et al., 2011b). Others have reported that the PSNP resulted in a decrease in children's time spent on domestic work (Woldehanna, 2009), decrease in child labor hours on public works (Hoddinott et al., 2009) and time spent in school (Tafere and Woldehanna, 2013).

Previous studies have either measured early impact prior to the maturity of the first phase of PSNP or relied on recall data to form baseline to examine asset accumulation effects of the program. Others that investigated outcomes after the end of the first phase either used recall data or outcomes after the start of the program. This paper contributes to the existing literature in three ways. One, it uses data prior to the start of PNSP (2003) as a baseline and compares it with outcome after the end of the first phase (2010). Two, it captures the situation at towards the end of the first five year period of PSNP when some behavioral responses are likely to occur given the uncertainty about continued participation in the program. We assess the potential terminal effect by using two alternative periods (2009-2003 and 2010-2003) in our econometric analysis. This allows us to detect potential strategic responses in households' livestock accumulation behavior to avoid exclusion or graduation from the program, which other studies were unable to do. Three, since the effect of the program on livestock accumulation and children's education is mixed in the literature, this study supplements the empirical evidence by combining

“before/after” and “with/without” approach while controlling for selection in to the program.

Our econometric results suggest that the program has a positive effect on livestock holdings of participant households. Participant households show significantly larger average increase in livestock holding of 2.68-2.69 tropical livestock units than non-participant households in the first five year period of the PSNP, after controlling for sample selection and attrition bias. Furthermore, children within participant households achieve significantly greater level of education than children in non-participant households. In the face of labor related shocks (illness and death), participant households are able to invest more in their children’s schooling than non-participant households, although shocks negatively affect investment in children’s education. The tendency among some households to sell their livestock towards the end of the five year period, perhaps to reduce the probability of being graduated from the program, does not significantly affect our conclusions. Our findings demonstrate the safety net effects of the program for households that were able to participate in the public works.

## **2 The Productive Safety Net Program (PSNP) – Overview and Related Literature**

### *2.1 Overview of the program*

Ethiopia’s Productive Safety Net Program is a development oriented social protection program aimed at solving the chronic food needs of rural households in the country. In 2005, the program commenced by covering four regions of the country (Tigray, Amhara, Oromiya and SNNPR) aiming to reach more than 1.6 million households (5 million people)

in 263 *woredas*<sup>1</sup>(districts) identified as chronically food insecure areas (Legovini, 2006; Gilligan et al., 2009; Siyoum, 2012). It is the largest social protection program in Sub Saharan Africa (excluding South Africa) and initially took up an annual budget amounting to 500 million USD<sup>2</sup> (Legovini, 2006; Gilligan et al., 2008). Currently, the pastoralist areas of the country are included in the program and the size of the beneficiaries has increased to 8.3 million people in 319 *woredas* (Siyoum, 2012; Rahmato et al., 2013). The first phase of PSNP operated between 2005 and 2009. The second phase of the program is runs for an additional five years (2010- 2014).

Participation in the two components of the program, public works and direct support, depends on the labor endowments within the household. The public works component of the PSNP targets households endowed with labor capacity and involves contribution of labor by adult household members-over the age of 16-for building community assets (e.g. conservation structures, dams, roads, schools). The direct support component does not require labor input and it is for the elderly, disabled, sick or mentally challenged, pregnant women, lactating women and orphaned teenagers In return, beneficiaries get cash and/or food, mainly wheat and cooking oil (Berhane et al., 2011a). The public works component takes a greater share than the direct support component of the PSNP (Gilligan et al., 2008). In Tigray region, for example, 90 percent of the beneficiaries participate in the public work component while 10 percent receive direct support (Tigray Food Security Coordination office, 2009).

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<sup>1</sup> *Wereda* (district) is the next administrative unit above the *tabia* (villages) level. Within each *tabia* there can be three to four *kushets* (communities).

<sup>2</sup> 1.3% of GDP in 2010

The public works, in the form of either food-for-work (FFW) or cash-for-work (CFW), requires beneficiaries to work five days per month per household member for the period the PSNP is operational (usually six months in the agricultural slack season) (Sharp et al., 2006). The maximum number of days that a household member can work is 15 days per month (Berhane et al., 2011a).<sup>3</sup> The payment for the public work participants was initially 6 Ethiopian Birr per day in the case of CFW and 3 kg of cereals in the case of FFW. Adjustments were made for inflation over the period of the program and CFW participants received 8 birr and 10 birr per day in 2008 and 2010, respectively (Hoddinott et al., 2012). In some *weredas*, beneficiaries received a mixture of cash and food payments (Sabates-Wheeler and Devereux, 2010). Payments are not always timely or complete such that households get paid more than one month after the work (Berhane et al., 2011a). According to a report by Berhane et al. (2011a), receipt of entitled payment –calculated based on the family size and the maximum number of days entitled to work- varies by region and family size. In our study area, Tigray region, small families received up to 79 percent of their entitlement while large families received up to 60 percent (Berhane et al., 2011a).

Targeting takes place at multiple stages and the methods include both administrative and community components (Berhane et al., 2011a). Food Security Task Forces formed at the *tabia* (village) and *woreda* (district) levels together with the *tabia* and *woreda* councils undertake targeting of the PSNP beneficiaries. Eligible households are those found in the chronically food insecure *woredas*; that faced food gaps and received

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<sup>3</sup> This labor cap rule implies that an able bodied individual can work on behalf of another household member provided that it does not exceed a maximum of 15 days in a month (Berhane et al., 2011).

food aid in the three years before the start of the program; faced shocks that caused significant depletion of assets and are without any support from family or other social protection programs (Government of Ethiopia, 2009). Additional criteria for targeting include endowment of household assets (land size, food stock, and labor availability); agricultural and non agricultural income; and specific conditions of households (female-headed households, households with chronically ill members and elderly-headed households looking after orphans) (Berhane et al., 2011a).

PSNP is part of the country's Food Security Program (FSP) and its goals are to reduce the food gap of households, promote asset accumulation and prevent asset depletion (Government of Ethiopia, 2009). It is expected that the program eliminates distress sale of assets at times of shocks and hence prevent asset depletion. Further, the program plans to bring asset accumulation through its combination with another component of the FSP, namely the Other Food Security Program (OFSP). The OFSP was transformed into Household Asset Building Program (HABP) in January 2010. It includes provision of credit and extension services to PSNP beneficiaries and aims to enhance agricultural productivity, food security and support asset accumulation (Berhane et al., 2011a; Hoddinott et al., 2012). Once PSNP beneficiaries achieve improved livelihoods, in terms of consumption and asset accumulation, they are expected to graduate from the program. Graduation therefore implies that participant households exit the program once they have attained better livelihoods and become food sufficient.<sup>4</sup> The enabling factors that are complementary for households' graduation are the support from the extension workers and financial

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<sup>4</sup> In some villages, there is self-graduation of households when they gain better income earning opportunities elsewhere. However, this is a rare phenomenon.

institutions combined with the benefits from the community assets built by PSNP (Government of Ethiopia, 2009, Berhane et al., 2011a).

## *2.2 Theoretical links and recent literature on impacts of the program*

Work fare programs such as the Productive Safety Net Program, involving FFW and CFW, can have a direct impact on the investment behavior of rural households. Particularly, the income benefit from the program can translate into investment in productive assets (such as livestock) and human capital (children's education). One, the cash income from CFW can be used to purchase livestock and pay for school. Two, the food benefit under FFW frees expenses that could have been used for food and hence allows investments. Further, households are able to maintain their stocks of productive assets in form of livestock, since such programs decrease the need to sell livestock at times of shocks. Put differently, it is possible that such programs reduce vulnerability and can even help households to climb out of poverty through investment in assets (Holden et al., 2006).

Public works programs may also have an indirect effect on investment in children's education since such programs require labor contribution. On the one hand, there may be negative effect on children's schooling outcome as children may be required to take care of their parent's work at home while adults participate in the public works. On the other hand, the income effect due to the program can promote sending of children to school. If the positive outcome outweighs the negative effect, public works can alleviate intergenerational poverty by enhancing investment in human capital (Porter and Dornan, 2010).

Impact of public works programs therefore ranges from protection of households from negative consequences of shocks to crowding-in of investment and reducing

vulnerability. But, the size and even direction of some of these effects are highly context- and design-specific (Barrett et al., 2005; Hagos and Holden, 2006; Holden et al., 2006; Barrett et al., 2008).

There is a growing body of literature that investigates the impacts of Ethiopia's PSNP. One study that examined the early impacts of the PSNP was Gilligan et al. (2009) who used survey data collected in 2006 in four major PSNP regions (Tigray, Amhara, Oromiya and SNNPR). They used a retrospective approach to collect data prior to the start of the program. Their findings indicated that the program increased in consumption, prevented depletion of assets and had no effect on rates of asset growth. In relation to asset holdings, a study by Andersson et al. (2011) showed that the participation in PSNP did not increase livestock holding while the program induced greater tree planting. They based their analysis on panel data collected in 2002, 2005, 2007 and 2008 in South Wollo, Amhara Region, covering up to three years after the introduction of the program.

Berhane et al. (2011b) examined the effect of public works participation on food security, assets, transfers and non-farm activities using data from all PSNP beneficiary regions. Authors find that the program improved households' food security status, raised livestock holdings (except Tigray region), and had no effect on private transfers and start up of non-farm business. A qualitative study by Siyoum et al. (2012) described a positive link between labor availability with in public work participant households and effect on their livelihood. They found that greater percentage of labor-rich households used PSNP transfers to smooth their consumption compared to labor-sufficient and labor-poor households. Labor-rich households were able to protect their assets and invest in livestock

using PSNP transfers. The study based its analysis on survey data from 2009/2010 for one of the chronically food insecure districts in Amhara region.

Another direction of research has been on the links between PSNP and children's education and time spent on public works. Using the Young Lives survey data for the years 2002 and 2006, Woldehanna (2009) found that the program significantly reduced children's time spent on domestic work and increased girls' time spent on their studies. He also found that the public works component of the PSNP significantly increased children's time spent on paid work. In another study, Hoddinott et al. (2009) provided evidence of reduction in child labor hours spent on public works. They assessed impacts using survey data from 2006 collected in four major PSNP regions of the country (one and a half years after PSNP started). Tafer and Woldehanna (2013) used Young Lives survey data in 2002, 2006 and 2009 and found that the public work component of the PSNP decreased the time spent in school and had a positive effect of school grade for age.

Most of the above studies carried out early impact assessments, i.e., before the end of the first phase of the program. The studies that carried out impact assessment after the end of the first phase do not use baseline data to compare with outcomes after the program's implementation. This study contributes new evidence to the literature by using baseline data to compare outcomes and measure impacts from the first full phase of the program. Our data allows us to combine with-without and before-after analysis while controlling for selection into the program. In addition, this paper uniquely tries to identify the potential influence on households' potential down-sale of livestock at the end of the first phase lest graduating from PSNP. Moreover, previous studies show mixed results concerning the

effect of PSNP on livestock accumulation and children's education. This merits further empirical investigation and this paper contributes to this by examining program effects after controlling for selection.

### **3 Data and Descriptive Analysis**

#### *3.1 Field site and data*

Data for this study comes from a household panel data survey in Northern Ethiopia, Tigray region - one of the chronically food insecure regions of the country. The defining characteristics of Tigray region include occurrences of frequent droughts, limited off-farm employment opportunities, and low credit availability (Bezu and Holden, 2008). The region has a population growth rate of 2.5 percent. Approximately one third (33 percent) of the region's population and 31 out of 34 *woredas* directly benefit from PSNP (Tigray Food Security Coordination Office, 2009).

This paper extracts its data from a five round household panel survey carried out in the period 1998-2010, with two to four years intervals in between. Initially, the survey in 1998 covered a stratified random sample of 400 households in 16 villages with 25 households in each village. In 2001, 2003, 2006 and 2010, there were follow-up surveys tracking the same households. The survey included information such as basic household characteristics, land and non-land assets, land use, livestock and crop selling activities, other income sources, PSNP membership and participation, shocks and household coping strategies. More detailed shock information was collected in the 2010 survey. The entire sample for our analysis contains a balanced panel of 333 households in the years 2003 and 2010. This allows us to carry out a pre- and post-program analysis. We tested for attrition

bias based on Moffit et al. (1999) and found evidence of its existence.<sup>5 6</sup> In section four, we describe how we corrected for it.

Our main variables of interest in this study are livestock holdings (measured in tropical livestock units-TLU) and children's education. The education variable is constructed as follows: First, we took the education level of children (age between 7 and 14) relative to the age-specific average education in our sample for 2003 and 2010.<sup>7</sup> Second, we took the variable constructed in the first step and generated average education of all children within each household for each year.

### *3.2 Participation in public works and direct support at study sites*

Table 1 shows participation of sample households in the public works component of the PSNP (FFW and CFW) in each village. Levels of participation showed variation across study communities as it ranged from 17 percent (in Kihen village) to 75 percent (in Adi Selam village). On average, 47 percent of the sample households participate in public works.

Participation in direct support is low with only 43 households (13 percent) participating.

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<sup>5</sup> One out of the 16 communities (25 households) had to be dropped due to lack of cooperation in the survey. Additional attrition was due to more household-specific conditions such as migration, death and other reasons for non-availability.

<sup>6</sup> Table A1 in the appendix contains the results from the attrition bias test.

<sup>7</sup> There are five categories of education level. These are illiterate; able to read and write or church education; elementary; junior and secondary; and others. The categories took values from one to five, respectively. We used these categories in order to harmonize the differences in the way education was measured in the two survey years (2003 and 2010). We computed the age-specific average education by taking the mean of the education categories for a specific age group. For example, the average education for children aged seven in our sample (for 2003) is 1.49. If a seven year old child in a household is illiterate (taking value=1); then the relative education for the child is  $0.67(1/1.49)$ .

The highest village level participation in the direct support component is 25 percent (May Alem village).

In table 2, we present the distribution of public works participation by the gender of household head. Female-headed participant households are 37 in number comprising 39 percent of all female-headed households and 23 percent of the participant households. The male participants on the other hand take up 51 percent of male-headed households and 77 percent of the participant households. This implies that male-headed households are more likely to be participants in public works than female-headed households. Sharp et al. (2006) state that gender difference in the level of participation in the public works is due to the fact that female-headed households are more labor-poor and have fewer livelihood options. In conformity with this, our data indicate that a greater share of female-headed households have access to direct support which targets labor-poor households (see table 3). 22 percent of the female-headed households benefit from direct support while it is only nine percent of the male-headed households that receive free support.

This paper focuses on the effect of the public works component of the PSNP. PSNP public works participation appears to be cut in both ends of the wealth scale, with those too well-off on one side and those too labor-poor on the other side (direct support participants). Since it potentially leaves us with a problem of having a very heterogeneous counterfactual, we dropped direct support participants (43 households) in the empirical analysis.<sup>8</sup>

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<sup>8</sup> Another line of reasoning is that investment decisions between public work participants and direct support beneficiaries are also likely to be different due to: (1) the former receive

### *3.3 Are public works participant households different in characteristics and endowments?*

Tables 4 and 5 contain the results of a two sample t-test for differences between participant and non-participant households.<sup>9</sup> Table 4 reports test results for major variables in the base year (2003) while table 5 shows results for 2010 (five years after the program started). Our data seem to suggest that participation mainly relates to labor force endowment, household size, number of children and asset endowments. In 2003, households that later became members of the PSNP public works program are significantly younger and have more children than non-participants (see table 4). In terms of asset endowments, non-participant households on average own larger land area and are better endowed with livestock assets than participant households. The significant difference in livestock ownership, however, disappears when livestock holding is divided by land area; probably because land limits how much livestock households can accumulate. Geographical location variables do not seem to indicate significant differences between the two groups.

In 2010, the differences in the number of children and age of household head are similar to the year 2003 (see table 5). On the other hand, other demographic variables such as household size and number of literate children are significantly higher for participant households. Non-participant households continue to have significantly greater asset endowment (land and livestock) than the participants, like in 2003. One can observe in

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an earned income while the latter get free benefit, (2) the fact that the inherent characteristics between the two groups are distinct. Hence, including direct support beneficiaries in the main sample may bias our empirical result.

<sup>9</sup> Here, non-participants do not include direct support participants since they are dropped for the empirical analysis.

Tables 4 and 5 that the changes in the major variables of interest (livestock and average children's education) between the two periods are not significantly higher for participant than non-participant households. We should not, however, conclude that the PSNP has no significant effect on these variables as we have not yet controlled for other variables possibly influencing these changes; selection bias and attrition bias in the sample.<sup>10</sup>

### *3.4 How do public works participants perceive the benefits from PSNP?*

We asked public works participants to report the benefits they obtained from PSNP. They cataloged benefits from a list we provided. Figure 1 shows the list of benefits as well as the number and percentage of public works participants that obtain the benefits. Among the 158 participant households, more than 60 percent (96 in number) reported a combination of at least three of the benefits. The majority of the participants (around 87 percent) indicated that the PSNP increased the food availability for consumption in the household. This relates to the fact that PSNP provides cereals and oil under the food-for-work program (Government of Ethiopia, 2009). As reported by 63 percent of the participants, the program reduced the need to migrate during agricultural slack periods. This is probably because the program's operational period is the agricultural slack period and household members stay within villages to participate in the developmental safety net projects. Respondents also indicated that the program reduced the need to sell livestock at

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<sup>10</sup> Kernel density distributions of change in TLU (not reported) indicates that participation in PSNP has contributed to stabilize the livestock holding of participant households as compared to non-participants (less variation in change).

times of harvest failure (56 percent of participants). This is consistent with one of the objectives of the PSNP, i.e., to prevent distress sale of assets at times of shocks (Government of Ethiopia, 2009). In one of the villages (Kihen), the village development agent pointed out that PSNP has minimized the sale of livestock and migration. Ability to send children to school due to the program is reported by 44 percent of the participant households. Other benefits mentioned include increased purchase of other goods and purchase of livestock (32 and 31 percent of participant households, respectively).

## **4 Empirical Strategy**

### *4.1 Empirical Model*

In order to investigate whether the PSNP induced investment in assets, we apply an endogenous treatment effects model using full maximum-likelihood. The treatment effects model, based on Heckman's selection model (Heckman, 1979), controls for selection bias attributed to treatment assignment when estimating the average treatment effect. This method is suitable as our econometric approach due to the potential existence of unobserved factors (Brown and Mergoupis, 2010) that may determine selection into the program and that may also be correlated with outcome variables that are used to identify impacts of the program. Our modeling approach involves assessing the impact of a binary endogenous treatment variable, conditioned by a set of exogenous variables (Cong and Drukker, 2000), on the outcome variable  $Y$  (livestock endowment and children's education). We specify the model in the following form:

$$D_{it2}^* = \alpha_0 + \alpha_1 \mathbf{X}_{it1} + \alpha_2 L_{it1} + \alpha_3 G_{it1} + \alpha_4 Z_{it1} + v_i \quad (1)$$

$$D_{it2} = \begin{cases} 1 & \text{if } D_{it2}^* > 0 \\ 0 & \text{if } D_{it2}^* = 0 \end{cases} \quad (2)$$

$$Y_{it2} - Y_{it1} = \beta_0 + Y_{it1} + \beta_1 \mathbf{X}_{it1} + \beta_2 L_{it1} + \beta_3 G_{it1} + \beta_4 S_i + \beta_5 \widehat{D}_{it2} + \beta_4 C_i + \varepsilon_i \quad (3)$$

Equations (1) and (2) model the treatment assignment.  $D_{it2}^*$  in equation (1) is a latent variable conditioned by a vector of regressors that determine participation in the program. The observed value of  $D_{it2}^*$  is represented by  $D_{it2}$  in equation (2). It renders 1 for non-negative values of  $D_{it2}^*$  and zero otherwise (equation 2). The variable  $Y_i$  is our outcome variable (livestock endowment or children education) and forms the dependent variable in the second stage [equation (3)]. The dependent variable is the change in livestock ownership or children education ( $Y_{it2} - Y_{it1}$ ) between 2010 (t2=end of first five year period of PSNP) and 2003 (t1=before implementation of PSNP). In the livestock model, we alternated the end years between 2010 and 2009 to check the variation in livestock dynamics caused by the potential down sale of livestock towards the end of the first phase of the program (to avoid graduation).  $\mathbf{X}_{it1}$  is a vector containing household characteristics in 2003 (age, gender and education of the household head; endowment of female and male adult labor force; and a binary variable for any off farm income other than PSNP).<sup>11</sup>  $L_{it1}$  represent farm size in 2003 (in *tsimdi*)<sup>12</sup>;  $G_{it1}$  represents geographic variables including a dummy variable for

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<sup>11</sup> We used 2003 variables as explanatory variables in order to be able to control for pre-treatment characteristics.

<sup>12</sup> 1 *tsimdi*=2500 meter square

market access in 2003 and regional dummies<sup>13</sup>; and  $S_i$  refers to a binary variable representing whether the household faced any severe shock between 2007 and 2010.

In the model for children's education, we include labor related shocks (illness and death of a household member) to assess its effect on human capital formation. The model also has an interaction term between participation in PSNP and labor related shocks which allow assessing whether PSNP buffers the negative consequences of shocks.  $G_{it1}$  in the children's education model adds distance from the household dwelling to primary school in 2003 (in minutes). The predicted probability of participation ( $\widehat{D}_{it2}$ ), which enters the second stage in equation 3, is the variable of interest. Positive and significant values of  $\beta_5$  imply accumulation of livestock and enhanced investment in children's education attributable to the PSNP after controlling for selection bias.

To make sure that our results do not suffer from attrition bias- due to those households that dropped out when forming the balanced panel, we corrected for it following Moffit et al. (1999). First, we ran an attrition probit model where the dependent variable takes value one for those that stayed in the sample and zero otherwise. Second, we calculated the inverse mills ratio from the attrition probit and included it in the second stage.  $C_i$  in equation (3) denotes the attrition bias correction variable (inverse mills ratio). The attrition probit results showed that households with smaller land area and no off-farm income sources have higher chance to leave the sample (see table A1 in the appendix). This is probably because little land available is a push factor and access to off-farm income is a

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<sup>13</sup> Regional dummies refer to four zones from which the sample was taken.

pull factor that may have caused some households to have given up their rural base and have left the village.<sup>14</sup>

One of the limitations in our analysis is that we are unable to control for effects of PSNP's community asset developments. The community asset developed via the PSNP generates an indirect benefit for both participants and non-participants. Our study assesses only the direct benefit for targeted beneficiaries versus non-beneficiaries. This implies that we are likely to underestimate the total benefits from the program. Another limitation in this paper is that we do not control for complementary programs (OFSP/HABP). Studies carried out by Gilligan et al. (2009) and Hoddinott et al. (2012) showed that the combination of the PSNP with OFSP increases the magnitude of the program effect. Hence, we expect that our findings underestimate the effect of the program.

#### *4.2 Identification strategy*

The treatment effects model requires an identifying variable that affects the probability of being treated (participation in the public works component of the PSNP) but does not directly influence the outcome variables. We include  $Z_{it1}$  in equation (1) as an instrumental variable to identify the second stage regression. In the livestock model,  $Z_{it1}$  represents agro-ecological zones in the sampled villages. We argue that this variable affects the likelihood of households' participation in the program but does not directly affect investment in livestock. Livestock are equally important in all agro-ecological zones while the program is

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<sup>14</sup> We rely on the non-linearity of the attrition probit model to identify it in the outcome equation since we lack instruments. Our results showed that the attrition bias correction variable (inverse mills ratio) is statistically insignificant in the outcome models. Hence, we are less concerned about the attrition problem.

likely to include more households in locations with more adverse agro-climatic conditions.  $Z_{it1}$  in the children's education model is the age of the household head in the base year (2003). While the head's age affects the probability of participation, we assume it does not directly influence the decision to invest in children's education. We carried out likelihood ratio tests to check the validity of the exclusion restrictions by taking the following steps. First, we estimated the main model; second, we included the instrument in the second stage of the main model and ran a second regression; and third, we employed the likelihood ratio test. The instruments satisfied the exclusion restriction, i.e., the equations are identified and the likelihood ratio test did not detect any significant correlation between the instruments and the outcome errors.<sup>15</sup>

## 5 Results

### 5.1 *Does the PSNP help households to accumulate more livestock?*

Table 6 summarizes the results from the treatment effects model with change in livestock holding as the dependent variable. Models 1A and 1B in the table test whether the program allowed households to accumulate livestock at the end of the first phase of the PSNP. While Model 1A uses 2009 as an end year, Model 1B uses 2010 as an end year.

Results in the first stage probit regression (measuring the probability of participation) indicate that households headed by older individuals are less likely to participate in the program. The coefficient is significant at 10 percent level of significance. A plausible explanation is that as the age of the household head increases, chances are that the individual becomes less able to participate in the public work component of the

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<sup>15</sup> See table A2 in the appendix.

program. This is consistent with the targeting criteria in the public works. Old age may also mean asset accumulation and hence less dependence on the support overall.

The second stage estimates in Table 6 portray that participation in the public works component of the PSNP enhanced accumulation of productive assets in the form of livestock. The positive and significant coefficient (at 10% level) for the predicted value of public works participation demonstrates this. As can be seen in Models 1A and 1B, participant households had 2.68-2.69 TLU larger increase in livestock holding compared to the non-participant households over the period under consideration after correcting for selection bias and attrition bias. Our results are significantly different from a study conducted by Andersson et al. (2011) using panel data from South Wollo zones of Amhara Region in Ethiopia. They found no significant improvement from PSNP participation on livestock holdings in their study area. Berhane et al. (2011b) also reported that the program did not enhance livestock accumulation in Tigray region. The different finding in our analysis may be due to the differences across locations or the fact that we are able to control for selection bias due to unobservable factors.

One noticeable finding in Models 1A and 1B is that one TLU unit increase in the initial livestock endowment in 2003 reduced the growth in the livestock endowment by 0.48-0.57 TLU in the period 2003-2009/10. This is probably due to the diminishing returns to investment in livestock attributed to the land/fodder constraint. Households with larger male labor force had a significantly higher growth in their livestock holding (Model 1B). On the other hand, larger female labor force endowment (Model 1A and 1B) and female-headship (Model 1B) did not seem to encourage livestock accumulation. It may be that male

labor is more involved in rearing livestock while females are more involved in other activities such as household chores, collection of water and firewood.

Information about graduation plans for PSNP spread in 2010. This may have resulted in some strategic reactions among PSNP participants in their livestock accumulation behavior in order to avoid graduation from the program. In our survey, we observed that 17 households had sold substantial amounts of livestock from 2009 to 2010, of which 13 are participants in PSNP. This constitutes four percent of the sample households and eight percent of PSNP participant households (13 out of 158).<sup>16</sup> We expected results to be different when considering the two time periods in Models 1A and 1B. Contrary to our expectation, it was not sufficient to change the basic effect of the PSNP on livestock accumulation since findings are consistent in Models 1A and 1B. The negligible difference in the coefficient for predicted public work participation in the two models shows that the extent of down sale did not significantly affect the conclusion of our study.

In order to investigate the livestock accumulation pattern closely, we ran separate regressions for participant and non-participant households.<sup>17</sup> We then plotted the predictions from the regression for the two groups. For this part of the analysis, we included the initial survey year (1998) and formed a balanced panel for the three periods

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<sup>16</sup> In order to see if this affected our econometric analysis, we checked whether those that sold significant number dropped out of our sample in forming balanced panel. Our data indicates that most of these households (17 out of 21 households) still appear in our balanced panel.

<sup>17</sup> Regression results can be obtained from authors upon request.

(1998, 2003 and 2010). Figure 2 shows the livestock endowment pattern for participants and non-participants in the years 1998, 2003 and 2010. In conformity with the regression results in table 6, the figure indicates that participant households showed better accumulation of livestock assets, after joining the PSNP. In sum, findings suggest that the program allowed households to accumulate livestock assets and/or protected against distress sales of livestock over the period under consideration.

## *5.2 Has the PSNP led to more investment in children's education?*

We test the impact of the PSNP on children's education in Model 2. Table 7 contains results for Models 2A and 2B by taking the change in the average education level of children (age group of 7-14) within the household as a dependent variable. Model 2A forms the initial model without including an interaction term. Model 2B expands from Model 2A by incorporating an interaction term between labor shock and PSNP participation. Estimation results in both models are consistent in terms of sign and significance of the other variables.

Results in Table 7 reveal that PSNP beneficiaries invest more on their children's education than non-beneficiaries. The point estimate for PSNP participation, which is significant at 10% level, shows that the average children's education increased more for the participant households than for the non-participant households. Children in participant households have 0.43-0.48 units larger increase in their average education level compared to children in the non-participant households, on average. This finding suggests that beneficiary households are enabled to send their children to school, indicating an indirect benefit that public works participants obtain. Our result is consistent with findings in a previous study by Hoddinott et al. (2009). Their study, which focuses on the four major

PSNP regions (Tigray, Amhara, Oromiya and SNNP), finds that the program decreased child labor hours spent on public works. In our data, approximately 44 percent of the participant households reported that they were able to send their children to school due to the PSNP.

A notable finding is that the increment in educational investment is lower for households with higher initial education level of children in 2003. The negative and highly significant coefficient (at 1% level of significance) for average children's education in 2003 confirms this finding. PSNP therefore appears to particularly have encouraged children's education in households with more education-poor children. This may be associated with the limits to how much more education can be obtained for children in this age group. Results also indicate a positive correlation between the maximum education level achieved by adults in the households and the level of investment in children's education. The more educated the adults are, the higher average education of children within the household.

One would expect lower schooling outcomes as a result of labor shocks (such as illness and death). In line with this, our findings in table 7 indicate that households that faced labor shock (illness and death) showed a lower increase in the average education of children, *ceteris paribus*. This, however, was to a less extent the case for participant households. The coefficient estimate for the interaction term between program participation and labor shock dummy, which is positive and significant at five percent level, demonstrates this. Participant households showed significantly less negative effect;  $(-0.35+0.25=-0.10)$ ; on children's education in the face of labor shocks compared to the non-participant households that experienced the same type of shocks. An implication is that the program to a large extent neutralized the negative impact of labor-related shocks on

investment in children's education. This finding is similar to the finding of de Janvry et al. (2006) showing that a conditional cash transfer program in Mexico reduced the need to take children out of school at times of shocks.<sup>18</sup>

To closely inspect the change in children's average education, we plotted the predictions of separate regressions for participants and non-participants (see Figure 3).<sup>19</sup> Again, we included the initial survey year (1998) to examine the pattern of change. One can clearly observe that participants showed an improvement in the children's average education compared to the non-participants. In general, participant households seem to have invested significantly more on children's education than non-participants after the introduction of PSNP.

## **6 Conclusion**

This study examined the impact of Ethiopia's Productive Safety Net Program on livestock asset accumulation and investment in children's education during the first five years of the program. It used two rounds of panel data from rural households in Northern Ethiopia, Tigray region. By using treatment effects model, which controls for selection bias due to unobservable factors, we found that the program stimulated livestock accumulation among PSNP beneficiary households as compared to non-beneficiary households, after correcting for attrition bias in the sample. Results show diminishing returns to livestock accumulation

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<sup>18</sup> Since the decisions to invest in children's education and livestock are potentially interdependent, we carried out an additional robustness test by including livestock holding (2003) in both stages of Model 2 (not reported). The estimates for children's education did not change significantly and TLU was statistically insignificant.

<sup>19</sup> Regression results can be obtained from authors upon request.

since households with low initial livestock endowments accumulate more livestock. An explanation for this is the scarcity of land and/or fodder that is mostly obtained from households' private land. Importantly, results show that the potential down sale of livestock- to avoid graduation from the program-did not significantly reduce the positive impact of the program on livestock accumulation.

Findings reveal that participant households invested more on their children's education than the non-participants, after controlling for selection into the program and the level of children's education before entering the program. There seems to be an indirect benefit gained from participating in public works in terms of the promotion of human capital formation and particularly so for households with children lagging behind in their level of education. Study results also showed that labor-related shocks like illness and death are negatively correlated with investment in children's education. Public work participant households who faced these shocks, however, were significantly less negatively affected in terms of children's education than non-participant households, also demonstrating the safety net effect of the program. This indicates that the negative consequence of the shocks to a less extent hindered participant households from sending their children to school.

In general, the program has allowed asset accumulation and served as a safety net for participant households who would have become worse off without the program. Given the findings that the program buffered households against shocks (in terms of reduced destocking of livestock and lower need to take children out of school), an issue of concern is the sustainability of the effectiveness of the program in terms of providing long-term investment opportunities to the participants when the program phases out. At the time

when the program phases out or households graduate from the program, there is a need to ensure that supporting schemes such as credit access and non-farm employment opportunities are created which then create investment opportunities to vulnerable poor rural households.

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Table 1: Participation in public works by village

Village	Public Works				
	Non-				Total
	Participants		Participants		
	#	%	#	%	#
Adi Menabir	15	71	6	29	21
Adi Selam	6	25	18	75	24
Asmena	9	39	14	61	23
Dibdibo	13	59	9	41	22
Genfel	13	62	8	38	21
Hadegti	14	67	7	33	21
Hagereselam	14	58	10	42	24
Kihen	19	83	4	17	23
Mahbere Genet	8	32	17	68	25
May Adrasha	12	71	5	29	17
May Alem	6	30	14	70	20
May Keyahat	6	26	17	74	23
Samre	13	59	9	41	22
Seret	12	50	12	50	24
Tseada Ambora	15	65	8	35	23
Total	175	53	158	47	333

Note: Participation variable is for the survey year 2010 which is considered as a measure of participation between the years 2005-2010(i.e., the first phase).

Table 2: Participation in public works by gender

Sex of Household Head	Public works participation				
	Non- Participants		Participants		Total
	#	%	#	%	#
Male	117	49	121	51	238
Female	58	61	37	39	95
Total	175		158		333

Table 3: Participation in direct support by gender

Sex of Household Head	Direct Support participation				
	Non-Participants		Participants		Total
	#	%	#	%	#
Male	216	91	22	9	238
Female	74	78	21	22	95
Total	290		43		333

Table 4: Mean values of household characteristics and endowments (2003) for public works participants and non participants (2010)

Variables(2003)	Non-Participants	Participants	t-tests
<i>Household Characteristics</i>			
Household head age	53.9 (1.24)	50.8 (1.09)	<b>1.91</b>
Household head sex(1=female)	0.27 (0.04)	0.28 (0.04)	-0.11
Head's education(1=literate)	0.37 (0.04)	0.35 (0.04)	0.41
Household size	5.30 (0.20)	5.65 (0.18)	-1.32
Number of children	2.31 (0.13)	2.70 (0.13)	<b>-2.09</b>
Number of adult females	1.26 (0.06)	1.39 (0.06)	-1.42
Number of adult males	1.42 (0.10)	1.32 (0.08)	0.74
Number of educated children	0.81 (0.08)	0.85 (0.07)	-0.33
Average education of children	1.03 (0.04)	1.01 (0.04)	0.33
<i>Endowments</i>			
Land area( <i>tsimdi</i> ) <sup>a</sup>	5.43 (0.33)	4.32 (0.23)	<b>2.83</b>
Number of oxen	1.01 (0.09)	0.78 (0.07)	<b>2.10</b>
Number of oxen per land area	0.23 (0.03)	0.23 (0.03)	-0.14
TLU	3.14 (0.30)	2.33 (0.20)	<b>2.32</b>
TLU per land area	0.69 (0.08)	0.66 (0.07)	0.31
<i>Geographical Location(walking minutes)</i>			
Distance from primary school	36.5 (3.25)	30.8 (2.09)	1.53
Distance from secondary school	131.6 (8.55)	121.1 (8.30)	0.88
Number of observations	132	158	

<sup>a</sup> 1*tsimdi*=0.25 ha. <sup>b</sup> Note: Standard errors in parenthesis.

Table 5: Mean values of household characteristics and endowments (2010) for public work participants and non-participants (2010) (After completion of first phase of PSNP)

Variables(2010)	Non-Participants	Participants	t-tests
<i>Household Characteristics</i>			
Household head age	56.2 (1.16)	54.0 (1.09)	1.42
Household head sex (1=female)	0.28 (0.04)	0.23 (0.03)	0.90
Head's education (1=literate)	0.33 (0.04)	0.29 (0.04)	0.63
Household size	5.11 (0.22)	5.70 (0.16)	<b>-2.19</b>
Number of children	1.90 (0.15)	2.25 (0.13)	<b>-1.74</b>
Number of adult females	1.42(0.07)	1.56 (0.07)	-1.34
Number of adult males	1.49 (0.10)	1.59 (0.10)	-0.71
Number of literate children	0.98 (0.09)	1.26 (0.08)	<b>-2.29</b>
Average children's education	1.01 (0.03)	1.06 (0.02)	-1.21
<i>Endowments</i>			
Land area( <i>tsimdi</i> ) <sup>a</sup>	5.19 (0.33)	3.87 (0.23)	<b>3.36</b>
Number of oxen (2010)	1.23 (0.09)	0.95 (0.07)	<b>2.55</b>
Number of oxen per land area (2010)	0.34 (0.04)	0.32 (0.03)	0.53
TLU (2010)	3.70 (0.27)	2.53 (0.16)	<b>3.83</b>
TLU per land area (2010)	1.05 (0.11)	0.86 (0.07)	1.44
Number of oxen (2009) <sup>c</sup>	1.53 (0.12)	1.17 (0.08)	<b>2.56</b>
Number of oxen per land area (2009) <sup>c</sup>	0.44 (0.05)	0.39 (0.04)	0.90
TLU (2009) <sup>c</sup>	4.45 (0.31)	3.19 (0.21)	<b>3.45</b>
TLU per land area (2009) <sup>c</sup>	1.31 (0.16)	1.11 (0.09)	1.11
<i>Geographical Location (walking minutes)</i>			
Distance from primary school	28.5 (1.58)	29.4 (2.00)	-0.34
Distance from secondary school	107.6 (7.29)	103.2 (6.59)	0.45
<i>Shocks in past years</i>			
Any severe shock (2007-2010)	0.62 (0.04)	0.63 (0.04)	-0.20
Any labor related shock (2007-2010)	0.11 (0.03)	0.18 (0.03)	<b>-1.72</b>
<b>Number of observations</b>	132	159	

<sup>a</sup> 1*tsimdi*=0.25 ha. <sup>b</sup> Note: Standard errors in parenthesis. <sup>c</sup> Livestock endowment for 2009 based on recall.

Table 6: Impact of PSNP Public Works on Livestock Holdings

	Model 1A (2009-2003)	Model 1B (2010-2003)
<i>Change in Tropical Livestock Units</i>		
Tropical Livestock Unit 2003	-0.48 (0.10)***	-0.57 (0.09)***
Age of Household Head 2003	0.02 (0.02)	0.01 (0.02)
Female-headed household 2003	-0.58 (0.57)	-0.79 (0.44)*
Education of head 2003 (1=literate)	-0.07 (0.42)	0.26 (0.36)
Land area in Tsimdi 2003 <sup>a</sup>	0.11 (0.08)	0.09 (0.08)
Number of adult females 2003	-0.55 (0.29)*	-0.71 (0.21)***
Number of adult males 2003	0.30 (0.21)	0.37 (0.16)**
Number of children 2003	0.24 (0.15)	0.13 (0.13)
Any very severe shock 2007-2010 (1=Yes)	-0.58 (0.40)	-0.50 (0.37)
Any off-farm income 2003 (1=Yes) <sup>b</sup>	0.06 (0.51)	-0.13 (0.39)
Access to a major market 2003 (1=Distant)	-0.60 (0.49)	-0.54 (0.37)
Public works participant	<b>2.69</b> <b>(1.54)*</b>	<b>2.68</b> <b>(1.60)*</b>
Zone 1	-2.38 (0.89)***	-2.10 (0.85)**
Zone 2	-0.96 (0.62)	-1.43 (0.52)***
Zone 3	-1.03 (0.84)	-1.63 (0.70)**
Constant	1.63 (1.95)	2.27 (1.65)
<i>Public Works Participation 2010 (1=Participant)</i>		
Age of Household Head 2003	-0.01 (0.01)	-0.01 (0.01)*
Female-headed household 2003	-0.07 (0.24)	-0.09 (0.23)
Education of head 2003 (1=literate)	-0.08 (0.21)	-0.18 (0.20)

Table 6 continued		
Land area in Tsimdi 2003 <sup>a</sup>	-0.01 (0.04)	-0.02 (0.04)
Number of adult females 2003	0.13 (0.12)	0.16 (0.12)
Number of adult males 2003	-0.08 (0.09)	-0.06 (0.09)
Number of children 2003	0.04 (0.07)	0.05 (0.07)
Any very severe shock 2007-2010 (1=Yes) <sup>c</sup>	0.30 (0.20)	0.33 (0.21)
Any off-farm income 2003 (1=Yes) <sup>b</sup>	-0.15 (0.21)	-0.14 (0.20)
Access to a major market 2003 (1=Distant)	-0.13 (0.19)	-0.07 (0.18)
Tropical Livestock Unit 2003	-0.03 (0.04)	-0.04 (0.04)
Zone 1	1.13 (0.29)***	1.15 (0.33)***
Zone 2	0.61 (0.26)**	0.62 (0.26)**
Zone 3	0.85 (0.26)***	0.87 (0.27)***
Agro ecological zones [1=kola (dry)] <sup>d</sup>	-0.62 (0.24)***	-0.53 (0.21)**
Constant	0.29 (0.62)	0.31 (0.59)
Observations	290	290
Log likelihood	-839.87	-763.69
Wald chi2	9.40	18.88
P-value	0.00	0.00
Anthro <sup>e</sup>	-0.97 (0.49)**	-1.30 (0.63)**
Lnsigma	1.08 (0.11)***	0.91 (0.10)***
Attrition bias correction (Inverse Mills Ratio) <sup>f</sup>	-1.65 (2.41)	-1.22 (2.02)

\* Significant at 10%; \*\* significant at 5%; \*\*\* significant at 1% Note: Bootstrapped standard errors in parentheses (400 replications) <sup>a</sup> 1tsimdi=0.25 ha <sup>b</sup> Off farm income excludes FFW/CFW income, <sup>c</sup> Second stage variables included as a control, <sup>d</sup> Instrument <sup>e</sup> Anthrho is the variable that tests and corrects for standard selection bias, <sup>f</sup> Attrition bias correction for households that dropped out of the sample.

Table 7: Impact of PSNP Public Works on Children's Education

	Model 2A	Model 2B
<i>Change in average children's education (2010-2003)</i>		
Average children education 2003	-0.97 (0.06)***	-0.97 (0.07)***
Female-headed household 2003	-0.21 (0.12)*	-0.21 (0.11)*
Education of head 2003 (1=literate)	-0.03 (0.06)	-0.04 (0.06)
Maximum level of adults' education 2003 <sup>a</sup>	0.03 (0.01)**	0.03 (0.01)**
Land area in Tsimdi 2003 <sup>b</sup>	0.01 (0.01)	0.01 (0.01)
Number of adult females 2003	0.00 (0.03)	0.01 (0.04)
Number of adult males 2003	-0.05 (0.03)	-0.05 (0.03)
Number of children 2003	-0.05 (0.03)*	-0.05 (0.03)*
Any labor shock 2007-2010 (1=Yes)	-0.18 (0.08)**	-0.35 (0.11)***
Any labor shock*public work participation		0.25 (0.11)**
Any off-farm income 2003 (1=Yes) <sup>c</sup>	0.08 (0.07)	0.07 (0.07)
Access to a major market 2003 (1=Distant)	-0.07 (0.06)	-0.07 (0.06)
Distance from primary school 2003 (hours)	-0.04 (0.07)	-0.05 (0.07)
Zone 1	-0.03 (0.11)	-0.02 (0.10)
Zone 2	0.18 (0.06)***	0.17 (0.07)***
Zone 3	-0.05 (0.11)	-0.05 (0.10)
Public works participant	<b>0.48</b> <b>(0.25)*</b>	<b>0.43</b> <b>(0.21)**</b>
Constant	1.02 (0.23)***	1.07 (0.23)***
<i>Public work participation (1=Participant)</i>		
Age of Household Head 2003	-0.03 (0.02)*	-0.03 (0.02)*

Table 7 continued		
Female-headed household 2003	0.63 (4.17)	0.61 (0.66)
Education of head 2003 (1=literate, 0=otherwise)	-0.20 (0.37)	-0.25 (0.40)
Land area in Tsimdi 2003 <sup>b</sup>	-0.03 (0.06)	-0.03 (0.05)
Number of adult females 2003	0.27 (0.23)	0.28 (0.22)
Number of adult males 2003	0.04 (0.16)	0.06 (0.16)
Number of children 2003	0.13 (0.14)	0.13 (0.12)
Zone 1	0.79 (0.58)	0.82 (0.56)
Zone 2	0.21 (0.45)	0.21 (0.42)
Zone 3	0.98 (0.49)**	0.98 (0.47)**
Any labor shock 2007-2010 (1=Yes) <sup>d</sup>	0.70 (0.51)	0.82 (0.48)*
Any off-farm income 2003 (1=Yes) <sup>c</sup>	-0.36 (0.31)	-0.35 (0.30)
Access to a major market 2003 (1=Distant)	-0.30 (0.36)	-0.29 (0.37)
Constant	0.95 (1.18)	1.07 (1.26)
Observations	162	162
Log likelihood	-89.80	-87.56
Wald chi2	5.55	5.45
P-value	0.02	0.02
Anthro <sup>e</sup>	-1.28 (0.82)	-1.23 (0.73)*
Lnsigma	-1.15 (0.13)***	-1.18 (0.13)***
Attrition bias correction (Inverse Mills Ratio) <sup>f</sup>	-0.10 (0.33)	-0.12 (0.41)

\* Significant at 10%; \*\* significant at 5%; \*\*\* significant at 1% Note: Bootstrapped standard errors in parentheses (400 replications). The number of observations shrank to 162 because there were households that did not have children (between age 7 and 14) in both periods (2003 and 2010). Average education, distance from primary school and maximum level of adult education are included in the first stage so that the same variables are controlled for in both stages (except the instrument).

<sup>a</sup> 1tsimdi=0.25 ha <sup>b</sup> The education level categories are illiterate; able to read and write or church education; elementary; junior and secondary; and others. The categories took values from one to five, respectively. <sup>c</sup> Off farm income excludes FFW/CFW income, <sup>d</sup> Second stage variables included as a control, <sup>e</sup> Anthrho is the variable that tests and corrects for standard selection bias <sup>f</sup> Attrition bias correction for households that dropped out

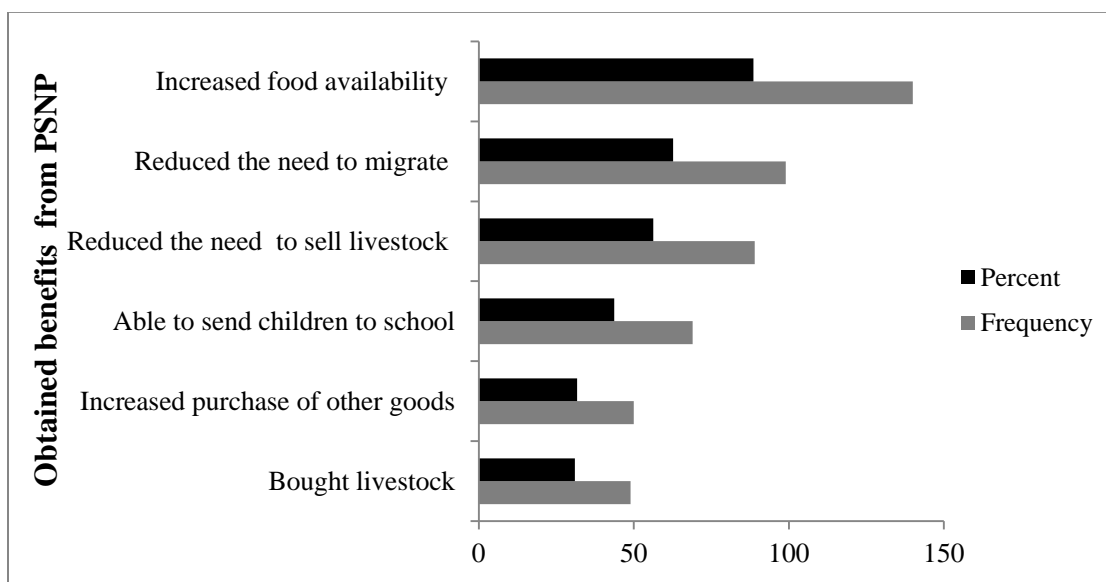


Figure 1: Obtained benefits from PSNP among public work participant households

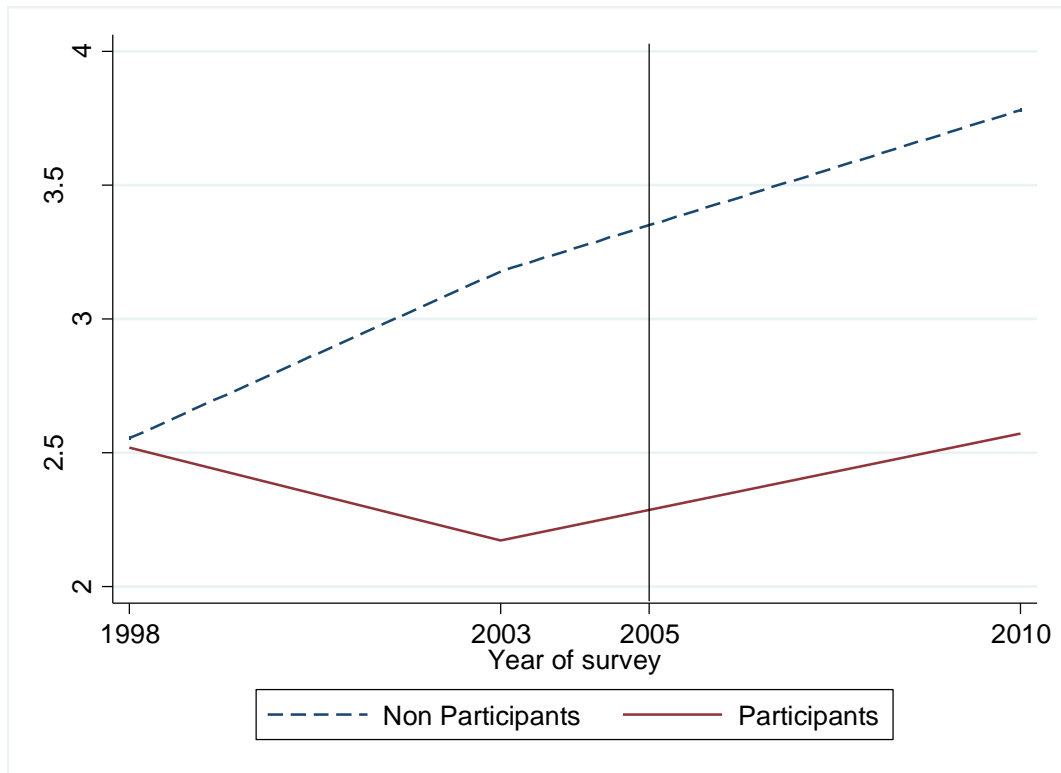


Figure 2: Predicted TLU (1998, 2003 and 2010) for Participants versus Non Participants

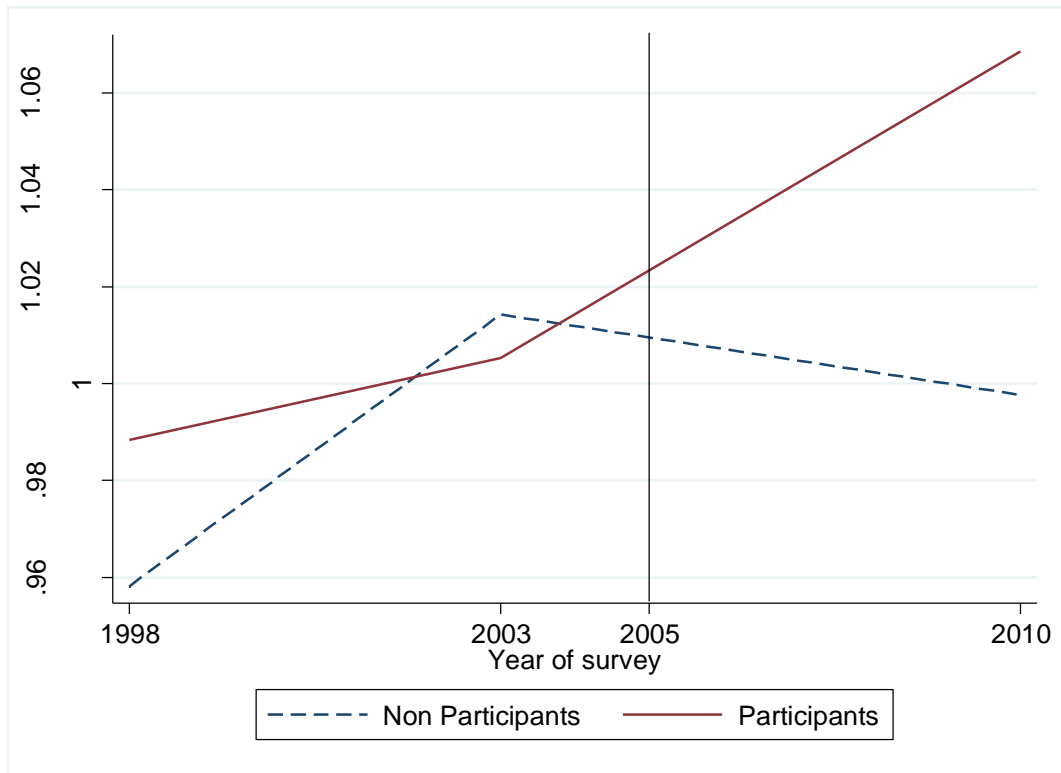


Figure 3: Predicted average children education (1998, 2003 and 2010) for participants versus non participants

## Appendix

Table A1: Test for Attrition bias

	Probit Model
<i>Attrition Dummy(1=stayers)</i>	
Tropical Livestock Unit 2003	- 0.04(0.04)
Age of Household Head 2003	0.01(0.01)
Female-headed household 2003	0.46(0.34)
Household head's any education (1=literate) 2003	0.17(0.28)
Household size 2003	0.07(0.11)
Number of children 2003	0.01(0.15)
Land Area on certificate in <i>tsimdi</i> (log) 2003	- 0.43(0.24)*
Any off farm income <sup>a</sup> (1/0) 2003	- 0.44(0.25)*
Zone 1	0.53(0.34)
Zone 2	0.86(0.37)**
Zone 3	0.70(0.35)**
Observations	353
Log likelihood	-67.03
LR chi2	19.61
P-value	0.05

\* Significant at 10%; \*\* significant at 5%; \*\*\* significant at 1% <sup>a</sup> Standard errors in parentheses  
This regression does not contain one village where survey respondents refused to be interviewed due to religious reasons.

Table A2: Likelihood ratio test results for exclusion restrictions

Models	LR chi2	P-value
<i>Model 1</i>		
Model 1A	1.50	0.47
Model 1B	0.45	0.50
<i>Model 2</i>		
Model 2A	0.08	0.78
Model 2B	0.13	0.72

Note: These test results are for the models presented in Table 6(Model 1) and Table 7 (Model 2).