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By

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Abstract

Although development intervention programs can have far-reaching impacts beyond their stated objective, there have been few careful studies of unintended outcomes of such programs. This study assesses the impact of Ethiopia's Productive Safety Net Program (PSNP) on household size and dependency ratio using the difference in differences method based on a panel data of four rounds over 12 years. Results show that member households in the PSNP have built a larger household size and dependency ratio than non-member households. These results are not only unintended by program designers but also worrisome as they potentially jeopardize the viability of the program in achieving its stated objective of enabling member households come out of poverty.

Keywords: Household size, consumer to worker ratio, safety nets, difference in differences

JEL codes: I38, O35.

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1. Introduction

Ethiopia has been suffering from recurring droughts and various other shocks that made the country languish in a persistent food insecurity problem. As a result of this, the country has been one of the top aid receiving countries in the world (Little, 2008, Abdulai et al., 2005). Aid has been coming in the form of relief to affected sections of the society for a long period of time though later there were efforts to link aid with rehabilitation of natural resources by means of the food for work (FFW) program (MoARD, 2015)[2]. Through FFW programs affected people were given aid for working on rehabilitation of mostly forests and degraded lands. Most of the FFW programs before the Productive Safety Net Program (PSNP), however, lacked predictability as they came usually as reactions to drought and other shocks. Other forms of FFW programs aimed primarily at building specific investments such as soil and water conservation structures and irrigation dams. The Government of Ethiopia, therefore, started to look for ways of using aid proactively as a means of not only enabling food insecure households get food during the lean periods of the year, but also as a means to enable these households achieve food security and more permanently escape poverty through asset building (MoARD, 2010). The PSNP is the result of this endeavor. The most important innovation of this program is that it provides a guaranteed access for households to FFW/cash for work (CFW) and free food access (FFA) to the labor deprived sections of the society for a period of five years.

Ethiopia has been implementing the PSNP since 2005 as a response to chronic food insecurity in rural areas and targeted chronically vulnerable areas and households. The PSNP program has two modalities; the public works (FFW/CFW) and direct support (FFA) programs (Gilligan et al., 2009).

[2] Ministry of Agriculture and Rural Development

There are studies on the impact of the PSNP on household food security, consumption and poverty (Gilligan et al., 2009, Nega et al., 2010, Holden et al., 2006, Bishop and Hilhorst, 2010, Debela and Holden, 2014). Other studies assessed impact on access to credit, modern farming techniques, non-farm business activities, asset accumulation and economic growth (Alderman and Yemtsov, 2013, Gilligan et al., 2009, Sabates-Wheeler and Devereux, 2013, Andersson et al., 2011, Debela et al., 2015). There is also a study on the impact of the PSNP on land-related investment by farmers (Adimassu and Kessler, 2015) while other studies have tried to delve into the issue of graduation from the PSNP (Sabates-Wheeler and Devereux, 2013, Arega, 2012). However, to the best of our knowledge, there has not been any study on the impact of this program on the household size and dependency ratio.

Public intervention programs such as the PSNP are expected to have both direct and indirect effects on behaviour and capabilities of households (Sadoulet et al., 2001). Some of the impacts can be unintended when the program was designed. Most of the public intervention programs, when they are conceived, aim at altering capacity of households with a view to enable them move out of poverty (Solomon et al., 2012). Nevertheless, it cannot be ruled out that such programs may also end up in related but unanticipated outcomes.

Household size can increase or decrease over time depending on births, deaths and migration of members. While birth of a new household member increases the household size, migration and death of members will decrease it. Tangled with this, the dependency ratio of the household too will vary. The interaction of these factors over time can be viewed from the perspective of Chayanov's development cycle of peasant households(Chayanov 1925). This development cycle begins with marriage of the new couple, followed by child bearing, rearing, and finally leaving of the grown up children to start their own original family. In this development cycle, household size

and the consumer to worker ratio (dependency ratio)[3] are expected to be smaller at the early and late years of the couple's cycle while it will be larger in their mid-years. There are many factors, which in turn determine the extent of new births, migration and death of household members. One important factor which determines all these three forces is the economic ability of the household to take care of more children, to maintain a given household size (avoid forced migration) and possibly to avoid premature death of members due to avoidable diseases. The PSNP comes into play regarding household size and dependency as it affects the economic ability of the household.

The public works component of the PSNP provides households with income and at the same time requires them to work on community asset building programs. On the one hand, the eligibility to be a member of the PSNP and the decision as a member on the amount of time to spend on public works depends on the size of the household (the consumption need of the household plus the ability to work). On the other hand, the PSNP provides them with access to food/cash payment which depends on the size of the household itself and which in turn enables it to feed and maintain a larger household size. Thus, there is a possibility for households to condition their choice of household size based, among other things, on what they get or expect to get from the PSNP and the level of disutility (drudgery) that comes due to work in the public works program. The desire to have a larger household and the increased ability to maintain a larger family due to the food/cash income from public works may lead to PSNP member households building a larger household size than they otherwise would have. This may lead to a higher dependency ratio in member households. The relation between the dependency ratio in the household and membership in the

[3] This ratio is computed by dividing the total number of household members adjusted for consumption equivalent to the total number of productive members of the household.

public works could be tricky, as a larger dependency ratio may have also affected selection into the program.

This study sets out to assess whether the PSNP, which promises continuous support to households over a number of years, potentially enables households to build a larger household size and a larger dependency ratio that can contribute to enhance the dependency on PSNP and undermine its purpose to reduce vulnerability and dependency. More specifically this study raises and tries to answer the following two research questions.

- Does PSNP membership lead to larger household size among member households?
- Does PSNP membership lead to a higher dependency ratio in the household?

This study is important at least on three grounds. Firstly, it tries to investigate a potential unintended impact that may undermine the longer-term benefits of the program and as such, it provides insights for future designing of similar programs. Secondly, it tries to see how the PSNP has affected household size and dependency ratio in households. These issues have not been examined so far in spite of the pivotal role they may play in determining the overall impact of this and other similar programs. Thirdly, this study employs a rigorous impact assessment method, which controls for endogeneity of selection into the program and uses a household panel data of four rounds running between 2003 and 2015 containing member and non-member households. This allows identification of this type of longer-term impact of the program.

2. Theoretical Framework

A common approach in analyzing rural household decision-making is to use agricultural household models. In such models, households are both utility maximizing consumers and profit maximizing producers of agricultural goods and they typically face imperfect markets (de Janvry and Sadoulet,

2006b). Theoretically, households are believed to be maximizing their utility to which larger household size is expected to contribute positively. This is true since having more members in the household not only leads to psychological satisfaction but also because there is a possibility of economic benefit from a larger household.

Having a larger household, on the other hand, has also a higher implicit cost of maintaining it. The cost of maintaining a household involves monetary costs of taking care of the needs of dependent members in the form of food, clothing etc., as well as labour costs. The labour costs refer to the amounts of labour needed to provide members of the household with their needs. This cost will be higher for households that realize an increase in the dependency ratio.

Rural households in Ethiopia tend to have a larger household size for both its utility and its economic value. A larger household has a positive contribution to utility as socio-cultural values have shaped peoples' perceptions in a way that favours having more members and staying together. Staying together in this context can be taken as a source of utility and the utility gained from this can be termed 'happiness of staying together'. With larger household size, there can also be the benefit of economies of scale in consumption due to sharing of household public goods (Deaton and Paxson, 1998). There is also an additional economic benefit of maintaining a large household if the household possesses the resources to make productive use of its members. Children and relatives can help in agricultural activities of the household and boost income or some can be sent for education and serve as future sources of additional income in the form of remittance or can serve as future insurance. The insurance can be support for the parents when they become old (a sort of pension). Especially for households who are participating in the public works component of the PSNP, larger household size means that they can work for more hours in the program and get more payment.

Therefore, it can be argued that household size on the one hand increases utility of the household and on the other increases the resource burden of the household. Thus, households face a case of trade-off between benefits of having a larger household size and the additional costs that come with it. Therefore, technically the choice of household size affects both the objective function (household utility) and the constraints of the household (full income constraint). The optimization problem of the household can now be modelled as follows based on(de Janvry and Sadoulet, 2006)

The household maximizes utility by consumption of goods and maintaining as large a household as it can. The household is assumed to have a minimum subsistence level of consumption (C_m) which it needs to satisfy always. This minimum subsistence level of consumption is a function of household size itself. Access to PSNP is expected to enable the household to satisfy its subsistence level of consumption even in the face of shocks to agricultural production. This in turn enables PSNP member households to maintain their household size even when there are such shocks. For households who do not have access to PSNP, one coping response to such shocks can be to send away family members (outmigration due to the push factor of food shortage). This outmigration may be permanent or temporary (an empirical issue). It is also possible that PSNP membership facilitates giving birth to and the survival of children. (The details of the model are shown in Appendix A).

Based on the discussion so far, we set out to test the following four major hypotheses regarding impact of PSNP on household size.

- ***Hypothesis 1a.*** *Ceteris-paribus, household size of PSNP member households will increase more over time than for non-member households*

- ***Hypothesis 1b.*** *This effect is expected to be strongest in the first phase of the program (2005-2010)*

This is expected to hold because during the first stage of the program which runs from 2005 to 2009 participating households know that they will be able to remain in the program for all the five years. Definite membership in the program, then, enables households to avoid forced migration of members as they will be able to feed them.

- ***Hypothesis 2.*** *Household size of PSNP member households is stagnant or declining in the second phase of the program (2010-2015)*

During this period emphasis had been placed on graduation of participants and it had been publicly stated that the program will phase itself out by 2015 enabling all participating households to graduate. This information at the start of the program and the implementation of graduation of members in the second phase of the program will force households to look into other means of survival. One such means of survival can be migration of youth members of the household and household heads in some instances.

- ***Hypothesis 3.*** *PSNP membership has contributed to an increasing dependency ratio in member households.*
- ***Hypothesis 4.*** *Households with higher dependency ratio were more likely to become members of PSNP*

An increase in household size may be due to having more children and PSNP membership may enable households to have more children, which will increase the consumer to worker (dependency) ratio. There is also a possibility for households with larger dependency ratio to be poorer and hence they may have been more likely to be found eligible to become members of the

3. Overview of Ethiopia's PSNP and Review of Studies on it

3.1. Objectives and Administrative Organization of PSNP

The PSNP program in Ethiopia is a core component of the country's food security program (Lavers, 2013). According to (MoARD, 2010, pp 5),[4] the program aims "to assure food consumption and prevent asset depletion for food insecure households in chronically food insecure *woredas* (districts) while stimulating markets, improving access to services and natural resources, and rehabilitating and enhancing the natural environment". The transfer of cash and/or food to the households is made with a view to enable consumption smoothing and avoid asset depletion by creating the means to rehabilitate community assets and improve access to social services. This program was officially launched in 2005 although the consultation with development partners started in 2003 (MoARD, 2015).

The program mobilizes targeted households and provides them with finance to be engaged in public works such as soil and water conservation on hill slopes and social services infrastructure. Cash/food is paid for up to five days of work a month per household member for six months a year, until the recipient households graduate from the program. Graduation is effected when the households are believed to have accumulated an asset and income level that enables them to meet 12 months of food needs and to withstand modest shocks (MoARD, 2015). There are also participating households in the direct support component of this program. These households receive unconditional cash or food transfers because they are households with members who are unable to work (MoARD, 2015).

[4] Ministry of Agriculture and Rural Development (of Ethiopia)

The program used a combination of geographic and administrative (community) targeting to select chronically food insecure households who live in chronically food insecure *woredas* (districts) (Berhane et al., 2014). Geographically, food insecure areas had been identified down to the *tabia* level. A *tabia* (municipality) is the lowest administrative level in Tigray/Ethiopia. When the program started in 2005, 190 *woredas* were selected based on their record of food aid that they received in the past (Berhane et al., 2014). Then *woreda* administrators determine the quota for each *tabia*. At the level of the *tabia*, a *tabia* committee selects beneficiaries and this is reviewed at a general assembly of *tabia* dwellers. In order to handle complaints, appeal committees are available both at the *tabia* and *woreda* levels. Eligibility is based on a three years continuous food gap of at least three months per a year. Dependence on food aid continuously for three years before the commencement of the PSNP served as a proxy indicator for this criterion (Gilligan et al., 2009). In addition to these, households who have suddenly become vulnerable due to a severe shock that made them lose their assets and be unable to support themselves and households who do not have family or any other form of support to sustain themselves are eligible (Sabates-Wheeler and Devereux, 2010). For selected households, all members qualify but the adult members work for themselves and on behalf of members who cannot work, such as children.

3.2. Earlier Impact Studies of PSNP

There have been several studies on the impact of the PSNP in Ethiopia on various indicators of productivity and development. One of the issues studied was whether PSNP led to improvement in food security and asset accumulation. In relation to this, Debella and Holden (2014) studied the impact of PSNP on child education and nutrition and found that program participants had better achievements on both during the first five years of the program. They also found that the program had a positive impact on livestock accumulation (Debella and Holden, 2014). Similarly, Andersson et al. (2011) studied the impact of PSNP on livestock and tree holding of rural

households and found that the program had no impact on livestock accumulation while it had a positive impact on tree holding. Although both of these studies used panel data, the former had covered longer time span (2003-2010) than the latter (2002-2007). Along the same line of research, Berhane et al. (2014) studied the impact of PSNP on food security (measured by the number of months that the household reports it can meet its food needs (2006-2010) and asset (livestock and farm tools) accumulation. They found that PSNP had a positive impact on food security and asset accumulation. In an earlier study they have also shown that PSNP member households who also accessed packages in the Other Food Security Program (OFSP)[5] were more food secure, accessed more credit for productive purposes, used more improved agricultural technologies and operated more non-farm business activities (Gilligan et al., 2009). A related study by Nega et al. (2010) assessed the impact of the interaction of the FFW component of PSNP and OFSP on poverty. They found that households who accessed both FFW through PSNP and OFSP have a lower poverty level than their matched non-participating counterfactual households do. The relationship between cash transfers and high food prices, as they influenced the outcomes of PSNP, was studied by Sabates-Wheeler and Devereux (2010). They found that the PSNP had served as cushion against a decline in income due to high food prices for the participating households in the period 2006-2008.

Some studies tried to see how the PSNP affected agricultural productivity. Adimassu and Kessler (2015) studied the impact of the program on investments by farmers on sustainable land management practices on their plots. They used the propensity score matching method on a cross

[5] OFSP refers to a collection different activities designed by the government with a view to increase income from agricultural activities and to enhance asset accumulation beyond the minimum threshold required for graduation from the PSNP. This program accompanied the PSNP. The household asset-building program (HABP) later replaced it. The aim here is enabling sustainable graduation from the PSNP.

sectional data collected during the 2011/12 cropping season from two districts in the central rift valley of Ethiopia. They found that participating households had invested less than non-participating households. However, there is no clarification as to whether this study controlled for PSNP investments on private land. Hoddinott et al. (2012) studied the impact of PSNP on fertilizer uptake and investment on land improvement. They used an extended form of the propensity score matching method (the dose-response model) on a panel data of three rounds (2006, 2008 and 2010) from Tigray, Amhara, Oromia and SNNP regions of Ethiopia. They found that PSNP had contributed positively to fertilizer uptake and investment on land.

Other studies have assessed the more recent phenomenon of graduation from the PSNP. A study by Sabates-Wheeler and Devereux (2013) has outlined the pathways to graduation and sketched a theory for it. In this theory they distinguish between threshold graduation (an administratively determined benchmark beyond which the beneficiary no longer is eligible) and sustainable graduation (a state in which livelihoods are fundamentally transformed due to the program). They identify the market context, the initial resource conditions and the efficiency of existing assets, the scale of transfer and coverage of the program, household level incentives and environmental contexts and shocks are the five most important factors to enable or undermine graduation.

4 Study Area, Data and Descriptive Analysis

4.1 Study area and data

Data for this study is collected from 12 *woredas* in the highlands of Tigray region. The data is a panel data of six rounds starting from 1998 and extending to 2015. This study employs the four last rounds, starting from the third round (i.e. 2003) up to the last round in 2015. Although the number of surveyed households has been increasing over time reaching 632 in the last round

(2015), from 400 households initially. Two new survey sites have been added while one had to be dropped. About 360 households have been present in all the four rounds that are relevant for this study.

Stratified random sampling was used to ensure large variation in population density, market access, agro-climatic conditions and access to irrigation in the region (Debela and Holden, 2014). Each survey round was carried out in the months June-September. Therefore, there will not be any bias due to seasonality. A questionnaire with predominantly the same structure and questions was used in all the rounds which enables to avoid bias due to lack of comparability of survey instruments. The households were asked about household characteristics, asset ownerships, including land ownerships. A community level questionnaire too was used to capture village level information such as demographics, agricultural production structure, infrastructure, institutions (such as PSNP access) and land related issues.

4.2 PSNP membership and Extent of Graduation in the study sites

The PSNP consists of public works and direct support components. The majority are members of the public works program. In fact, up to 90% of the total members in the PSNP in Tigray are engaged in the public works program (Debela and Holden, 2014). Membership in public works of the PSNP in our study area is illustrated in table 4.1 below.

Table 1. Membership in the public works component of the PSNP

Membership status	2010		2015	
Public works	Number	Percentage	Number	Percentage
Members	157	47.57	120	38.96
Non-members	173	52.43	188	61.04
Total	330	100	308	100

Source: NMBU and MU Household Panel data survey.

One reason for the decline in membership in 2015 is graduation of some members from the program while another is found to be sample attrition. Table 4.2 below presents level of graduation based on response by respondents and the level of attrition in 2010 and 2015.

Table 2. Graduation from the PSNP and Sample Attrition

Graduation status	Number	percentage	Attrition	Number	percentage
Graduated	20	8.16	2010	22	6
Not graduated	245	91.84	2015	50	14.1
Total	265*	100	Total	72	-

Note: Observations are smaller than the total because only these households replied to the question on graduation status. *Source*: NMBU and MU Household Panel data survey.

The situation regarding *tabia* level membership rate shows a marked difference. Some *tabias* have a membership level as high as 70% to 75% while others show a membership as low as 17.1% to 28.6%. Number of public works members had decreased in all *tabias* in 2015. The decline is partly due to graduation from the program and partly due to sample attrition (see Appendix b for details).

4.3 Membership into the public works of the PSNP and household size

We have data starting from 2003 while the program had started in 2005. Therefore, we can do a before the treatment and after the treatment comparison (difference-in-difference) of household size and dependency ratio between the two groups as well as have an assessment of the common trend before treatment by comparing 2003 and 2006, assuming that no significant effect of the program on these variables has occurred by early 2006[6].. Table 3 shows the development of these variables over the four survey rounds.

[6] The 2006 survey took place in June-July 2006 and collected data household data for the period 1st May 2005-30th April 2006. This coincides with the start of the PSNP.

Table 3. Household size, Dependency ratio and Public works membership

Year	Public works (1=Member)	Number of observations	Mean Household size	Mean dependency ratio
2003	0	222	5.09(0.204)	1.88(0.067)
	1	132	4.99(0.143)	1.86(0.047)
2006	0	173	5.59(0.190)	2.01(0.063)
	1	161	5.35(0.186)	2.03(0.068)
*2010**	0	173	4.57(0.186)	1.70(0.060)
	1	157	5.69(0.166)	2.01(0.059)
2015	0	187	4.8(0.173)	1.63(0.046)
	1	121	5.13(0.232)	1.62(0.057)

Authors' own computation based on NMBU & MU household panel data. (Figures in parentheses are standard errors).

From the above table we observe that there is a significant difference between the two groups in terms of both household size and dependency ratio only in 2010. As this year is a year just after the end of the first phase of the program, we may suspect that PSNP might have a role to play in explaining this difference. The dependency ratio shows a decline throughout the program implementation period for both the members and non-members. Although we have not examined the reason for the decline in the dependency ratio over time, one possible cause could be aging of household members or impacts of family planning efforts. We control for these in the econometric analysis.

4.4 Household features and endowments among member and non-member households

Regarding the control variables for this study (See Table 4 below), the two groups were almost the same before the start of the program (in 2003) and in 2006. They show statistically significant difference on several variables in 2010.

A mean difference test for the geographical variables (not included in Table .4) shows that there is no statistical difference between the two groups for these variables.

Table 4. Mean difference in key control variables between members and non-members of the public works

Key control variables	Membership status(1=member)	Mean of key Household level control variables			
		2003	2006	2010	2015
Head sex	0	0.79(0.031)	0.76(0.031)	0.70(0.036)	0.78(0.03)
	1	0.78(0.033)	0.79(0.031)	0.76(0.034)*	0.74(0.04)
HH head age	0	53.6(1.26)	54.8(1.16)	59.7(1.07)	62.5(1.09)
	1	53.8(0.94)	55.1(1.06)	53.7(1.09)***	59.6(1.25)
HH head education(1=literate)	0	0.31(0.04)	0.37(0.037)	0.28(0.34)	0.30(0.034)
	1	0.36(0.03)	0.29(0.036)	0.29(0.36)	0.35(0.044)
Spouse's age	0	41.4(1.88)	40.9(1.58)	48.0(1.92)	43.5(1.50)
	1	42.6(1.48)	42.8(1.63)	42.9(1.71)**	43.2(1.85)
Spouse's education(1=literate)	0	0.40(0.04)	0.30(0.04)	0.58(0.038)	0.39(0.036)
	1	0.42(0.03)	0.30(0.04)	0.49(0.04)	0.38(0.044)
Non- farm income (1=hh gets N.F. income)	0	0.34(0.04)	0.45(0.039)	0.40(0.037)	0.54(0.037)
	1	0.37(0.03)	0.39(0.039)	0.38(0.039)**	0.55(0.045)
Total area of land the HH owns in tsimdi	0	5.5(0.51)	4.76(0.28)	4.6(0.26)	4.79(0.29)
	1	4.6(0.24)*	4.31(0.27)	4.0(0.24)	4.52(0.34)
Total number of livestock the HH owns	0	3.22(0.28)	2.26(0.15)	2.84(0.19)	3.0(0.185)
	1	2.69(0.14)	2.18(0.12)	2.29(0.14)*	2.5(0.186)*
Number of observations	0	132	173	173	187
	1	222	161	157	121
	Total	354	334	330	308

Source: Authors' computation based on NMBU & MU household panel data. *** Significant at 1%. ** Significant at 5% and * significant at 10%. Figures in parenthesis are standard errors.

4. Empirical Strategy

The treatment for this study is membership in the public works component of PSNP. We can think of the introduction of the PSNP in the year 2005 as a natural experiment and try to analyze its impact on various indicators. Our data allows us to consider such an approach since we have data on both the treated and control groups before and after the start of the PSNP. Therefore, the impact of membership in public works on household size and the dependency (Consumer/Worker) ratio can be captured by using a standard difference-in-differences model, which can be specified as follows.

$$Y_{it} = \beta_0 + \beta_1 pw + \delta_i yr_t + \alpha_i yr_t . pw + \varphi_i X_{it} + \lambda IMR + u_{it} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 1$$

In this model,

- the outcome variable Y_{it} has two forms; namely, household size and dependency ratio in the household.
- β_1 is the coefficient which captures the estimated mean difference in household size between the treatment group (public work member households) and control group (non-member households) before the start of the PSNP (i.e. it is the baseline difference between the two groups). δ_i are a coefficient of the years in the panel rounds. We are interested in two of the four years; namely 2010 and 2015. Year 2010 is when the first phase of the program ends while 2015 is when the second phase of the program ends.
- α_i are the difference-in-differences estimators which show whether the expected mean change in household size from before to after the PSNP was different between members and non-members of the public works program. We have two estimates of these coefficients; one for the first phase of the program (2005-2010) and another including the second phase of the program (2005- 2015). Our prime interest is on these coefficients.
- φ_i are coefficients on the control variables. In explaining household size and dependency, we expect that household features, endowments and access variables will be important in addition to membership in to public works of the PSNP. We have hypothesized earlier that membership in public works is expected to affect household size and dependency positively. From the vector of household features, we expect that age of household head and the spouse will affect household size and dependency non-linearly, whether the head is male will have a positive effect, while education of the household head and the spouse will affect household size and dependency negatively. In relation to the endowment variables (area of land and livestock the household owns), we expect that they will affect household size and dependency positively as they enable maintaining a large household

and hence more children. We also expect that the access variables (distance in walking minutes to the health center and Secondary School), will affect household size and dependency negatively as both variables indicate access to information regarding family planning and opportunities outside the household.

We introduce λ with a view to control for attrition bias for the panel data we use is unbalanced. One way to control for such a bias is to include the inverse mills ratio (IMR) from a probit regression of attrition as in Miller and Wright (1995). We obtain the inverse mills ratio (IMR) from a probit regression of attrition on the control variables of our outcome equation and dummies for the zones in which respondent households live. The zone dummies serve as instruments in this regression (equation 2 below).

$$Attri = \varsigma_0 + \varsigma_i Z_{it} + v_{it} \quad \text{.....(2)}$$

Where $Attri$ is a dummy variable which equals one for households who were absent in the second and/or the third and/or the fourth survey rounds. This dummy variable is zero for households who were present in all the four survey rounds.

The data we use here is a panel data of four rounds and there has been some attrition in each round. We have an attrition rate of 5.7% in 2006, 5.9% in 2010 and 14.1% in 2015. Given these attrition figures, the first thing we did was to check for attrition bias in our regression and control for it (see Appendix C for the attrition probit regression). With this in mind, we proceeded to use the unbalanced data. We stick to using the unbalanced panel because a resort to the balanced panel reduces observations are by a significant amount.

5. Results and Discussion

First, we estimated the impact of membership in public works on household size with a Difference-in-Difference (DiD) approach (Table 5 below). We start by discussing the household size variable. The household size change in the 2003-2006 period can be used as an assessment of the common trend assumption before the intervention, which started from 2005. The household size in early 2006 should not yet had been affected by program participation. It can be seen that the household size has a significantly more positive development from 2003 to 2006 for the non-members than the member households. From 2006 to 2010, we see, however, that the household size increases significantly for member households. A test of the relative household size change for member versus non-member households from 2006 to 2010 is highly significant (Prob > chi2 = 0.0003), (see Table 6 below). We cannot therefore reject hypothesis 1a which states that household size will increase more for member households than for non-member households. A similar test for 2015 versus 2010 revealed no significant change between member and non-member households in this period. This is consistent with a reduced effect of the safety net program on household size in this second phase of the program. A test comparing 2015 and 2006 revealed a significant positive effect for the two phases of the program (Prob > chi2 = 0.0006). We cannot therefore reject hypothesis 1b which states that the effect on household size is expected to be strongest in the first phase of the program. The program appears to have been able to stabilize and even increase household size for member households while non-member households have been unable to continue the positive trend in household size that we observe from 2003 to 2006. We think this difference is due to the work and access to food opportunities that member households benefit from as members of the safety net program. In the second period of the safety net program from 2010 to 2015, when graduation of members started, household size has declined somewhat for

member households. This implies that we cannot reject hypothesis 2. The results show that household size for member households peaked in 2010 when the first phase of the program ended.

The changes in average household size for member and non-member households from 2003 to 2015 are shown in Figure 1.

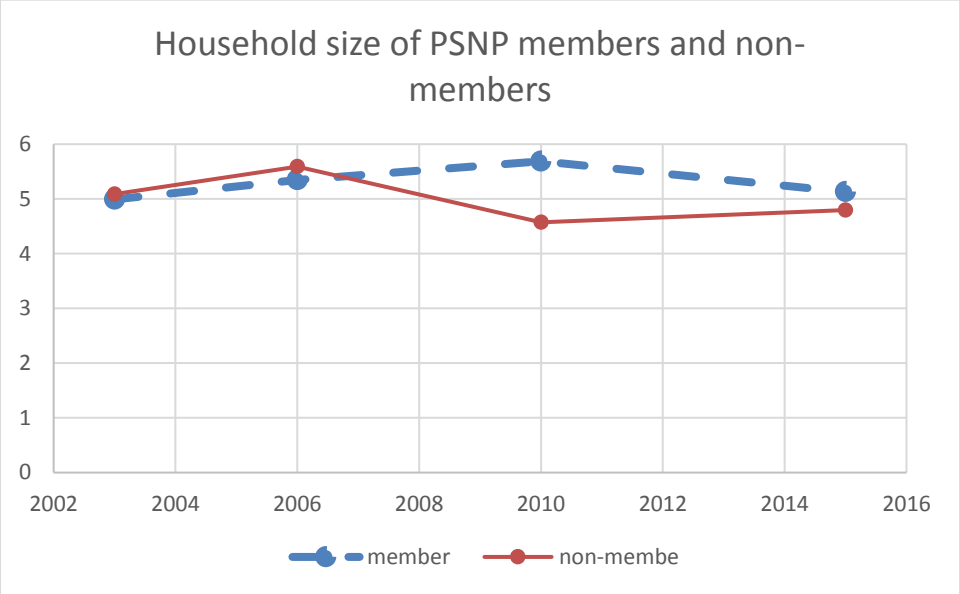

Figure 1. Household size for member and non-member households over time.

The DiD estimates and Figure 1 show that mean household size of public works member households has increased by almost one additional member compared to that of the non-members in the first phase of the program. This change came after the pre-project period when household size of non-members showed a significantly stronger positive trend than that of member households before they were treated.

The second model in Table 5 shows the DiD estimates for the effect of the safety net program on the dependency ratio of households. While the result in the Table does not show obvious impacts

of the safety net program on the dependency ratio, additional tests revealed such effects. These tests showed a significant more negative trend for member households than for non-member households from 2003 to 2006 (an assessment of the common trend assumption) with all the other controls in place (Prob > chi2 = 0.0344). This was a bit surprising given the very similar trend observed in Figure 2 for this period.

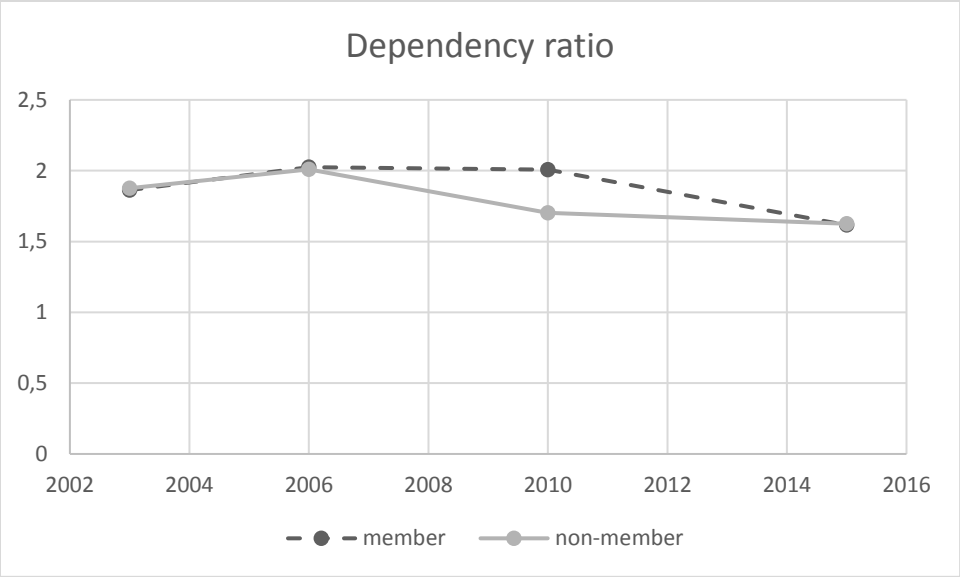

Figure 2. Dependency ratio for member and non-member households over time.

However, it makes it clear that the dependency ratio of member households is not higher or increasing more than for non-member households in the period before the program starts. A test for the difference in change in dependency ratio for members versus non-members from 2006 to 2010 showed a significant more positive trend for members than non-members (Prob > chi2 = 0.0657). We cannot therefore reject hypothesis 3. When testing for the difference in dependency ratio for member versus non-member households from 2010 to 2015, we find no significant difference between member and non-member households. This is also surprising given the difference in trend in Figure 2. This again is an effect of the inclusion of additional control

variables in the DiD model. Finally, when comparing the change from 2006 to 2015 (both phases of the program) for member versus non-member households, we find a significant difference (Prob > chi2 = 0.0408) in favor of a significant positive impact of the safety net program on dependency ratio of member households over the two phases of the program. However, this appeared not to be because member households had a significantly higher dependency ratio than non-member households at the start of the program. We therefore have evidence implying that we can reject hypothesis 4 stating that households with higher dependency ratio were more likely to become members of PSNP.

Table 5. Panel Household Difference in Difference Household Fixed Effects Regression for impact of membership in public works on household size and household dependency ratio

VARIABLES	Household Size	Dependency ratio
Member household in PW	-0.066	-0.063
	(0.265)	(0.106)
Year 2006 dummy	0.695***	0.158*
	(0.234)	(0.088)
Year 2010 dummy	0.019	0.013
	(0.235)	(0.093)
Year 2015 dummy	-0.306	-0.221**
	(0.237)	(0.089)
Interaction 2006*PW	-0.724**	-0.079
	(0.313)	(0.119)
Interaction 2010*PW	0.663**	0.108
	(0.320)	(0.113)
Interaction 2015*PW	0.278	-0.087
	(0.301)	(0.118)
Household head sex(1=male)	-0.265	-0.077
	(0.183)	(0.060)
Household head age	0.161***	-0.040***
	(0.036)	(0.010)
Household head age squared/100	-0.169***	0.026***
	(0.033)	(0.009)
Education of HH head (1=literate)	0.591***	0.141***
	(0.146)	(0.050)
Age of spouse	0.119***	0.035***
	(0.011)	(0.004)
Spouse age squared/100	-0.109***	-0.034***
	(0.020)	(0.007)
Spouse Education	-0.643***	-0.081
	(0.193)	(0.067)
Late stage of HH head (1=spouse age >45)	-0.609***	-0.490***
	(0.228)	(0.091)
Off farm income(1=HH gets income)	-0.096	0.017
	(0.149)	(0.050)
Total area of land the HH owns in Tsimdi	0.033*	0.012*
	(0.018)	(0.006)
Total livestock units the HH owns	0.042	0.016
	(0.032)	(0.011)
Walking minutes distance to health centre/1000	2.729	0.288
	(1.667)	(0.494)
Walking minutes distance to secondary school/1000	-0.844	0.023
	(0.891)	(0.252)
Attrition lambda	0.635	-0.061
	(0.538)	(0.178)
Constant	-11.817	3.901
	(9.647)	(3.209)
Observations	1,293	1,293
R-squared	0.412	0.349
Number of households	354	354

Figures in parenthesis are bootstrapped (number of iterations= 400) standard errors. *** Significant at 1%, ** significant at 5%, * significant at 10%.

Overall, our analysis reveals very similar results for household size and dependency ratio although the effects of the program on household size were more significant than those on the dependency ratio.

Table 6 Tests across years of the impact of the PSNP on household size and dependency

Model	2003-2006		2006-2010		2010-2015		2006-2015	
	chi2 (1)	Prob > chi2	chi2 (1)	Prob > chi2	chi2 (1)	Prob > chi2	chi2 (1)	Prob > chi2
Household size	12.59	0.0004	13.08	0.0003	0.02	0.8986	11.69	0.0006
Dependency	4.48	0.0344	3.39	0.0657	0.06	0.8067	4.18	0.0408

The results we obtained shed light on possible unintended impacts of the program against previous studies that have shown mostly positive impacts on stated objectives of the program, such as enhancing asset building and improving food security. These new findings indicate that the program might have brought about changes in household and individual behaviors and livelihood strategies of rural households in Ethiopia, which were not intended when the program was designed. We believe that such an impact of encouraging maintaining of a larger household size together with increased dependency ratio of households is worrisome for all stakeholders in the program. Unless other impacts of PSNP in terms of improved land management and productivity can be sustained and have resulted in a reduction in long-term vulnerability of the households even after graduation, these unintended outcomes may threaten the long term and sustainable improvement of the wellbeing of rural households, which is the ultimate objective of the program.

Examining the effect of the confounding factors, we see that from the category of household features, age of household head and spouse, education of household head and spouse and whether the household is at the latter stage of the household development cycle (Chayanov 1925), are found to be statistically significant. The finding shows that age of household head and the spouse

have a positive (but declining as age increases) impact on household size. This is an expected result as an increase in age of both the head and the spouse can be associated with more children and in some cases more members of the extended family joining the household. The increase in household size, of course, is not linear over time since fertility is time bound and when the head and spouse get older more members leave the household due to marriage of children and migration for various reasons. The effect of these variables on dependency ratio is found to be negative and significant which is in consonance with the possibility of children growing up and leaving the family.

Education is the other variable, which is found to be statistically significant in this category. Whether the household head is literate is found to have a positive effect on both household size and dependency ratio, while, whether the spouse is literate is found to have a negative and significant effect on household size only. The result concerning education of the household head is quite unexpected and not easy to explain while the result concerning spouse education is a corroboration to findings of studies which show that women's education is associated with lower fertility such as in Martin (1995). Late stage of the household development cycle is found to have a negative and significant effect on both household size and dependency.

From the category of endowment variables, area of land that the household owns is found to have a positive and significant effect (at 10% level) on household size and dependency ratio in the household. This result is justifiable as ownership of more land enables maintaining a larger household.

Regarding the health service and school access variables, both are found to have no significant effect on household size and dependency ratio of the household. This result may indicate that

health and education facilities are not having the desired social impacts in relation to these indicators of social development.

6. Conclusion

This study assessed the impact of membership in the public works component of the PSNP on household size and dependency ratio of member households using panel data of four rounds (2003-2015) in the Tigray region of Northern Ethiopia. We found that PSNP membership resulted in increased household size and dependency ratio during the first five period of the program (2005-2010) and much of this effect was also sustained in the second phase (2010-2015) of the program. Therefore, the public works component of the PSNP looks to have enabled member households to maintain larger household sizes and dependency ratios compared to non-member households. These outcomes may be unintended and perhaps undesired from the point of view of program designers and implementers. This may mean that its positive impact on food security and asset accumulation that previous studies have shown might have been dampened by increased household sizes and dependency ratios. This in turn might mean that the overall success of the program in achieving its stated objective of enabling households to break out of the food insecurity trap is perhaps entangled by other undesired effects. Obviously, such an outcome could make households worse off after graduation from the program and can lead to extended dependency of households on the program.

In determining household size and the dependency ratio, household features such as age and education of the household head and the spouse are found to be significant factors. Most notably, education of the spouse is found to be negative and significant, a result which indicates that educating women appears to have a positive outcome on controlling household size and reducing dependency ratio. Size of land owned by the household is also found to have a positive effect on

household size and dependency ratio, which indicates that wealthier households tend to maintain a larger household with more children.

The implication of the main finding of this study is that there is a need for a detailed analysis of potential related impacts of an intervention program, like the PSNP, and complimenting it with packages that aim at enhancing the efficacy of the program in achieving its primary objectives.

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Appendix

A. Theoretical model specification

We use the rural household modeling framework as developed by de Janvry and Sadoulet (2006a) to show that membership in to public works and maintaining a larger household size are interlinked.

We start by assuming that the household tries to maximize expected utility of its life time subject to a set of constraints and tries to maintain a minimum subsistence consumption (C_m).

$$Max \sum_{t=0}^{T} \beta^t \, U(C_t - C_{mt}) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots A.1$$

The consumption function of the household can be specified as follows.

$$C_t = (A_t, M_t, H_t, E_t) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots A.2$$

Where consumption (C_t) is a function of consumption of own produced agricultural goods (A_t), manufactured goods (M_t), the enjoyment of staying together (H_t) and household level features (H_t).

Subject to the following constraints.

$$C_t = I_t - S_t \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots A.3$$

$$\overline{L} = L_t^a + L_t^{nf} + L_t^{pw} + L_t^z + L_t^l \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots A.4$$

$$q_t = \varphi(L_t^a, A_t) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots A.5$$

$$I_t = P_t Q_t + w_t^{nf} L_t^a + w_t^{pw} L_t^{pw} + L_t^l \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots A.6$$

$$A_t = (1 + r)(A_{t-1} + S_t) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots A.7$$

$$Z_t = Z(L_t^z, C_t, HS, shock) + Z_{t-1} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots A.8$$

In this specification, the total labour endowment that the household possesses ($\bar{L}$) is allocated into agricultural production (L_t^a), none farm activities (L_t^{nf}), public works (L_t^{pw}), household chores (L_t^z) and leisure (L_t^l). The agricultural production technology is given by equation (5) in a way showing that it increases with labour allocated to agriculture (L_t^a) and the stock of land and non-land productive assets (A_t) and (φ) captures shocks which affect production. In equation (6) we have the full income while in equation (7), we capture how the stock of land and non-land productive assets grow over time. The asset base is assumed to grow at an average rate of r and is augmented by savings (S_t). Similarly in equation (8), we represent household size (Z_t) which increases as a function of labour allocated to household maintenance chores (L_t^z) and consumption (C_t) and previous level of household size (Z_{t-1}). The relationship between household size (Z_t) and stage of the household (HS) is supposed to follow Chayanov (1925) household development cycle theory. An examination of household size in Russian peasant households in the second half of the 19th century by Chayanov (1925) shows that household size keeps on increasing up to the 26th year of stay of the spouses. We are interested in the stages in which the household size grows (up to 26 years of stay for the household) and the stage after that, in which household size decreases. The situation of the Russian peasants during that time is more or less similar to the current situation of rural households that we are examining in this study. Since we do not have data on how long the spouses have stayed together, we represent the variable HS with a dummy, which is one for a household with a spouse aged more than 45 years. Household size may increase until the spouse

reaches the age of 45 due to fertility. For spouses aged more than 45 years, fertility is expected to be low or none due to menopause. We include ($shock$) in the household size equation to capture various shocks the household might face, such as death of a member or agricultural yield reducing shocks that might cause outmigration of some members. Although we have it in the theoretical model, sadly we fail to take account of such shocks in our study for we do not have data on it in all the panel rounds.

Substituting equation (4) into equation (5) and then equation (5) into equation (2) and finally equation (2) into the objective function leads to the following optimization problem.

$$MaxU = \sum_{t=0}^{t} \beta^t \, U\{\left[P_t q_t\left(L_t^a, A_{t,}\varphi\right) + w_t^{nf} L_t^{nf} + w_t^{pw} L_t^{pw} - S_t\right] - C_m\} \ldots\ldots\ldots\ldots\ldots \text{A.9}$$

Subject to

$$\overline{L} = L_t^a + L_t^{nf} + L_t^{pw} + L_t^z + L_t^l \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots A.10$$

$$A_t - A_{t-1} = rA_{t-1} + (1+r)S_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots A.11$$

$$Z_t - Z_{t-1} = Z(L_t^z, C_t, HS, shock) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots A.12$$

The choice variables are L_t^a, L_t^{nf}, L_t^{pw}, L_t^z, L_t^l and S_t ; while, the state variables are A_t and Z_t. We assume that initial conditions for the state variables are given as A(0) = A_0 and Z(0) = Z_0 where, $A_0 = \bar{A} > 0$ *and* $Z_0 = \bar{Z} > 0$. With a fixed terminal time T, the conditions of transversality for the state variables 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. We assume that saving is a residual from consumption[7]

Keeping the constraints for the choice variables, the dynamic *Lagrangian* of this problem can be stated as under.

$$\phi = \beta^t U\{[P_t q_t(L_t^a, A_t, \varphi_t) + w_t^{nf} L_t^{nf} + w_t^{pw} L_t^{pw} - S_t] - C_m\}$$
$$+ \lambda_t[\bar{L}\, L_t^a - L_t^{nf} - L_t^{pw} - L_t^z - L_t^l] + \theta_t[rA_{t-1} + (1+r)S_t]$$
$$+ \delta_t[Z_t(\bar{L} - L_t^a - L_t^{nf} - L_t^{pw} - L_t^l), C_t, HS, shock] \ldots\ldots\ldots\ldots\ldots\ldots\ldots A.13$$

The first order conditions (FOC) with respect to labour allocated to the public works and household maintenance chores are given as follows.

$$\frac{\partial \phi}{\partial L_t^{pw}} = \beta^t \frac{\partial U}{\partial C_t}\frac{\partial C_t}{\partial L_t^{pw}} - \delta_t \frac{\partial Z_t}{\partial L_t^{pw}} - \lambda_t = \beta^t \frac{\partial U}{\partial C_t} w^{pw} - \delta_t \frac{\partial Z_t}{\partial L_t^{pw}} - \lambda_t = 0$$

$$\Rightarrow \lambda_t = \beta^t \frac{\partial U}{\partial C_t} w^{pw} - \delta_t \frac{\partial Z_t}{\partial L_t^{pw}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots A.14$$

$$\frac{\partial \phi}{\partial L_t^z} = \delta_t \frac{\partial Z_t}{\partial L_t^z} - \lambda_t \Rightarrow \lambda_t = \delta_t \frac{\partial Z_t}{\partial L_t^z} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots A.15$$

Solving equations (13) and (14) as a system illustrates the possible relation between the PSNP (public works) program and the household size maintained by the household. The relation is given by the following equation.

[7] Although saving can be a behavioral relationship and may be determined by a set of factors, we left the specification of the saving function as asset accumulation in good years facilitates asset depletion in bad years – i.e. consumption smoothing in a stochastic environment.

$$\delta_t \frac{\partial Z_t}{\partial L_t^{pw}} = \delta_t \frac{\partial Z_t}{\partial L_t^{z}} - \beta^t \frac{\partial U}{\partial C_t} w^{pw} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots A.16$$

Both components on the right hand side of equation (15) are positive. This implies that the sign of the change in household size, which results from participation in food for work, depends on the net of these two forces.

B. Membership and Graduation by *tabia*

Table A.1 Membership to Public works by *tabia* in 2010 and 2015

Tabia	*Public works*									
	2010					*2015*				
	Non-Members		*Members*			*Non-Members*		*Members*		*Total*
	#	*%*	*#*	*%*	*Total*	*#*	*%*	*#*	*%*	
Samre	13	59.1	9	40.9	22	15	71.4	6	28.6	21
Mahbere Genet	8	33.3	16	66.7	25	7	35.0	13	65.0	20
May Alem	6	30.0	14	70.0	20	8	44.4	10	55.6	18
Seret	12	50.0	12	50.0	25	12	57.1	9	42.9	21
Kihen	19	82.6	4	17.4	23	18	85.7	3	14.3	21
Genfel	13	61.9	8	38.1	22	10	52.6	9	47.4	19
Emba Asmena	9	40.9	13	59.1	22	10	45.5	12	54.5	22
Hagere Selam	14	56.0	11	44.0	25	14	58.3	10	41.7	24
Debdebo	12	57.1	9	42.9	21	13	65.0	7	35.0	20
May Keyahti	6	26.1	17	73.9	23	11	50.0	11	50.0	22
Adi Selam	6	25.0	18	75.0	24	11	45.8	13	54.2	24
Hadegti	14	66.7	7	33.3	22	15	78.9	4	21.1	19
Tsaeda Ambora	15	65.2	8	34.8	23	16	76.2	5	23.8	21
Adi Menabir	14	70.0	6	30.0	21	16	80.0	4	20.0	20
May Adrasha	12	70.6	5	29.4	18	12	75.0	4	25.0	16
Total	173	52.4	157	47.6	336	188	61.0	120	39.0	308

Source: NMBU Mekelle University Survey 2003-2015

Table A.2 Graduation level by tabia in 2015

Tabia	# of Members	# of Graduates	% of graduates from participants
Samre	6	0	0.0
Mahbere Genet	13	1	7.7
May Alem	10	2	20
Seret	9	3	33.33
Kinen	3	1	33.33
Genfel	9	0	0.0
Emba Asmena	12	1	8.3
Hagere Selam	10	0	0.0
Debdebo	7	1	14.3
May Keyahti	11	4	36.4
Adi Selam	13	2	15.4
Hadegti	4	1	25
Tsaeda Ambora	5	1	20
Adi Menabir	4	1	25
May Adrasha	4	2	50
Total	120	20	16.7

Source: NMBU Mekelle University Survey 2003-2015

C. Controlling for Attrition Bias

Table C.1 Panel data probit regression to estimate sample attrition

(Attdumy= 1 for non-stayers)

Variables	Attrition
Household head sex	0.021
	(0.517)
Household head age	0.043
	(0.799)
Education of HH head	-0.106
	(0.510)
Occupation of HH head (1=non-farmer)	0.081
	(0.570)
Non-farm income(1=HH gets income)	-0.039
	(0.438)
Total livestock owned by the HH	-0.081
	(0.205)
Total area of land owned by the HH	0.151
	(0.318)
Distance to health facility	0.069
	(0.283)
Distance to secondary school	-0.237
	(0.263)
zonedumy1	-0.605
	(0.672)
zonedumy2	-1.168
	(0.870)
zonedumy3	-0.487
	(0.623)
Constant	-13.260***
	(3.595)
lnsigma	5.250***
	(0.151)
Observations	1,293
Number of HHs	354

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