Public Works in Ethiopia. Crowding out on-farm labor?

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Abstract

This paper analyzes the impact of Public Works (PW) from the Productive Safety Net Program (PSNP) in the agricultural regions of Ethiopia. In particular, based on a household model with two inputs, I explore the effects of the program on capital and labor decisions using the Ethiopian Rural Household Surveys (ERHS) from 2004 and 2009. Results indicate that PW did not have an effect crowding out adult labor on-farm but it reduced child labor. Furthremore, after analyzing the relationship between capital and labor inputs, there is not evidence suggesting that the program had an effect on the demand of capital inputs (i.e., units of livestock and value of farming tools).

1. Introduction

Ethiopia has been affected by food insecurity for decades. The high variability of the weather conditions is one of the factors that has contributed the most to this problem. For this reason, in 2005 the Ethiopian government implemented the "Productive Safety Nets Program" (PSNP). The intervention took place for four years. The goal was "... to provide transfers to the food insecure population in chronically food insecure woredas (districts) in a way that prevents asset depletion at the household level and creates assets at the community level" (Government of Ethiopia, 2004). The program targeted food insecure households and consisted in providing off-farm labor or direct transfers to its beneficiaries.

Although different studies (Andersson et al., 2011; Bogale and Genene, 2012; Gilligan et al., 2009) have evaluated the impact of the program, non of them have measured the impact

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of it after the completion of its second phase (2009). For example, Gilligan et al. (2009) measure the impact of the program using propensity score matching with data from 2006 (i.e., 18 months after the implementation of the first phase) and recall questions from 2005. Using different definitions for program participation, they found that the PSNP increased food security but did not have any effect on capital accumulation. Likewise, Hoddinott et al. (2010) estimate the effect of the program on child labor and child schooling. Using experimental and matching methods they find that participation in the PSNP leads to a reduction on child's labor and an increase in school attendance. However, the data from these studies do not include households characteristics prior to the existence of the program. Furthermore, a limitation of the matching methods is the assumption of non-selection of unobservables. Even so, some unobservables may affect both the participation decision in the program and the outcomes of interest (e.g., food security and asset accumulation). For instance, more "motivated" households may be more likely to participate in the program and have more assets.

On the other hand, Andersson et al. (2011) measure the impact of the program on investment in productive assets using both panel data and matching methods. They suggest that the PSNP could have displaced on-farm labor and farm investments. Although their results indicate that the program does not have a negative effect on capital investment, they do not analyze the relationship between capital and labor inputs. A caveat of this work is that the data used in the analysis only covered a specific region in Ethiopia. Therefore, the results may lack external validity.

Since the goal of the PSNP is to avoid households' asset depletion through the provision of off-farm labor and cash transfers, it is important to understand the impact of the program on households' asset holdings before the implementation of its third phase. Furthermore, based on the design of the PSNP, a more complete analysis would examine the relationship between labor and capital inputs. If capital and labor are complements and the program crowds out on-farm labor, the effect on capital accumulation would be negative.

Based on a households model, this paper extends previous research of the PSNP impact. It explores the conditions under which one of the components of the program (i.e., Public Works) benefits households by increasing the demand of off-farm labor and it examines the indirect effect of the program on capital inputs. To test the predictions of the model, I use the Ethiopian Rural Household Surveys (ERHS) from 2004 and 2009. These surveys include information from 1,477 households in 15 villages of Ethiopia in each round. However, these surveys are not representative at the National level. Therefore conclusions only apply to non-pastoralist areas in Ethiopia.

Since the PW may affect each household's demand of capital through its labor decisions, I use a system of equations that describes the demand of capital and labor to measure the impact of the program. Following Andersson et al. (2011), I use units of livestock as a proxy for asset holdings (capital). Furthermore, I use the value of farming tools employed in farming activities as an additional proxy for capital inputs. I find that PW reduced child labor but did not have an effect on adult labor on-farm. Likewise, I find some evidence indicating that capital and labor inputs are either complements or substitutes depending on the measure of capital used. For example, while the units of livestock and labor inputs are substitutes, the value of farming tools and labor inputs are complements. Thus, a reduction in child labor has a negative effect on the value of farming tools. In particular, I find that the magnitude of this effect is a reduction of 0.2 percent in the value of farming tools. Furthermore, results suggest that households may cope labor shock by increasing the supply of off-farm labor.

This paper is organized in six parts including this introduction. Section two describes the PSNP in Ethiopia. Section three presents the theoretical framework. Section four describes the data and section five presents the identification strategy and results. Section six concludes.

2. Productive Safety Net Program in Ethiopia

The Productive Safety Net Program (PSNP) in Ethiopia is one of the Government's program to reduce poverty and vulnerability among the most food insecure households in the most food insecure areas of Ethiopia. The implementation of the first phase began on January 2005, and the second phase was launched in 2007 running until 2009. Once the program was launched and resources were distributed across regions, community leaders identified eligible households which were free to participate in the program.

Some factors considered in the distribution of resources across regions depended on population size, natural resources, harvest estimates, past relief receipts, livelihood and food security assessments. The second stage was to identify eligible households. The Program Implementation Manual (PIM) describes selection of beneficiaries as a mixed of administrative criteria and community inputs (Andersson et al., 2011). In particular, it defines chronically food insecure households as those who lived in a food insecure area, faced food shortages in the last three years, received food assistance, lost assets and were unable to support themselves, and did not have any family support or other means of social protection. Assets, income, and other sources of support (i.e., remittances) were also taken into consideration but the PIM did not established any standardized threshold (Sharp et al., 2006).

Although the program aimed to target food insecure and vulnerable households, several analysis (Coll-Black et al., 2011; Sharp et al., 2006; Slater et al., 2006) show that poverty was the leading eligibility criterion. This could be explained by the fact that communities found it difficult to understand/identify food insecurity with a standardized measure (Sharp et al., 2006). In fact, while 69 percent of communities targeted poverty as the priority criteria to eligibility in the program, only 11 percent of them prioritized food insecurity as the eligibility criteria (Coll-Black et al., 2011). It is important to note that regions were given enough flexibility to modify the selection of beneficiaries based on their own needs. In practice, the selection of beneficiaries started at the woreda level where the eligibility criteria described in the PIM was adapted to each specific region. From there a special team was selected at the kebele level which was responsible of training and establishing a team at the community level which was then responsible of screening households and developing the list of beneficiaries. In principle this could reduce the transparency of the program yet Sharp et al. (2006) suggest that the PSNP resources went to the poor and food insecure. Actually, Coll-Black et al. (2011) show that households did not perceive that the eligibility criteria was based on personal connections, religious affiliation or ethnicity.

The PSNP consisted of two components in which households could participate: Public Works (PW) and Direct Support (DS). The public works component provides off-farm labor to households. Participants were entitled up to five days of paid work per month per household member. The number of hours per day was established by each region. Public works wages offered were slightly below market wages to avoid generating "perverse" incentives in households that were not food insecure. The goal of this component was to create a labor market for unskilled labor and at the same time to engage farmers in community-based activities that involved the construction of community assets (e.g., road construction, schools and clinics construction, reforestation and small-scale irrigation). It is important to mention that the demand for public works increased during the dry season (non harvest season) to avoid displacing on-farm labor. The second component of the program consists in direct transfers to households that can not participate in public works but are food insecure (e.g., sick or mentally challenged, pregnant women after six the month, lactating women in the first ten months after child birth and orphaned teenagers)(Sharp et al., 2006). While households can only participate in one component of the program, the program is flexible enough so that households can move from one component to the other when their available labor decreases due to illness or pregnancy (World Bank, 2010).

Although one of the principles of the PSNP was to reduce the dependency on food aid, the limited availability of food in the markets lead to a preference for food payments. Thus, the principle of the program was adapted to favor a mix of cash and food payments which

were used strategically in response to the market conditions of each specific area. Therefore, each region selected the type of transfer that would benefit its community the most based of household preferences, markets proximity and availability, and cash management capacity (World Bank, 2010).

In 2005, the wage paid for the public works was either 6 Birr (0.34 US) or three kilograms of grain per day Sharp et al. (2006). In the middle of 2005, after the program was launched, prices started to increase causing local governments to switch to food transfers by the beginning of 2007. In 2008, the cash wage increased to 8 Birr per day (0.45 US) and the food payments remained the same. The central government committed to keep providing three kilograms of the cheapest cereals to households. The sustained increase of prices lead towards greater requests of food transfers and an increase in cash wages to 10 Birr per day (0.56 US) in 2009 (World Bank, 2010). Although most households received cash transfers, most of them preferred in food payments. Following Slater et al. (2006), households argued that food payments were better because they provided more food than what they would be able to afford with cash payments. Furthermore they avoided the transactions costs of going to the markets and dealing with local traders.

It is important to note that the increase in prices experienced since 2005 is not explained by the cash transfers of the program. According to Rashid and Taffesse (2009) prices in recipient and non-recipient regions before and after the program followed the same trend. However, there is evidence that the program induced to an increase in the production of cereals in recipient regions in about 2-3 percent (World Bank, 2010).

3. Theoretical Framework

Following Sadoulet et al. (1996), I develop a household model where income is obtained from the production of an agricultural good y_t and off-farm labor l_t^o. Inputs for the production of y_t are on-farm labor l_t^{in} and capital k_t. I assume that the production process for agricultural goods can be described by $y_t = F(k_t, l_t^{in}, \theta)$, where k_t and l_t^{in} are the capital and labor devoted to the production of the agricultural good, and θ_t represents a production shock which follows a process $\theta_t = \bar{\theta}_t - \sigma_t$ where $\bar{\theta}$ is a random variable identically distributed which takes values between $[0, 1]$, σ_t is the variance of innovations. I assume that the production function F is increasing, concave and continuously differentiable in its arguments. A household can either use its labor on-farm or sell labor. The price of hiring labor selling labor in the market is w^o. Households can also accumulate capital by investing each period such that $i_t = k_{t+1} - k_t$ where the price of capital is given by r.

Suppose that each household has preferences over an infinite stream of consumption

$c-\bar{c}=\{c_t-\bar{c}\}_{t=0}^{\infty}$ and leisure $\bar{L}-l=\left\{\bar{L}-l_t\right\}_{t=0}^{\infty}$ given by a time-separable utility function of the form:

$$U(c-\bar{c},\,\bar{L}-l)=\sum_{t=0}^{\infty}\beta\,u(c_t-\bar{c},\,\bar{L}-l_t)$$

where c is consumption, $\bar{c}$ is subsistence consumption, l is labor devoted to on-farm and off-farm activities, and $\bar{L}$ is the labor endowment. Following a multiplicative Stone-Geary utility function, I assume that the utility function is given by $u(c_t-\bar{c},\,\bar{L}-l_t)=\mu ln\,(c_t-\bar{c})+(1-\mu)ln\,(\bar{L}-l_t)$. μ is the intensity parameter and it represents the importance of consumption relative to leisure. β is the household discount factor and is assumed to be $0<\beta<1$. The dynamic maximization problem can be written as:

$$\begin{aligned}
V(c,\,l,\,k) &= Max_{c,\,l,\,L,\,K'}\left\{U(c-\bar{c},\,\bar{L}-l)++\beta V(k^{'})\right\}\,st: && (1)\\
F(k,\,l^{in},\,\theta)+w^{o}l^{o} &\geqslant c+ri && (2)\\
i &= k^{'}-k && (3)\\
\bar{L} &\geqslant l\\
l &= l^{in}+l^{o}
\end{aligned}$$

Replacing $u(c-\bar{c},\,\bar{L}-l)$ with its functional form in equation (1), I get the first order conditions from equation (4) as follows:

$$\begin{aligned}
V(l^{in},\,l^{o},\,k) &= Max_{l^{in},\,l^{o},\,k'}\left\{\mu ln\left(F(k,\,l^{in},\,\theta)+w^{o}l^{o}-r(k^{'}-k)-\bar{c}\right)\right. && (4)\\
&\quad \left.+(1-\mu)ln\,(\bar{L}-l)+\beta V(k^{'})\right\}\\
\frac{\partial V(l^{in},\,l^{o},\,k)}{\partial l^{in}} &= \mu\tfrac{1}{c-\bar{c}}\quad \frac{\partial F}{\partial l^{i}}=(1-\mu)\frac{1}{\bar{L}-l^{in}-l^{o}} && (5)\\
\frac{\partial V(l^{in},\,l^{o},\,k)}{\partial l^{o}} &= \mu\tfrac{1}{c-\bar{c}}\,w^{o}\quad =(1-\mu)\frac{1}{\bar{L}-l^{in}-l^{o}} && (6)\\
\frac{\partial V(l^{in},\,l^{o},\,k)}{\partial k'} &= \mu\tfrac{1}{c-\bar{c}}r\quad =\beta E\left(\frac{\partial V(l^{in'},\,l^{o'},\,k^{'})}{\partial k'}\right) && (7)
\end{aligned}$$

I assume that the production function follows a CES functional form such that $F(k,\,l^{in},\,\theta)=\theta\left[\alpha l^{in^{\rho}}+\gamma k^{\rho}\right]^{\frac{1}{\rho}}$ which allows for either complementarity or substitution between capital and labor inputs (i.e., if $\rho\to 1$, capital and labor are perfect substitutes; if $\rho\to\infty$, capital and labor are perfect complements). Knowing this and replacing equation (6) in (5) I get that the supply/demand of on-farm labor is given by equation (8):

$$l^{in^*} = \frac{k\gamma^{\frac{1}{\rho}}}{\left(\left(\frac{w^o}{\alpha\theta}\right)^{\frac{\rho}{1-\rho}} - \alpha\right)^{\frac{1}{\rho}}} \tag{8}$$

Also, recall that $l^{o*} = \bar{L} - l^{in*}$. Hence the supply of off-farm labor is described by:

$$l^{o*} = \bar{L} - \frac{k\gamma^{\frac{1}{\rho}}}{\left(\left(\frac{w^o}{\alpha\theta}\right)^{\frac{\rho}{1-\rho}} - \alpha\right)^{\frac{1}{\rho}}} \tag{9}$$

Finally, the demand of capital is given by equation (10)

$$k^{'*} = \frac{l^{in}\alpha^{\frac{1}{\rho}}}{\left(\left(\frac{r\left(\frac{1-\beta}{\beta}\right)\frac{E\left(c'-\bar{c}\right)}{c-\bar{c}}}{\gamma E\left(\theta'\right)}\right)^{\frac{\rho}{1-\rho}} - \gamma\right)^{\frac{1}{\rho}}} \tag{10}$$

According to the conditions above the reduced form of the supply/demand of on-farm labor is given by $l^{in*} = l^{in}(w^o, k, \theta)$, the reduced form of the supply of off-farm labor by $l^{o*} = l^o(\bar{L}, w^o, k, \theta)$ and the demand of capital by $k^* = k(r, l^{in}, \theta)$.

Comparative Statics

Since Public Works (PW) increases off-farm wages, I am interested in knowing how changes in wages affect the supply of labor on-farm. Additionally, I am also interested in knowing the effect of this latter on the demand of capital. In this case the impact would depend upon the value of ρ. For example, if capital and labor are substitutes the demand for capital would increase with a decrease of on-farm labor, but if they are complements the demand of capital will decrease. Thus, if PW affects negatively on-farm labor, it would have a positive effect on asset holdings if capital and labor are substitutes. Thus, as opposed to Andersson et al. (2011), it is not obvious that an increase in the supply of off-farm labor would crowd out farm investment.

For simplicity, without loss of generality, I assume that $w^o > \alpha\theta$. Which is that wages are higher than the share of labor in production times the production shock. I get the following comparative statics from equation (8):

- Effect of a change of wages on the supply/demand of on-farm labor:

$$\frac{\partial l^{in}}{\partial w^o} = -\frac{k\gamma^{\frac{1}{\rho}}(\alpha\theta)^{\frac{1}{1-\rho}} w^{o\,\frac{2\rho-1}{1-\rho}}}{(1-\rho)(w^{o\,\frac{\rho}{1-\rho}} - \alpha\,(\alpha\theta)^{\frac{\rho}{1-\rho}})^{\frac{1}{\rho}+1}}$$

1. If $\rho \to 1$, then $\frac{\partial l^{in}}{\partial w^o} < 0$. If capital and labor are substitutes, an increase of off-farm wages will decrease on-farm labor, increasing labor off-farm.
2. If $\rho \to \infty$, then $\frac{\partial l^{in}}{\partial w^o} > 0$. If capital and labor are complements, and increase of off-farm wages will increase on-farm labor, decreasing labor off-farm.

Since the aim of the program is to decrease vulnerability and food insecurity, it is also important to know the effect of a change in the variance of the shock on the supply of on-farm labor.

- Effect of a change in the variance of the shock on the supply/demand of on-farm labor:

$$\frac{\partial l^{in}}{\partial \sigma} = -\frac{k\gamma^{\frac{1}{\rho}}(\alpha\theta)^{\frac{\rho}{1-\rho}}\alpha(w^{o\,\frac{\rho}{1-\rho}} - \alpha\,(\alpha\theta)^{\frac{\rho}{1-\rho}})^{\frac{1}{\rho}}(1+\alpha\theta(w^{o\,\frac{\rho}{1-\rho}} - \alpha\,(\alpha\theta)^{\frac{\rho}{1-\rho}})^{-1}(\alpha\theta)^{\frac{2\rho-1}{1-\rho}})}{(1-\rho)(w^{o\,\frac{\rho}{1-\rho}} - \alpha\,(\alpha\theta)^{\frac{\rho}{1-\rho}})^{\frac{2}{\rho}}}$$

1. If $\rho \to 1$, then $\frac{\partial l^{in}}{\partial \sigma} < 0$. If capital and labor are substitutes, an increase in the variance of the production shock will reduce on-farm labor, increasing labor off-farm.
2. If $\rho \to \infty$, then $\frac{\partial l^{in}}{\partial \sigma} > 0$. If capital and labor are complements, and increase in the variance of the production shock will increase on-farm labor, decreasing labor off-farm.

When labor and capital are substitutes and volatility increases, households favor off-farm labor. However, the result is the opposite when they are complements.

4. Data and Descriptive Statistics

4.1 Data

I use two rounds of the Ethiopian Rural Household Survey (ERHS) from 2004 and 2009. These data were collected by the Economics Department, Addis Ababa University (Economics/AAU), the Center for the Study of African Economies (CSAE), University of Oxford and the International Food Policy Research Institute (IFPRI), Washington DC. The sample

size is 1,477 rural households in 15 Ethiopian villages. Although it is not nationally representative, it could be considered broadly representative of households in non-pastoralist farming systems. The advantage of this data set is that it provides a rich and unique set of variables about household characteristics, agricultural information (inputs and outputs), as well as community level data on NGO activity, production and marketing (Dercon and Hoddinott, 2011).

The 2009 round, includes information of households that participated in the PSNP. Additionally, it provides information of payments received and number of hours worked in Public Works during 2008 and 2009. Note that I restrict the sample to those households with data in 2004 and 2009. The resultant restricted sample is a balanced panel of 1,349 households.

Following Andersson et al. (2011), I use the number of livestock and farming assets as proxies for each household's capital. They suggest that agricultural households often save by investing in productive assets such as livestock because it can be used to smooth consumption and as a source of income. Furthermore, livestock can also be used in farming activities, increase labor productivity and thus total production.

4.2 Descriptive Statistics

From the sample of 1,349 households, 33 percent of participated in the PSNP, 48.51 percent of them participated in public works and 29.46 percent received direct transfers. The other 22 percent remaining participated in both components of the program. Figure 1 shows the average number of hours worked by household per month in the PW. It seems that the highest supply of labor corresponds to the off-season months (March-August).

Although the program aimed to target poor households, non-poor households also benefited from the program. In fact, 47 percent of the PSNP participants were non-poor. Figure 2 presents the relationship between the estimated probability of participation in public works and consumption per-capita in 2009. Although poor and non-poor households participated in the program, it seems that poorer households are more likely to participate on it. Notice that the probability of participation drops fast on consumption per-capita and tends to zero for values of consumption per-capita greater than 500 Birr. Figure 3 shows the distribution of real consumption per-capita in 2009 of participants and non-participants. Note that the biggest portion of participants and non-participants lie around consumption per-capita values between 0 and 100 Birr. Although the distributions look pretty similar, the Kolmogorov-Smirnov test suggests that they are statistically different.

Along these lines, Table 1 reports summary statistics between Public Works participants and non-participants at the baseline and at the end of the second phase of the program. In

general, participants and non-participants are very different from each other. For example, participants are more likely to be poor, have less livestock, assets, consumption per-capita, are located further from the markets and demand more off-farm labor. Although most of the differences and similarities between groups are conserved across time, participants experienced more negative shocks compared to non-participants in 2009.

Table 2 shows the difference of the difference of means between participants and non-participants before and after the program of different variables of interest. In general, it seems that the program increased labor off-farm. Furthermore, it seems that the consumption gap between participants and non-participants decreased. To corroborate these results, I examine the correlation between the program and on-farm and off-farm labor, and capital inputs.

Because it is possible that some households self select themselves out of the program, some unobservables may affect both household's participation into the program and their labor and capital decisions. To account for the possible negative selection bias, I use a household fixed effect model. This latter specification would give unbiased estimators under the assumption that participation in the program is based on unobserved but time invariant household characteristics. The specification for this follows equation (11):

$$Input_{i,t} = \alpha_1 + \varphi D_t + \tau PW_{i,t} + \upsilon_i + \varepsilon_{i,t} \tag{11}$$

The dependent variables in equation (12) are units of capital or labor inputs. As mentioned before the proxies for capital inputs are units of livestock and number of agricultural tools (i.e., ploughs, hammers, saddles and axes) used in farming activities. Likewise, the proxies for labor inputs are average number of days per month worked in farming activities. I differentiate between adult family labor and child labor. Finally, I also examine the relationship between off-farm labor and participation in public works.

The right hand side variables correspond to the following: PW is the program participation variable and takes the value of 1 if a household participated in the Public Works component of the PSNP in 2009. Therefore, under the assumption that equation (12) describes the true data generating process, τ would measure the impact of the program on the stock of capital and the supply of labor. φ is the coefficient of time dummies and υ_i is a household fixed effect. Note that in this case, this specification is similar to a difference in difference model.

Table 3 presents the estimation results of specification (12). This set of regressions describes the correlation between participation in the public works component of the PSNP and productive inputs. Columns (1) and (3) describe the correlation between different types

of labor and participation in the program; and columns (4)-(5) show the correlation between participation in the program and capital inputs. Results are overall as expected: as predicted by the model the correlation between program participation and labor inputs is negative, having an important impact on child labor. If specification (12) described the true data generating process, participating in the program would decrease child labor by 75 percent at the mean. Finally, it seems that the correlation between participating in Public Works and capital inputs is also negative. In these cases, the program would reduce the units of livestock by 23 percent. Note that the effect of the program on the value of farming tools is positive. In this case, participating in the program increases the value of farming tools by 15 percent.

5. Identification Strategy and Results

5.1 Identification

According to the results of the fixed effects specification, it seems that Public Works reduced child labor and the stock of capital inputs. However there is not statistical evidence indicating that the program had a negative impact on adult labor on-farm. On the other hand, as analyzed in the theoretical framework, the demand of capital and labor in production are interrelated. If this is the case, the results of Table 3 may be biased.

Based on the conditions in section 3, capital decisions depend on the level of labor employed in production. At the same time, labor decisions depend upon the level of capital used in production. Furthermore, the program has a direct impact on the supply of off-farm labor which affects on-farm labor. Therefore, I assume that the program affects capital through the supply of labor for farming activities. Following the first order conditions from section 3, I estimate the reduced form equations of the model with a system of equations that describe capital and labor decisions as follows:

$$l^o_{i,t} = \alpha_1 + \tau PW_{i,t} + \lambda_1 l^{in}_{i,t} + \theta_{l_{i,t}} + \beta_{11} X_{1_{i,t}} + \beta_{21} Z_{1_{i,t}} + \upsilon_{1i} + \varepsilon_{1_{i,t}} \quad (12)$$

$$l^{in}_{i,t} = \alpha_2 + \vartheta l^o_{i,t} + \kappa Capital_{i,t} + \theta_{l_{i,t}} + \beta_{12} X_{2_{i,t}} + \beta_{22} Z_{2_{i,t}} + \upsilon_{2i} + \varepsilon_{2_{i,t}} \quad (13)$$

$$Capital_{i,t} = \alpha_3 + \lambda_3 l^{in}_{i,t} + \theta_{k_{i,t}} + \beta_{13} X_{3_{i,t}} + \beta_{23} Z_{3_{i,t}} + \upsilon_{3i} + \varepsilon_{3_{i,t}} \quad (14)$$

The dependent variable in equation (12) is the supply of off-farm labor. It is measured as the average number of days per month worked off farm, note that it includes the average number of days per month that each household participated on public works. τ is the parameter of interest and predicts the effect of the program on off-farm labor. It is expected

to be positive and statistically different from zero. λ_1 identifies the relationship between off-farm and on-farm labor. Because theses types of labor are assumed to be highly substitutable (i.e., $l^o = \bar{L} - l^{in}$), λ_1 is expected to be negative and statistically different from zero.

The dependent variable in equation (13) is the supply of labor for on-farm activities. It is measured as the average number of days per month worked on farming activities (i.e., planting, harvesting and cultivation). ϑ measures the impact of off-farm labor on on-farm labor, it is expected to be negative and significantly different form zero if the program mobilizes on-farm labor towards off-farm activities. κ measures the impact of capital on the supply of on-farm labor. If both inputs are complements this coefficient should be positive, but if they are substitutes the coefficient will be negative and statistically different from zero. $\theta_{l_{i,t}}$ is a dummy variable that takes the value of one if the household experiences any negative labor shock during the year. I assume that this shock is idiosyncratic and only affects the supply of labor. In this sense, I take labor shocks that correspond to abandonment, divorce or separation. This is if an individual left the household. From the sample, 28 percent of households suffered of this shock, from these only 18 percent participated benefited from Public Works. It is important to note that 60 percent of those experiencing the shock reported loss of household income and reduced consumption. An alternative type of shock in labor is if the household lost labor due to death of any of its members. This type of shock only affects labor under the assumption that households participate in local funeral societies (i.e., iddir) that cover funeral expenses.

Finally, the dependent variable in equation (14) is the measure of each households' stock of capital. It is measured as the number of livestock, oxen or farming tools in each household. λ_3 is the parameter of interest in this case, and indicates the relationship between capital and on-farm labor. If both inputs are substitutes λ_3 will be negative and statistically different from zero. $\theta_{k_{i,t}}$ is a dummy variable that takes the value of one when the household experiences a negative shock on its capital. Note that this shock is idiosyncratic. Furthermore, I assume that this type of shock only affects the stock of capital (i.e., destruction or theft of tools or inputs for production, and theft of livestock).

$X_{i,t}$ is a vector of household time-varying co-variates that are determinants of the capital and labor supply (e.g, fertilizer use, pesticides use, household size) uncorrelated with the error term ε_{it}; I also include region and/or year dummies interacted with other time-varying co-variates in some specifications. $Z_{i,t}$ is a vector of instrumental variables and υ_i is a hosehold fixed effect.

5.2 Exclusion Restrictions

Note that the system of equation described above has three endogenous variables. In this case, the key element that will allow me to identify the parameters of interest is the existence of an exclusion restriction for each endogenous variable. These variables need to be correlated with the endogenous dependent variable of each equation but uncorrelated with the other endogenous variables. I need at least three exclusion restrictions for the model to be identified.

For the supply of off-farm labor, I use the distance between each household and the center of its village. I assume that this distance affects off-farm labor directly but not the other endogenous variables. In this case, shorter distances would imply more outside options to on-farm labor. In fact, Quisumbing et al. (2005) suggest that distance to public works is an important factor that influences the decision of participating in Public Works. Conversely, I use the average age of "productive" children in the household as an exclusion restriction for the supply of on-farm labor. In this case, I assume that older "productive" children, which I define as children between 5 and 14 years old, increase on-farm labor directly but do not affect the supply of off-farm labor nor the stock of capital. I also include the number of "non-productive" children. Following Quisumbing et al. (2005), I assume that more "non-productive" children, which I define as the number of children younger than 5 years old will decrease the chances of women working off-farm, thus decreasing off-farm labor. Finally, I assume that the level of capital in period $t-5$ does not affect labor decisions in t. Hence, I use the values of capital in $t-5$ as the exclusion restriction for capital.

5.3 Results

Table 4 reports the estimation results for equations (12), (13) and (14) solved with 3SLS. Columns (1)-(2) show results using the average number of days per month of adult labor on-farm; and columns (3)-(4) show results when the the proxy for labor on-farm is child labor. While the proxy for capital inputs in columns (1) and (3) is the units of livestock, the proxy for capital inputs in columns (2) and (4) is the value of farming tools (i.e., ploughs, hammers, saddles and axes).

Results in table 4 show that participation in Public Works increase off-farm labor by 23 days, which is an increase of four times the value of off-farm work at the mean. Furthermore, note that households experiencing labor shocks (i.e., abandonment, divorce or separation) increase their supply of off-farm labor by 1.2 days. This is an increase of 27.5 percent in off-farm labor at the mean. In this sense, off-farm labor serves as a mechanism that households

use to cope labor shocks. However, observe that there is not any marginal effect of the program for those who experienced the shock.

On the other hand, there is not evidence suggesting that off-farm labor crowed-out adult labor on-farm. Although the sign of the coefficients are negative, they are not statistically different from zero. Even so, along the lines of Hoddinott et al. (2010), results suggest that one day increase in off-farm labor reduces child labor by 1.82 percent at the mean. Hence, if the program increases off-farm labor by 23 days per month, it would reduce child labor by at least one day per month. Furthermore, it is important to note that the effect of the labor shock on the supply of on-farm labor is negative in almost all cases. Nonetheless the coefficients are only statistically different from zero when the capital proxy is the value of farming tools. In these cases, labor shocks reduce the supply of adult by 51 percent at the mean and child labor by 42 percent at the mean.

Similarly, results in Table 4 suggest that labor and capital inputs may be complements or substitutes depending on the capital proxy used. In particular, while on-farm labor and the units of livestock seem to be substitutes; on-farm labor and the value of farming tools seem to be complements. In this case, a reduction of adult labor would increase the units of livestock by 2.75 percent at the mean but would decrease the value of farming tools by 3 percent. Likewise, a reduction in child labor would decrease the value of farming tools by 18.5 percent. Finally, as expected, a shock in capital inputs (i.e., theft or death of livestock) has a negative effect on the stock of capital.

This set of results indicate that participation on Public Works had a significant effect on off-farm labor. In fact, participating in the program increased off-farm labor more than 4 times its value at the mean. Surprisingly, off-farm labor did not have any impact on adult labor on-farm but it had a negative impact on child labor. In this sense, regardless of the substitution or complementarity between capital and adult labor, capital accumulation is not affected through this channel. Likewise, the negative effect on the supply of child labor had a negative impact on the value of farming tools winch is equivalent to a reduction of 0.2 percent in this type of capital.

6. Conclusion

The high proportion of food insecure households accompanied by the high risk of droughts in Ethiopia were the main causes of the creation and implementation of the "Productive Safety Nets Program" (PSNP) in Ethiopia. Although the intervention took place for four years (2005-2009), there are not any analyzes that cover this period of time. Since the goal of the PSNP is to avoid households' asset depletion through the provision of off-farm labor and

cash transfers, it is important to understand the impact of the program on households' asset holdings before the implementation of its third phase. Furthermore, based on the design of the PSNP, a more complete analysis would consider the possible substitution effect between labor and capital inputs for those participating in the Public Works(PW) component of the program.

Following Sadoulet et al. (1996), an increase in off-farm wages may induce farmers to crowd out on-farm labor. Under this assumption, the program would reduce on-farm labor and perhaps capital accumulation. To understand this effect, one should consider that capital and labor decisions at the household level may be simultaneous. Along these lines, if capital and labor are complements it may be the case that a reduction in labor may generate a reduction in capital. However, if these inputs are substitutes, a reduction in labor may cause an increase in capital. Thus, the PW may be an effective policy in increasing household assets and hence would be efficient in reducing long term poverty.

I test the predictions of the model using Ethiopian Rural Household Surveys (ERHS) from 2004 (baseline) and 2009. Using a model of three simultaneous equations, I find that PW had a negative effect on the supply of child labor for agricultural production. However, I do not find evidence that the program had a negative effect on adult labor on-farm. Thus, there is not evidence suggesting that the program affected negatively the accumulation of capital by crowding out on-farm labor. Likewise, I find some evidence indicating that while the units of livestock and labor inputs are substitutes, the value of farming tools and labor inputs are complements. Finally, results also suggests that off-farm labor my be a mechanism that households use to cope labor shocks. However, these effects are not any different for those participating in PW.

The results of this paper pose some important questions for future research and policy makers in Ethiopia. First, while the program has not crowed out on-farm adult labor but has decreased child labor, it would be important to understand the mechanism in which the program could enhance capital accumulation. Second, it seems that households who face labor shocks increase their supply of off-farm labor. Therefore, if off-farm labor is used as a risk coping mechanism, it would be interesting to analyze the effect of this on other risk sharing strategies.

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7. Appendix

7.1 Tables

Table 1: Summary Statistics

	2004			2009		
Variable	Participant	Non-participant	t-stat	Participant	Non-participant	t-stat
Value of livestock	1,762	3,592.77	-9.51***	4,876.09	9,269.07	-6.86***
Units of livestock	1.941	3.924	-10.23***	3.397	5.472	-6.97***
Units of oxen	0.657	1.082	-5.21***	0.734	1.023	-3.90***
Household size	5.552	5.887	-1.71*	5.884	5.787	0.51
Real consumption per-capita	65.91	94.68	-5.53***	49.19	63.07	-3.72***
Value of farming assets	292.53	616.47	-5.33***	1,679.94	3,043.11	-3.85***
Number of farming assets	7.975	16.75	-10.88***	31.91	55.83	-10.74***
Household is poor	0.435	0.360	1.78*	0.670	0.471	5.05***
Males in household	1.241	1.506	-2.87**	1.520	1.600	-0.89
Average age male households	36.51	38.222	-1.20	35.05	37.97	-2.26**
Distance to center of town	105.92	59.48	4.93***	105.92	59.48	4.93***
Shock in t	0.220	0.405	-5.07***	0.664	0.523	3.58***
Days worked adult labor (month)	12.91	15.47	-1.41	20.78	17.96	1.06
Days worked child labor (month)	2.554	2.872	-0.38	2.98	3.216	-0.19
Days off farm labor-PW included (month)	2.054	1.520	0.95	26.66	3.728	17.32***
Days off farm labor (month)	2.054	1.520	0.95	14.27	3.728	12.45***
Days PW (month)				12.39	0	20.00***

Table 2: Difference in Means

	Participants			Non-participants			Diff
Variable	2004	2009	Diff	2004	2009	Diff	in Diff
Value of livestock	1,762.00	4,876.09	3,114.09***	3,592.77	9,269.07	5,676.30***	-2,562.21
Units of livestock	1.94	3.40	1.46***	3.92	5.47	1.55***	-0.09
Units of oxen	0.66	0.73	0.08	1.08	1.02	-0.06	0.14
Household size	5.55	5.88	0.33	5.89	5.79	-0.10	0.43
Real consumption per-capita	65.92	49.20	-16.72***	94.69	63.07	-31.61***	14.90
Value of farming assets	292.53	1,679.94	1,387.41***	616.47	3,043.11	2,426.64***	-1,039.23
Number of farming assets	7.98	31.91	23.94***	16.75	55.84	39.08***	-15.14
Household is poor	0.44	0.67	0.23***	0.36	0.47	0.11***	0.12
Males in household	1.24	1.52	0.28**	1.51	1.60	0.09**	0.19
Average age male households	36.51	35.05	-1.46	38.22	37.98	-0.25	-1.21
Distance to center of town	105.92	105.92	0.00	59.49	59.49	0.00	0.00
Shock in t	0.22	0.66	0.44***	0.41	0.52	0.12***	0.33
Days worked adult labor (month)	12.92	20.79	7.87***	15.48	17.96	2.48**	5.39
Days worked child labor (month)	2.55	2.98	0.43	2.87	3.22	0.34	0.08
Days off farm labor-PW included (month)	2.05	26.67	24.61***	1.52	3.73	2.21***	22.40
Days off farm labor (month)	2.05	14.28	12.22***	1.52	3.73	2.21***	12.22
Days PW (month)	0.00	12.39	12.39***	0.00	0.00		12.39

Table 3: Correlation between Public Works participation and production inputs

	Adult family labor	Child labor	Off-farm labor	Units Livestock	Log Value Farming Assets
VARIABLES	(1)	(2)	(3)	(4)	(5)
Public Works	-2.549	-1.497***	22.40***	-1.028***	0.155
	(1.721)	(0.487)	(1.461)	(0.285)	(0.109)
Year 2009	5.463***	1.717***	2.208***	2.683***	1.701***
	(1.324)	(0.448)	(0.358)	(0.158)	(0.041)
Constant	7.721***	1.240***	1.605***	3.023***	5.411***
	(0.564)	(0.189)	(0.187)	(0.0802)	(0.195)
Observations	2,200	2,200	2,200	1,898	2,154
Dependent Variable					
Mean	10.25	1.98	4.47	4.48	6.256
Std dev	27.97	8.96	11.07	5.02	1.535

Errors clustered by household.Household FE included.

Table 4: Effect of PW participation: Structural Model

	Off farm labor			
	(1)	(2)	(3)	(4)
Public Works	22.82***	23.30***	22.80***	22.97***
	(1.359)	(1.322)	(1.359)	(1.318)
Labor shock	1.236***	1.605***	1.243***	1.374***
	(0.577)	(0.526)	(0.577)	(0.525)
Labor shock*Public Works	-0.413	-0.520	-0.409	-0.392
	(1.745)	(1.681)	(1.744)	(1.675)
On-farm labor variables	Adult labor		Child labor	
Off-farm labor	-0.015	-0.011	-0.006***	-0.011***
	(0.010)	(0.011)	(0.002)	(0.003)
Labor shock	-0.368	-0.876***	0.009	-0.139*
	(0.235)	(0.261)	(0.062)	(0.079)
Capital variables	Units of livestock	Log(Value Famring Tools)	Units of livestock	Log(Value Famring Tools)
On-farm labor	-0.123***	0.029***	-0.104	0.185***
	(0.029)	(0.007)	(0.115)	(0.023)
Capital shock	-1.645***	-0.436***	-1.688***	-0.438**
	(0.515)	(0.208)	(0.517)	(0.207)

3SLS. Household FE included.

Figure 1: Average days worked in Public Works per household

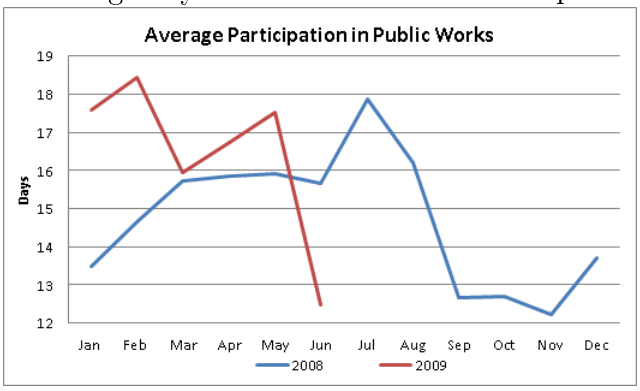

Figure 2: Probability of Participation in the Program vs. real consumption per-capita 2009

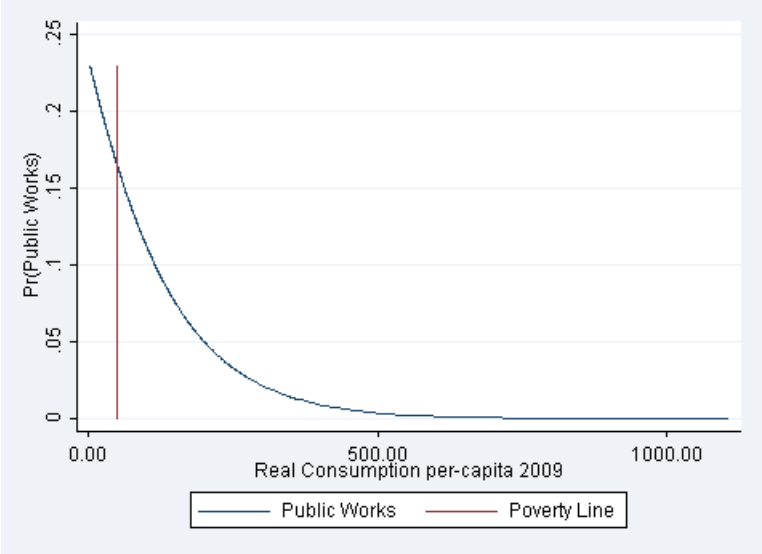

Figure 3: Probability of Participation in the Program vs. real consumption per-capita 2009