Do cooperatives benefit the poor? Evidence from Ethiopia

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Abstract

This paper analyzes how producer cooperatives may benefit households in rural environments. In particular, it explores if cooperatives help poor households to exit poverty through three mechanisms: increases in prices, total factor productivity, and relaxation of credit constraints. In a multi-period model I characterize the conditions that must hold so that the "always" poor can exit poverty when participating in cooperatives. I test the implications of the model using the Ethiopian Rural Household Surveys (ERHS) from 1997, 1999, 2004 and 2009. Preliminary results indicate that although cooperatives have a positive impact increasing household's productivity, they have a negative effect on the access to higher technologies.

1. Introduction

In recent years, many developing countries have presented cooperatives as one development strategy that may empower communities to exit poverty (Develtere et al., 2008; Emana, 2009,). However, despite the potential gains that cooperatives have for poor rural communities (e.g., increasing bargaining power of smallholders in imperfect markets; facilitating

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access to new markets; allowing communities to share risk collectively), it is not clear if they can achieve these gains (Bernard et al., 2010). In fact, studies have shown that poor households are less likely to participate in cooperatives and that in most cases, cooperatives are located in areas where access to markets are better than average. This suggests that cooperatives tend to favor better-off households (i.e., more educated and with more land) (Bernard et al., 2008).

Following Carter and Barrett (2006), a poverty reduction policy should be oriented for those individuals who otherwise would not be able to climb out of poverty on their own. They propose the analysis of an asset-based approach to poverty which differentiates between transitional and structural poverty by identifying an asset threshold at which individuals can escape poverty (i.e., above this threshold a poor individual could escape poverty in the long run, but below this threshold he would be "trapped" in poverty). Therefore, if cooperatives are meant to reduce poverty, it is necessary to understand if poor smallholders participate in cooperatives and if this participation provides a means to exit poverty for those individuals who are structurally poor.

Based on the theory of asset dynamics and poverty traps (Barrett et al. 2008; Carter and Barrett 2006; Carter and Ikegami 2007; Fletschner and Carter 2008), this paper presents a theoretical model that explores the conditions under which a producer may benefit from a cooperative. A feature of my analysis is the inclusion of labor in the production function. A limitation of the models that do not consider labor in the production function is that further analysis regarding how substitution between capital and labor inputs affect market power cannot be done (Sexton and Lavoie, 2001). This addition is relevant to consider, especially in scenarios of industries with market power.

I assume that producers choose between a high and a low production technology. In equilibrium, producers who always use the low technology are always poor. However, a poor producer that chooses the high technology is able to exit poverty in the long run. The high technology is always preferred to the low technology once a producer achieves a certain level of capital which I define as the technology adoption frontier. Comparative dynamics of the model suggest that an increase in prices, total factor productivity (TFP) of the high technology, or a decrease in credit constraints may decrease poverty by facilitating poor households access to the high technology. The model predicts that the best policy would be to increase the TFP of the high technology. The second best policy varies according to the parameters of the model. For example, a percentage decrease in the fixed costs of accessing the high technology (i.e., relaxation of credit constraints) is better than a percentage increase in prices of the same magnitude if the output elasticity of labor is smaller than $\frac{1}{2}$ (i.e., an industry with market power). On the other hand, a policy that increases the TFP of the low technology discourages producers to invest in the high technology. In this case, the magnitude of the reduction in poverty would be the lowest.

To test the predictions of the model, I use the Ethiopian Rural Household Surveys (ERHS) from 1997, 1999, 2004 and 2009. These surveys include information of 1,477 households in 15 villages of Ethiopia in each round. My empirical strategy focuses on regressing yearly productivity (profits/ha) and access to a high technology on yearly participation in cooperatives and other exogenous variables. I found that whereas the impact of cooperatives on households productivity was positive, it was negative on access to a high technology. These results may suggest that cooperatives increase the productivity of the low technology discouraging households to invest in a high technology that would take them out of poverty in the long term.

This paper is organized in four parts including this introduction. Section two develops the theoretical model of households' capital accumulation. Section three shows comparative dynamics and explores how cooperatives may facilitate access to the high technology trough three mechanisms: increasing prices and TFP, and reducing the fixed costs of accessing the high technology. Section four describes the data, presents summary statistics, the identification strategy and its results. Finally, section five presents conclusions.

2. Theoretical Framework

Here I present a household model where households derive their income from selling their production of an agricultural commodity (e.g., cocoa, rice, corn, coffee) Y_t. Inputs for the production of Y_t are labor l_t and capital k_t. While households are endowed with a fixed amount of labor each period $\overline{L}$, they can buy additional units of labor in the market at a wage w. Therefore the total labor employed in the production of their commodity is given by the units of their own labor l^{in}, plus the units of labor bought in the market l^{out} such that $l = l^{in} + l^{out}$. Households can also accumulate capital by investing each period such that $i_t = k_{t+1} - (1-\delta)k_t$, where δ is depreciation.

Suppose that each household has preferences over an infinite stream of consumption $c = \{c_t\}_{t=0}^{\infty}$ and labor $l^{in} = \{l_t^{in}\}_{t=0}^{\infty}$ given by a time-separable utility function of the form:

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

where u is assumed to be continuous, positive monotonic and concave. β is the household discount factor and is assumed to be $0 < \beta < 1$. Its income is used to buy private goods c, capital k, and labor l^{out}. It derives utility from consumption on private goods and leisure.

The production process for agricultural goods can be described by $F(k\,,l,\,A)$, where k and l are the capital and labor devoted to the production of the agricultural good, and A is a production shifter. Each period the household decides its consumption level, and the units of labor and capital that it is going to allocate in the production of the agricultural good. Under perfect certainty, the maximization problem is given by:

$$
\begin{aligned}
Max\, u(c_t,\, l_t^{in}) & \quad st\, \forall\, t \\
P_t F_t(k_t,\, l_t,\, A) &\geq c_t + i_t + w l_t^{out} \\
i_t &= k_{t+1} - (1-\delta)k_t \\
c_t &\geq 0 \\
l_t^{in} &\leq \overline{L} \\
l_t^{out} &\geq 0
\end{aligned}
$$

I assume that preferences follow the functional form specified in (1). Where γ is the risk aversion of the household and θ is the Frisch elasticity of labor supply.

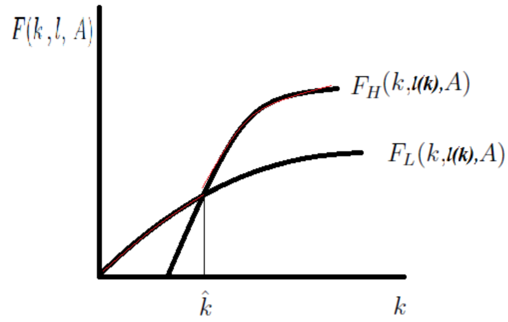
$$U(c,\, l^{in}) = \frac{1}{1-\gamma}\left(c - \frac{l^{in^{(1+\theta)}}}{1+\theta}\right)^{1-\gamma} \tag{1}$$

Following Barrett et al. (2008), I assume that producers have access to two types of technologies described by the following functions:

$$F(k,\, l,\, A) \quad = \quad \begin{cases} F_L(k,\, l,\, A) & = A_L k^{\alpha} l^{\zeta} \\ F_H(k,\, l,\, A) & = A_H k^{\alpha} l^{\zeta} - E \end{cases} \tag{2}$$

Where $A_L < A_H$, $\alpha + \zeta < 1$, and $E > 0$ is the cost of employing $F_H\,(k,\, l,\, A)$. Each producer will choose the high technology when a given combination of inputs $\hat{l}$ and $\hat{k}$, makes $F_L\left(\hat{k},\, \hat{l},\, A_L\right) \leqslant F_H\left(\hat{k},\, \hat{l}\, A_H\right)$. Therefore, the producer chooses his technology according to $F(k,\, l,\, A) = max\,\{F_L(k,\, l,\, A),\, F_H(k,\, l,\, A)\}$ which is the upper envelope of both technologies (Figure 1).

Figure 1



After clarifying assumptions and general functional forms that represent production and utility, I rewrite the model as a dynamic programming problem and proceed to solve it.

$$V(k) = Max_{A,c,l}\left\{U(c,\, l^{in}) + \beta V(k^{'})\right\} \qquad st: \tag{3}$$

$$c + k^{'} - (1-\delta)k + wl^{out} = PF(k,\, l,\, A) \tag{4}$$

$$c \geq 0,\ l^{out} \geq 0 \quad , \quad \bar{L} \geq l^{in} \tag{5}$$

The maximization problem can be rewritten as:

$$V(k) = Max_{A,k^{'},l}\left\{U(c\left(k,\, k^{'},\, l^{in},\, l^{out}\right),\, l^{in}) + \beta V(k^{'})\right\} \tag{6}$$

The first order conditions are given by equations (7)[1], (8), and (9):

$$\frac{\partial V(k)}{\partial k^{'}}: \quad \frac{\partial U(c, l^{in})}{\partial c} = \beta \frac{\partial U(c^{'}, l^{in^{'}})}{\partial c^{'}} \left[P^{'}\frac{\partial F(k^{'},\, l^{'},\, A^{'})}{\partial k^{'}} + (1-\delta)\right] \tag{7}$$

$$\frac{\partial V(k)}{\partial l^{in}}: \frac{\partial U(c,\, l)}{\partial c} P \frac{\partial F(k,\, l,\, A)}{\partial l^{in}} = -\frac{\partial U(c,\, l)}{\partial l^{in}} \tag{8}$$

$$\frac{\partial V(k)}{\partial l^{out}}: \quad \frac{\partial U(c,l)}{\partial c}\left[P\frac{\partial F(k,l,A)}{\partial l^{out}} - w\right] = 0 \tag{9}$$

[1] $\frac{\partial V(k)}{\partial k^{'}} : \frac{\partial U(c,\, l^{in})}{\partial c} - \beta \frac{\partial V(k^{'})}{\partial k^{'}} = 0$

Using the envelope theorem, I can get $\frac{\partial V(k^{'})}{\partial k^{'}}$:

$\frac{\partial V(k)}{\partial k} : \frac{\partial U(c,\, l^{in})}{\partial c}\frac{\partial c}{\partial k}$

$\frac{\partial V(k)}{\partial k} : \frac{\partial U(c,\, l^{in})}{\partial c}\left[P\frac{\partial F(k,l,A)}{\partial k} + (1-\delta)\right]$

Updating $\frac{\partial V(k)}{\partial k}$ one period forward and using this in $\frac{\partial V(k^{'})}{\partial k^{'}}$, I get:

$\frac{\partial V(k)}{\partial k^{'}} : \frac{\partial U(c,\, l^{in})}{\partial c} = \beta \frac{\partial U(c^{'},\, l^{in^{'}})}{\partial c^{'}}\left[P^{'}\frac{\partial F(k^{'}, l^{'}, A)}{\partial k^{'}} + (1-\delta)\right]$

The results in equations (7), (8), and (9) indicate that the marginal rate of substitution of labor and consumption has to be equal to the marginal productivity of labor, and that the inter-temporal rate of substitution of consumption has to be equal to the value of the marginal product of capital. Rewriting the first order conditions using the functional forms of utility and production, I get:

$$\frac{\partial V(k)}{\partial k'} : \left(c - \frac{l^{in(1+\theta)}}{1+\theta}\right)^{-\gamma} = \beta\left(c' - \frac{l^{in'(1+\theta)}}{1+\theta}\right)^{-\gamma}\left[P'\alpha A'k'^{\alpha-1}l'^{\zeta} + (1-\delta)\right] \tag{10}$$

$$\frac{\partial V(k)}{\partial l^{in}} : P\zeta Ak^{\alpha}l^{\zeta-1} = l^{in^{\theta}} \tag{11}$$

$$\frac{\partial V(k)}{\partial l^{out}} : P\zeta Ak^{\alpha}l^{\zeta-1} = w \tag{12}$$

Let $MRS = \frac{MU_c}{MU_{c'}}$. Then, I can write (10) in terms of the inter-temporal marginal utility of consumption to get the rule of capital accumulation.

$$k' = \left(\frac{P'\alpha A'l'^{\zeta}}{\frac{MRS}{\beta} - (1-\delta)}\right)^{\frac{1}{1-\alpha}} \tag{13}$$

From (11) and (12) I get the optimal decisions of labor such that l^{in} and l^{out} are given by:

$$l^{in} = w^{\frac{1}{\theta}} \tag{14}$$

$$\begin{aligned} P\zeta Ak^{\alpha}\left(l^{in} + l^{out}\right)^{\zeta-1} &= w \\ \left(l^{in} + l^{out}\right)^{\zeta-1} &= \frac{w}{P\zeta Ak^{\alpha}} \\ l &= \left(\frac{w}{P\zeta Ak^{\alpha}}\right)^{\frac{1}{\zeta-1}} \qquad (15) \\ l^{out} &= \left(\frac{w}{P\zeta Ak^{\alpha}}\right)^{\frac{1}{\zeta-1}} - w^{\frac{1}{\theta}} \qquad (16) \end{aligned}$$

Steady State

Assume $A' = A$. Let $\rho = \left(\frac{1}{\beta} - (1-\delta)\right)$. In steady state, $\frac{\partial U(c, l^{in})}{\partial c} = \frac{\partial U(c', l^{in'})}{\partial c'}$, which implies that the marginal rate of substitution of inter-temporal consumption is 1. Replacing this condition in (13), the levels of capital and labor in steady state are given by (17), and (18) below:

$$k_{ss}^{*} = \left(\frac{P\alpha A l_{ss}^{*\zeta}}{\rho}\right)^{\frac{1}{1-\alpha}}$$

$$k_{ss}^{*} = \left(\frac{1}{PA}\left(\frac{\rho}{\alpha}\right)^{1-\zeta}\left(\frac{w}{\zeta}\right)^{\zeta}\right)^{\frac{1}{\alpha+\zeta-1}} \tag{17}$$

Finally, I replace the expression above in equation (15) to get the level of labor in the steady state:

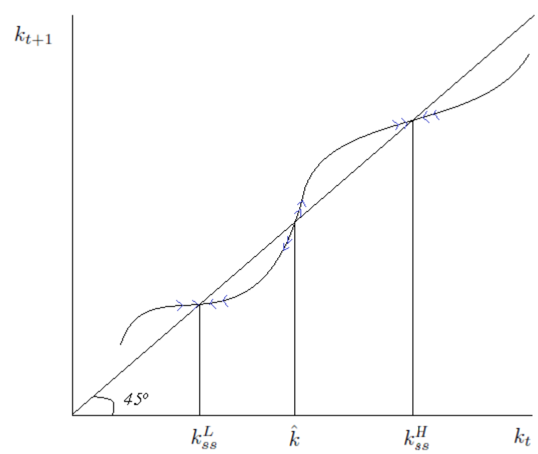
$$l_{ss}^{*} = \left(\frac{w}{P\zeta A}\right)^{\frac{1}{\zeta-1}} k_{ss}^{*\frac{-\alpha}{\zeta-1}}$$

$$l_{ss}^{*} = \left(\frac{w}{P\zeta A}\right)^{\frac{1}{\zeta-1}} \left[\left(\frac{1}{PA}\left(\frac{\rho}{\alpha}\right)^{1-\zeta}\left(\frac{w}{\zeta}\right)^{\zeta}\right)^{\frac{1}{\alpha+\zeta-1}}\right]^{\frac{-\alpha}{\zeta-1}}$$

$$l_{ss}^{*} = \left\{\frac{1}{PA}\left(\frac{w}{\zeta}\right)^{1-\alpha}\left(\frac{\rho}{\alpha}\right)^{\alpha}\right\}^{\frac{1}{\zeta+\alpha-1}} \tag{18}$$

Note that $k_{ss}^{*}$and l_{ss}^{*} are increasing in the technology level. Therefore, I define the steady state levels of $F_i(k,\, l,\, A)$ as $k_{i_{ss}}^{*}$, and $l_{i_{ss}}^{*}$ where $i = H, L$. $k_{H_{ss}}^{*} > k_{L_{ss}}^{*}$, and $l_{H_{ss}}^{*} > l_{L_{ss}}^{*}$. In equilibrium, producers accumulate capital to one of the steady state levels $\left(k_{H_{ss}}^{*},\, l_{H_{ss}}^{*}\,; k_{L_{ss}}^{*},\, l_{L_{ss}}^{*}\right)$ depending on the technology they use (dynamic behavior).

Figure 2



Denote $\hat{k}$ and $\hat{l}$ as the technology adoption frontier levels, that is the level of capital and labor that make producers indifferent between using high and low technology, such that

$F_L(\hat{k}, \hat{l}, A_L) = F_H(\hat{k}, \hat{l}, A_H)$. If producers have an initial level of capital and labor such that $(k_0, l_0) \geqslant \left(\hat{k}, \hat{l}\right)$, they will be able to use the high technology from period 0 and will end up at the high steady state $\left(k^*_{H_{ss}}, l^*_{H_{ss}}\right)$. Furthermore, if $k_0 < \hat{k} \leqslant k^*_{L_{ss}}$, producers start with the low technology, but eventually would switch to the high technology ending up at the high steady state. Conversely, if $k_0 \leqslant k^*_{L_{ss}} < \hat{k}$ producers will end up at the low steady state $\left(k^*_{L_{ss}}, l^*_{L_{ss}}\right)$.

3. Evaluating Cooperatives as Policy Intervention

Following Carter and Ikegami (2007), producers can be classified in three different categories according to their dynamic behavior and poverty trajectories. Those who always converge to the poor steady state independently of their initial level of capital; those who, independently of their initial level of capital, always converge to the high steady state, and those who are able to exit poverty because they adopt the high technology.

From equation (2), the levels of capital and labor that make producers indifferent between technologies are given by $\hat{k}$ and $\hat{l}$ such that $A_L\hat{k}^\alpha\hat{l}^\zeta = A_H\hat{k}^\alpha\hat{l}^\zeta - E$. Furthermore, I can define the level of labor $\hat{l}$ in terms of $\hat{k}$ as in equation (18). Solving for $\hat{k}$, I get that the adoption frontier level of capital is given by equation (19) below.

$$
\begin{aligned}
A_L\hat{k}^\alpha \left(\left(\frac{w}{P\zeta A_L\hat{k}^\alpha}\right)^{\frac{1}{\zeta-1}}\right)^\zeta &= A_H\hat{k}^\alpha \left(\left(\frac{w}{P\zeta A_H\hat{k}^\alpha}\right)^{\frac{1}{\zeta-1}}\right)^\zeta - E \\
\hat{k}^{\frac{\alpha}{1-\zeta}} \left(\frac{P\zeta}{w}\right)^{\frac{\zeta}{1-\zeta}} \left(A_H^{\frac{1}{1-\zeta}} - A_L^{\frac{1}{1-\zeta}}\right) &= E \\
\hat{k} &= \left(\frac{w}{P\zeta}\right)^{\frac{\zeta}{\alpha}} \left(\frac{E}{A_H^{\frac{1}{1-\zeta}} - A_L^{\frac{1}{1-\zeta}}}\right)^{\frac{1-\zeta}{\alpha}} \qquad (19)
\end{aligned}
$$

To examine if a policy intervention that promotes cooperatives is able to reach the poor and help them escape poverty, it is necessary to analyze if the cooperative benefits (i.e. increase in prices explained by the households' collective action, increase in the TFP if the cooperative offers technical assistance to its members, relaxation of credit constraints), are high enough so poor households are able to adopt the high technology. Along the lines of the model examined above, I will analyze separately if an increase in prices P, TFP A, or a decrease in the fixed costs of the high technology E would facilitate producers to move towards the high technology. Furthermore, through comparative dynamics, I will analyze what policy would have the highest impact in facilitating access to high technology.

3.1 Comparative Dynamics

According to equation (19), an increase in prices$P$, in the high technology A_H, or a decrease in the fixed costs of the high technology E will decrease the level of the technology adoption frontier. However, an increase in low technology A_L, will increase it. More specifically, the marginal effects are described by equations (20), (21), (22), and (23) below:

$$\frac{\partial \hat{k}}{\partial P} = -\frac{\zeta}{\alpha P}\left(\frac{w}{P\zeta}\right)^{\frac{\zeta}{\alpha}}\left(\frac{E}{A_H^{\frac{1}{1-\zeta}} - A_L^{\frac{1}{1-\zeta}}}\right)^{\frac{1-\zeta}{\alpha}} < 0 \tag{20}$$

$$\frac{\partial \hat{k}}{\partial A_H} = -\frac{1}{\alpha}\left(\frac{w}{P\zeta}\right)^{\frac{\zeta}{\alpha}}\left(\frac{E}{A_H^{\frac{1}{1-\zeta}} - A_L^{\frac{1}{1-\zeta}}}\right)^{\frac{1-\zeta}{\alpha}} \frac{A_H^{\frac{\zeta}{1-\zeta}}}{A_H^{\frac{1}{1-\zeta}} - A_L^{\frac{1}{1-\zeta}}} < 0 \tag{21}$$

$$\frac{\partial \hat{k}}{\partial A_L} = \frac{1}{\alpha}\left(\frac{w}{P\zeta}\right)^{\frac{\zeta}{\alpha}}\left(\frac{E}{A_H^{\frac{1}{1-\zeta}} - A_L^{\frac{1}{1-\zeta}}}\right)^{\frac{1-\zeta}{\alpha}} \frac{A_L^{\frac{\zeta}{1-\zeta}}}{A_H^{\frac{1}{1-\zeta}} - A_L^{\frac{1}{1-\zeta}}} > 0 \tag{22}$$

$$\frac{\partial \hat{k}}{\partial E} = \frac{1-\zeta}{\alpha E}\left(\frac{w}{P\zeta}\right)^{\frac{\zeta}{\alpha}}\left(\frac{E}{A_H^{\frac{1}{1-\zeta}} - A_L^{\frac{1}{1-\zeta}}}\right)^{\frac{1-\zeta}{\alpha}} > 0 \tag{23}$$

By definition $\frac{\partial \hat{k}}{\partial A_H} > -\frac{\partial \hat{k}}{\partial A_L}$. However, a comparison among the magnitude of the remaining marginal effects is not straightforward. Even so, I will establish the the following:

1. Assume that $\zeta A_H > P$. The marginal effect of an increase in the price P is greater than the marginal effect of an increase in high technology TFP A_H when the difference between technologies is high (i.e., $\frac{A_L}{A_H} \to 0$). Therefore, $\frac{\partial \hat{k}}{\partial P} > \frac{\partial \hat{k}}{\partial A_H}$ if $\left(1 - \frac{P}{\zeta A_H}\right)^{1-\zeta} \geqslant \frac{A_L}{A_H}$. Note that $A_H \ggg P$ when the output elasticity of labor is small (i.e., $\zeta \to 0$).

2. Assume that $E \geqslant P$. The marginal effect of an increase in the price P is greater than the marginal effect of a decrease in the fixed costs of accessing the high technology E if $\frac{E}{P} \geqslant \left(\frac{1-\zeta}{\zeta}\right)$ or always that the output elasticity of labor is greater than$\frac{1}{2}$, such that $\frac{\partial \hat{k}}{\partial P} > \frac{\partial \hat{k}}{\partial E}$ if $\zeta \geqslant \frac{1}{2}$. Note that $E \ggg P$ when the output elasticity of labor is small (i.e., $\zeta \to 0$).

3. The marginal effect of an increase in the high technology TFP A_H is greater than the marginal effect of a decrease in the fixed costs of accessing the high technology E, if $\frac{A_L}{A_H} \geqslant \left(1 - \frac{E}{A_H(1-\zeta)}\right)^{1-\zeta}$ or always that the fixed cost of accessing the technology is greater or equal to the value of the high technology such that $\frac{\partial \hat{k}}{\partial A_H} > \frac{\partial \hat{k}}{\partial E}$ if $E \geqslant A_H$.

It is important to note that the marginal effect of an increase in prices is increasing in the high technology TFP A_H, and decreasing on both low technology TFP A_L and the fixed cost of high technology E. Furthermore, the marginal effect of an increase in high technology TFP A_H is increasing in the price P and decreasing on both the low technology TFP A_L and the fixed cost of high technology E. Finally, the marginal effect of a decrease in the fixed costs E, increases on both the price P and the high technology TFP A_H, and decreases on low technology TFP A_L.

By taking the logarithm of equation (19), I can express $\hat{k}$ in terms of its percentage changes $\frac{\dot{\hat{k}}}{\hat{k}} = \frac{\hat{k}_{t+1}-\hat{k}_t}{\hat{k}_t}$ as in the equation below:

$$\frac{\dot{\hat{k}}}{\hat{k}} = -\frac{\zeta}{\alpha}\frac{\dot{P}}{P} + \frac{1-\zeta}{\alpha}\frac{\dot{E}}{E} - \frac{1}{\alpha} \quad \frac{1}{A_H^{\frac{1}{1-\zeta}} - A_L^{\frac{1}{1-\zeta}}} \left(\frac{\dot{A_H}}{A_H} A_H^{\frac{1}{1-\zeta}} - \frac{\dot{A_L}}{A_L} A_L^{\frac{1}{1-\zeta}} \right) \tag{24}$$

From equation (24), the impact on $\frac{\dot{\hat{k}}}{\hat{k}}$ from a percentage increase in prices $\frac{\dot{P}}{P}$ is higher than the impact of a decrease in the fixed costs $\frac{\dot{E}}{E}$ of the same percentage when the output elasticity of labor is higher than $\frac{1}{2}$ (i.e., $\frac{\partial \dot{\hat{k}}/\hat{k}}{\partial \dot{P}/P} > -\frac{\partial \dot{\hat{k}}/\hat{k}}{\partial \dot{E}/E}$ if $\zeta > \frac{1}{2}$).

Therefore, cooperatives would facilitate access to the high technology through increases in prices, high technology TFP, or decreases in the fixed costs of accessing the high technology (e.g., relaxation of credit constraints). Although the marginal effect of each policy depends on the values of the parameters, a policy that increases prices would have the highest impact if $A_H \ggg P$, and $E \ggg P$ (i.e., $\frac{P}{A_H} > \zeta$ and $\frac{P}{E} > \zeta$). If this is the case, the second best policy would be to increase the high technology TFP always that $E \geqslant A_H$. Note that when the output elasticity of labor is low (i.e., $\zeta \rightarrow 0$), the difference between the price and the other two variables has to be significantly high for P to be the best policy. This is because a low output elasticity of labor, implies a low elasticity of supply which leads to market power in an oligopsonic industry. On the other side, a policy that promotes an increase in A_L, would increase the technology adoption frontier delaying the access to the high technology. In this case, the magnitude of the reduction in long term poverty is the lowest.

The comparative dynamics analyzed above are limited to the analysis of how changes in prices P, TFPs A or fixed costs of the high technology E impact the technology adoption frontier ($\hat{k}$) thresholds. Even so, changes in wages w, output elasticity of labor ζ, or output elasticity of capital α, also affect the variables of interest.

4. Data and Summary Statistics

4.1 Data

The data set used to test the implications of the model described in the previous section is the result of five rounds of the Ethiopian Rural Household Survey (ERHS) during 1994, 1997, 1999, 2004 and 2009. This data set was collected by the Economics Department, Addis Ababa University (Economics/AAU), the Centre for the Study of African Economies (CSAE), University of Oxford and the International Food Policy Research Institute (IFPRI), Washington DC. It covers information of 1,477 rural households in 15 villages from Ethiopia. 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, agriculture information (inputs and outputs), as well as community level data on NGO activity, production and marketing (Dercon and Hoddinott, 2011). At the household level, the surveys provide information of households that sell output, buy input, or access to credit in cooperatives. This information will be the proxy for cooperative membership/participation. Furthermore, the community level data provides information about the number of agricultural cooperatives per village. It also provides information about the closest cooperative outside the village. I will use this information as a proxy for access to cooperatives in each village.

4.2 Ethiopian Cooperatives and Summary Statistics

Cooperatives in Ethiopia were established in the 1950's. However, before 1991 they were based on "Marxist" principles whose goal was to end the capitalist "exploitation". During this period, the repressive Derg regime abused cooperatives and created prejudice against them (Kodama, 2007). In 1991 cooperative activities came to decline with the collapse of the Derg regime. With the change of government, the surviving cooperatives entered a transitional phase and few years after the collapse cooperatives were promoted and supported by the government and other non governmental agencies.

In 1998, the new government issued the "Cooperative Societies Proclamation" encouraging smallholders to organize into agricultural cooperatives based on the principles of a free-market economy. The goal was to improve living conditions of farmers through production and productivity, promoting self reliance, improving technology and increasing income. However, the lack of training and literacy of smallholders restricted the creation of cooperatives (Emana, 2009). In this sense, larger farmers seemed to have easier access to cooperatives.

With the new cooperatives proclamation and the decline of international prices of coffee, the government created six coffee farmers cooperative unions to manage coffee exports. At the same time, the Agricultural Cooperative Development International (ACDI) and Volunteers in Overseas Cooperative Assistance (VOCA) began implementing the USAID-funded five-year Agricultural Cooperatives in Ethiopia (ACE) project (Dorsey and Assefa, 2005). Most of the participants were drawn from the Oromia region due to its agricultural potential. The rest of the participants were drawn from Amhara, Tigray and the Southern regions (Assefa, 2005). The first ACDI/VOCA program (Cooperative Union Project - CUP) was implemented during 1998 and 1999 with the goal to enhance food security and rural income. The second program (Agricultural Cooperatives in Ethiopia - ACE) was implemented from 2000 to 2004, with goals similar to the CUP but also promoted women's participation in cooperatives, diversification of cooperative businesses, natural resource management and HIV/AIDS intervention. Among the benefits of these programs are increased bargaining power in marketing of outputs, access to credit and inputs at cheaper prices (Assefa, 2005).

In 2002, the Federal Cooperative Commission was established to reinforce the cooperative movement. The goal was to provide at least a cooperative in 70 percent of the Ethiopian municipalities (kebeles) by 2010. As of 2005, the share of cooperatives in municipalities increased from 10 percent in 1991 to 35 percent (Francesconi, 2009). Evidence of this is found in the data from the ERHS. According to the community level data in the 15 villages surveyed, the number of agricultural cooperatives increased from 5 in 1997 to 22 in 2009 (Figure 3). Furthermore, the number of households participating in a cooperative also increased between 1994 and 2009. Figure 4, shows the evolution of farmers in the ERHS participating in cooperatives between 1994 and 2009 for the major Ethiopian argi-commodities (i.e., teff, barley, wheat, maize and coffee). Note that participation is defined as when a farmer sells output, buys input, or accesses to credit in cooperatives. It is important to mention that in Ethiopia, membership is not required to participate from the cooperative services. The main difference between membership and non membership in agricultural or multi purpose cooperatives is the dividend shares that are exclusive to members.

In 2008, the Ethiopian Commodity Exchange was created to reduce uncertainty in agricultural markets and promote commercialization of the major Ethiopian agri-commodities. Membership to this markets is encouraged for cooperatives. This may explain the incidence of cooperatives in the major agri-commodity production sites in Ethiopia. Nowadays "agricultural cooperatives are the pillar of agricultural development" in Ethiopia. However, cooperatives still appear to be dependent on public support and in most of the cases they lack of managerial practices (Francesconi, 2009). Although, the government has promoted the involvement of cooperatives in the established commodity exchange, cooperative membership has had an insignificant impact on agri-commodity commercialization. In fact, only the minority of cooperatives engage activities of output marketing (i.e., marketing and multi purpose cooperatives). Although, these cooperatives often provide storage and higher prices for farmers output, these are not enough incentives for all farmers to ensure greater participation. Actually, poorer farmers tend to sell less and consume more. It may be the case that cooperatives fail to provide marketing services to their members because they operate in the context of rural communities where they are subject to social norms, social inclusion and solidarity (Francesconi, 2009). Evidence of the low participation in marketing cooperatives is found in the ERHS. The number of households selling their output to cooperatives was 1.29 percent in 1994 and declined to 1.13 percent in 1999.

On the other hand, the most prevalent service of cooperatives is the distribution of inputs. In fact, according to the ERHS data, the number of households buying fertilizer from cooperatives increased from 37.89 percent to 53.59 percent between 1994 and 1999 (Table 1). This is explained by the range of policies that the government has implemented to facilitate the access to improved seeds and chemical fertilizers (mainly Urea and DAP). In fact, whereas the shares of private companies in the Ethiopian fertilizer market decreased from 33 percent to 0 between 1995 and 1999, the shares of the public sector and cooperatives in this market increased from 50 percent to 100 percent in the same period (Spielman et al., 2011). Nowadays, cooperatives are the most important channel, if not the only one, to accessing to fertilizers and other subsidized agricultural inputs. However, they provide no incentives to small-scale entrepreneurship that would move farmers towards a higher technology or more profitable markets. In fact, research suggests that even if improved technology was made available in Africa, a large number of smallholder farmers could neither access nor sustain it (Francesconi, 2009).

Table 3 shows summary statistics of the data reported by households' participation in cooperatives. As mentioned before, participation is one if a household sells output, buys inputs, or access to credit from a cooperative. Note that most of the household characteristics are significantly different between participants and non-participants. Along with the findings of Bernard et al. (2008), it seems that participants are wealthier and more educated than non-participants.

4.3 Identification Strategy and Results

Some evidence from the ERHS indicates that the number of cooperatives and participants has increased between 1994 and 2009. Furthermore, it exists a positive correlation between technology choices (i.e., fertilizer and pesticides) and participation in cooperatives (Table 2).

However, as Bernard and Spielman (2009) suggest, it seems that participants are wealthier than non participants. In this sense, one may think that wealthier/more able households are more likely to participate in cooperatives. Therefore, the treatment (participants) and control (non participants) groups are not necessarily comparable in observable characteristics. For this reason, it is not likely that the treatment group would have had the same poverty trajectories without cooperatives (counter-factual) as the control group. A second challenge for the identification strategy is the bias due to unobservables (selection bias). It may be the case that some unobservables jointly influence the poverty trajectories of households and their participation decision conditional on some observables. It is possible that more "able/productive" households are more likely to participate in cooperatives. As a result, a simple regression that overlooks the source of endogeneity may overestimate the impact of cooperatives. Getting unbiased estimates depends on the assumption that each producer's productivity or technology choice must be uncorrelated with unobserved determinants of participating in a cooperative after controlling for observed determinants.

To address these problems, I will take advantage of the panel data and the natural experiments allowed by the establishments of cooperatives in different regions between 1994 and 2009. Note that existent cooperatives previous to 1998 were cooperatives functioning under a different regulation than cooperatives established after this time. Along the lines of the implications of the model described in sections two and three, I assume that cooperatives affect household's productivity and their access to a high technology. However, it may be the case that participation in a cooperative may be correlated with some unobservables that also affect the household's productivity and their access to the high technology. To account for this positive selection bias, I instrument each household's "ability" with the the productivity measure of 1994 (baseline) and interact it with the cooperative participation variable and a time fixed effect. In this case, I assume that the productivity of the farmer in 1994 is a good instrument of his "ability" previous to the existence of cooperatives and influences cooperative participation (Table 3). Furthermore, if more able farmers are more likely to participate in cooperatives, then the coefficient of the this term (ϑ) will be positive and statistically different from zero. The interaction with the time fixed effects intents to capture the increasing prevalence of cooperatives over time and the influence of this on cooperative participation. The equations to be estimated are the following:

$$\begin{aligned} Productivity_{i,t} &= \alpha_1 + \gamma_{1t} + \beta_{11} Productivity_{i,1994} + \sum_{t=2}^{4} \delta_{1j} (\gamma_t * Productivity_{i,1994}) \\ &\quad + \beta_{12} Coop_{i,t} + \vartheta_1 Coop * Productivity_{i,1994} + \beta_1 x_{i,t} + \varepsilon_{1i,t} \end{aligned} \tag{25}$$

$$Pr(High\,technology) = \alpha_2 + \gamma_{2t} + \beta_{21} Productivity_{i,1994} + \sum_{t=2}^{4} \delta_{2j}(\gamma_t * Productivity_{i,1994}) + \beta_{22} Coop_{i,t} + \vartheta_2 Coop * Productivity_{i,1994} + \beta_2 x_{i,t} + \varepsilon_{2i,t} \quad (26)$$

Where β_{12} and β_{22} is the parameter of interest and measures the impact of cooperative participation on the household productivity and his access to a high technology. $x_{i,t}$ is a vector of household time-varying covariates that are determinants of the productivity and the technology choice uncorrelated with the participation on cooperatives, γ_t is a time effect, $Productivity_{i,1994}$ is the productivity at the baseline year which is measured as profits (value of output-input costs) per hectare of all crops planted in 1994, and *Coop* indicates the household cooperative participation. It takes the value of 1 when the household buys inputs, sells output or accesses to credit from a cooperative in a given year. An alternate measure of cooperative participation is the number of cooperatives in a village. Although it would not measure the effect of cooperative participation, it would measure the effect of the cooperatives prevalence by village on the dependent variables.

The dependent variable in equation (25) is a measure of productivity (profits/ha) by year. Additionally, the dependent variable in equation (26) is a measure of the high technology (i.e, soil conservation and irrigation). An additional identification strategy will include household fixed effects. In this case, β_1, δ_j and ϑ will be equal to zero. This latter would give unbiased estimators under the assumption that cooperative participation is based on unobserved but fixed household characteristics.

The first set of regressions models the impact of cooperatives on household productivity. I included year fixed effects and two different measures of cooperatives participation. Table 4 reports the estimation results for equation (25), columns (6)-(9) include household fixed effects. The results are overall as expected: productivity increases with cooperative participation. For the parameter of interest, the cross section estimates are not statistically different from the fixed effects estimates. Therefore, the productivity and poverty measures at the baseline year may be good instruments for the unobserved variables that influence cooperative participation[2]. However, the interaction term between productivity and cooperative participation is negative in column (2). This suggests that the positive impact of cooperatives on productivity decreases with the productivity at the baseline (1994). As predicted by the theoretical model, cooperatives increase household productivity in Ethiopia. However, the impact is heterogeneous between households with the highest impact for less productive households. This may be explained by the type of services provided by cooper-

[2]Tables 7 and 8 include some regression results of these instruments on cooperative participation.

atives. Note that cooperatives have been essential in the provision of fertilizer and seeds. Therefore, the marginal benefit of participating in a cooperative for a household with high productivity would be small if he did not face problems/barriers of accessing to these inputs previously to the establishments of cooperatives.

The second set of regressions models the impact of cooperatives on the access to high technology. Tables 5.1 and 6.1 report the estimation results for equation (26) with a probit model. The dependent variable in Table 5.1 takes the value of 1 if the household has practices of soil conservation (terracing) and 0 otherwise. Conversely, the dependent variable in Table 6.1 takes the value of 1 if the household has irrigation on his plots. Interestingly, the impact of cooperatives in both technologies is consistently negative. In fact, it seems that the prevalence of cooperatives by village makes this negative impact bigger. As before, the results with fixed effects are not significantly different from the cross section estimates. The average marginal effects of the variables of interest are found in tables 5.2 and 6.2. According to these results, cooperative participation decreases the probability of accesing to soil conservation practices in 14 percent. Furthermore, the probability of accesing to irrigation systems may decrease in 3-7 percent when participating in a cooperative. Along the lines of the predictions of the model, the negative impact of cooperatives on the access to high technologies can be explained by increases in the low technology productivity that discourage households to invest in high technologies.

5. Conclusions

This paper aims to analyze if cooperatives are effective in reducing poverty in rural Ethiopia. Some evidence from recent research in Africa (Bernard et al., 2008) suggests that better-off households are more likely to participate in cooperatives. However, it is not clear if structurally poor households could exit long term poverty through participation in cooperatives (i.e., easier access to high technologies). If this is the case, cooperatives may be an effective policy reducing poverty. Otherwise, cooperatives should be accompanied with other policy interventions that enhance capital accumulation or promote the access to high technologies amongst the persistently poor.

The theoretical model developed in section 2, considered exogenous changes on different variables on the production side of the household. However, when farmers participate in a cooperative that sells their product to an oligopsonic industry, one would expect the farmers' bargaining power to increase with the number of farmers participating in that cooperative. If the industry is oligopsonic, in equilibrium the price that farmers receive for their product is lower than the price they would receive in a competitive market. Therefore, if forming a cooperative increases the farmers' market power in the industry, the price that farmers receive when a cooperative exists would be higher than the price in the purely oligopsonic case. This price would be something in between the oligopsonic and the competitive equilibrium prices (i.e., $P^{PC} \geqslant P^{Coop} > P^{O}$). If this is the case, the price that farmers receive when selling their output should not be treated as exogenous. Actually, it would depend on the elasticity of supply of the farmers' output, their aggregate supply, and the market power of the oligopsony. Comparative dynamics suggest that when the elasticity of supply is low, an increase in prices would not be the best policy to facilitate access to high technology. Future work will estimate the elasticity of supply of the farmers' output, the degree of market power in the oligopsony along with the minimum proportion of farmers that are required to participate in the cooperative to gain some bargaining power. Note that in average only 20% of smallholders producers participated in cooperatives or producer associations in 2005 (Bernard et al., 2008).

Nonetheless, the goal of this paper is to understand how cooperatives may reduce poverty though facilitating access to a high technology. Some limitations of this model are the assumption of an exogenous price, the exclusion of a labor market for producers, the assumption of homogeneity between labor hired and own labor and the exogeneity of the benefits provided by the cooperative. Furthermore, this model relies on the long run dynamic behavior and poverty trajectories of households. Therefore, further analysis about the short run impacts on poverty cannot be done. However, from a policy making perspective, allocating resources overlooking long run effects could result more inefficient than overlooking short run effects.

Based on the theoretical model, I explore the conditions under which a producer benefits from a cooperative. I analyze the testable implications of the model using a four year panel data (i.e., 1997, 1999, 2004 and 2009) from the Rural Household Surveys from Ethiopia. Results suggest that participation in cooperatives increased households productivity during this period. However, it did not facilitate the access to high technologies (i.e., soil conservation practices and irrigation). In fact, cooperative participation had a negative effect on the access to high technologies. This may be explained by the fact that cooperatives have been important in the provision of inputs like fertilizers and seeds in Ethiopia. While accessing to subsidized fertilizer and seeds increase total factor productivity of households, it does not encourage investment in high technologies. Therefore, cooperatives may be increasing the total factor productivity of low technologies while delaying the access to high technologies and hence a structural reduction in poverty. A second version of this paper will include additional instruments to control for the positive selection bias of households that participate in a cooperative: the distance from each household to the closest cooperative, an alternative measure of productivity (i.e, estimated total factor productivity), and climate variables at the village level. The results of this paper pose some important questions for future research and policy makers in Ethiopia. First, what has to be done/changed to encourage farmers to access to high technologies? Second, if cooperatives encouraged access to high technologies, can poor households sustain them?

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6. Appendix

Table 1

Percentage of households using services from a cooperative

Service	1994	1997	1999
Marketing	1.29%	1.56%	1.13%
Fertilizer	37.89%	50.82%	53.59%
Pesticides	45.79%	15.72%	27.63%
Credit		5.2%	

Source ERHS, estimates author

Table 2

Correlation between inputs and cooperative participation

Input bought	1994	1997	1999	2004	2009
Fertilizer	0.1994	0.1285	0.4625	0.442	0.4472
Pesticides	0.1183	0.1838	0.2272	0.2544	0.2412
Tractors		0.0226	0.0039	0.0275	0.0161
Transportation		0.0138	0.1433	0.0379	0.0181
Seeds			0.0239	0.1095	0.0386

Source ERHS, estimates author

Table 3

Summary Statistics					
	Coops =0 (N=5,085)		Coops =1 (1,423)		
	Mean	Std. Dev.	Mean	Std. Dev.	t-stat ($H_0 : \mu_1 = \mu_2$)
Value of livestock in HH	3239.20	6094.53	5075.62	7862.16	-8.17***
Units of livestock in HH	3.24	3.97	4.06	4.28	-6.55***
Units of tropical oxen in HH	0.69	1.10	1.11	1.33	-7.83***
HH has any oxen	0.38	0.49	0.53	0.50	-6.95***
Total food consumption in HH	425.54	416.25	681.82	632.74	-14.43***
Total consumption in HH	538.51	524.02	865.00	791.99	-14.67***
Real consumption pcp in HH	78.84	83.87	84.36	82.59	-2.22***
HH size	5.81	2.74	6.13	2.53	-4.03***
HH is poor	0.42	0.49	0.38	0.49	2.65***
Plot area	1.42	1.45	1.78	0.81	-4.55***
Kgs purchased fertilizer	11.82	40.13	31.25	87.18	-5.3***
Expenses in fertilizer	33.05	110.58	116.9	250.55	-7.98***
Sex of Head	1.23	0.42	1.13	0.34	6.24***
Age of Head	45.05	15.52	46.48	15.37	-1.37
Literacy of Head	3.63	0.59	3.47	0.64	3.75***
Head Attended School	0.19	0.39	0.25	0.43	-3.31***
Years of School of Head	4.5	5.13	4.57	5.21	-0.19

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

Table 4

$$Productivity_{i,t} =$$
$$\alpha + \gamma_t + \beta_1 Productivity_{i,1994} + \sum_{t=2}^{4} \delta_j(\gamma_t * Productivity_{i,1994}) + \beta_2 Coop_{i,t} + \vartheta Coop * Productivity_{i,1994} + \beta x_{i,t} + \varepsilon_{i,t}$$

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Dependent Variable: Profits (birr)/ha (Value of output - Input costs /ha)						
Cooperative participation=1	179.8***	181.4***		133.1***	143.5***	135.2***	124.0***
	(25.70)	(25.70)		(20.48)	(35.20)	(19.84)	(19.96)
Number of cooperatives in village			-12.73				
			(18.45)				
Profits/ha 94	0.00535	0.0312**	0.00776				
	(0.00658)	(0.0129)	(0.00607)				
Poor 94=1				-189.0***	-187.7***		
				(31.09)	(31.01)		
Coop*Profits/ha 94		-0.0317**					
		(0.0136)					
Coop*Poor 94					-22.75		
					(38.60)		
Household size	-8.309***	-8.467***	-6.818**	-7.172***	-7.233***	-7.871***	-2.023
	(2.917)	(2.922)	(3.028)	(2.602)	(2.594)	(2.545)	(2.330)
Log Consumption							68.18***
							(14.03)
Constant	353.4***	353.3***	357.8***	431.9***	431.3***	354.3***	27.44
	(26.26)	(26.22)	(26.54)	(32.11)	(32.11)	(24.50)	(62.39)
Observations	4,010	4,010	4,010	4,747	4,747	4,943	4,943
R-squared	0.052	0.053	0.037	0.053	0.053		
Household FE	No	No	No	No	No	Yes	Yes
Number of households						1,356	1,356

Robust standard errors in parentheses, errors clustered at household level. Year FE included. *** p<0.01, ** p<0.05, * p<0.1

Columns (1)-(3) include the interaction of Profits/ha 94 with time. Columns (4)-(5) include the interaction of Poor 94 with time.

Table 5.1

$$Pr(Soil\,Conservation) = \alpha + \gamma_t + \beta_1 Productivity_{i,1994} + \sum_{t=2}^{4} \delta_j (\gamma_t * Productivity_{i,1994}) + \beta_2 Coop_{i,t} + \vartheta Coop * Productivity_{i,1994} + \beta x_{i,t} + \varepsilon_{i,t}$$

	Dependent Variable: $Pr(Soil\,Conservation = 1)$								
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Cooperative participation	-0.475***	-0.474***		-0.483***		-0.415***		-0.453***	
	(0.0549)	(0.0550)		(0.0647)		(0.0632)		(0.0628)	
Number of cooperatives in village			-0.607***		-0.552***		-0.545***		-0.580***
			(0.0404)		(0.0324)		(0.0438)		(0.0435)
Profits/ha 94	-0.00189**	-0.00187**	-0.00106						
	(0.000805)	(0.000803)	(0.000826)						
Poor94				0.372***	0.356***				
				(0.131)	(0.131)				
Coop*Profits/ha 94		-5.94e-05							
		(4.61e-05)							
Household size	0.0325***	0.0323***	0.0198*	0.0317***	0.0232**	0.0401***	0.0315***	0.0614***	0.0509***
	(0.0101)	(0.0101)	(0.0102)	(0.00911)	(0.00920)	(0.0121)	(0.0119)	(0.0125)	(0.0125)
Log Consumption								0.0808**	0.0659*
								(0.0388)	(0.0383)
Coop*Poor 94				-0.0590					
				(0.0976)					
Constant	-1.769***	-1.768***	-1.649***	-2.095***	-2.003***	-3.979***	-3.828***	-3.151***	-2.933***
	(0.0905)	(0.0904)	(0.0897)	(0.120)	(0.120)	(0.184)	(0.178)	(0.225)	(0.224)
Observations	4,044	4,044	4,044	5,030	5,030	4,621	4,621	5,228	5,228
Household FE	No	No	No	No	No	Yes	Yes	Yes	Yes
Number of households						1,345	1,345	1,356	1,356

Robust standard errors in parentheses, errors clustered at household level. Year FE included. *** p<0.01, ** p<0.05, * p<0.1

Columns (1)-(3) include the interaction of Profits/ha 94 with time. Columns (4)-(6) include the interaction of Poor 94 with time.

Table 5.2

Average Marginal Effects of Cooperative Participation*

	Dependent variable: $Pr(Soil\,Conservation = 1)$				
Variables	(1)	(2)	(3)	(4)	(5)
Cooperative participation	-0.145***	-0.144***		-0.145***	
	(0.0164)	(0.0164)		(0.0191)	
Number of cooperatives in village			-0.178***		-0.159***
			(0.0110)		(0.00874)
Observations	4,044	4,044	4,044	5,030	5,030

Robust standard errors in parentheses, errors clustered at household level. Year FE included. *** $p< 0.01$, ** $p< 0.05$, * $p< 0.1$

*Regression results from probit model in Table 5.1

Table 6.1

$$Pr(Irrigation) = \alpha + \gamma_t + \beta_1 Productivity_{i,1994} + \sum_{t=2}^{4} \delta_j (\gamma_t * Productivity_{i,1994}) + \beta_2 Coop_{i,t} + \vartheta Coop * Productivity_{i,1994} + \beta x_{i,t} + \varepsilon_{i,t}$$

	Dependent Variable: $Pr(Irrigation = 1)$								
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Cooperative participation	-0.161**	-0.158**		-0.301***		-0.315***		-0.325***	
	(0.0628)	(0.0628)		(0.0760)		(0.0606)		(0.0606)	
Number of cooperatives in village			-0.346***		-0.271***		-0.279***		-0.277***
			(0.0376)		(0.0325)		(0.0363)		(0.0363)
Profits/ha 94	-0.00204**	-0.00199**	-0.00161*						
	(0.000797)	(0.000796)	(0.000838)						
Coop*Profits/ha 94		-9.37e-05**							
		(3.90e-05)							
Household size	0.0246**	0.0243**	0.0173	0.0207**	0.0152	0.0276**	0.0215*	0.0332***	0.0244**
	(0.0113)	(0.0113)	(0.0114)	(0.00997)	(0.00992)	(0.0115)	(0.0112)	(0.0117)	(0.0115)
Log Consumption								0.0735*	0.0387
								(0.0388)	(0.0380)
Poor94				0.140	0.132				
				(0.306)	(0.306)				
Coop*Poor 94				-0.0207					
				(0.110)					
Constant	-2.724***	-2.722***	-2.649***	-2.847***	-2.791***	-3.320***	-3.211***	-3.646***	-3.385***
	(0.161)	(0.161)	(0.161)	(0.233)	(0.233)	(0.206)	(0.203)	(0.271)	(0.266)
Observations	4,044	4,044	4,044	5,030	5,030	5,228	5,228	5,228	5,228
Household FE	No	No	No	No	No	Yes	Yes	Yes	Yes
Number of households						1,356	1,356	1,356	1,356

Robust standard errors in parentheses, errors clustered at household level. Year FE included. *** p<0.01, ** p<0.05, * p<0.1

Columns (1)-(3) include the interaction of Profits/ha 94 with time. Columns (4)-(6) include the interaction of Poor 94 with time.

Table 6.2

Average Marginal Effects of Cooperative Participation*

	Dependent Variable: $Pr(Irrigation = 1)$				
Variables	(1)	(2)	(3)	(4)	(5)
Cooperative participation	-0.0327**	-0.0322**		-0.0618***	
	(0.0127)	(0.0127)		(0.0154)	
Number of cooperatives in village			-0.0689***		-0.0553***
			(0.00704)		(0.00627)
Observations	4,044	4,044	4,044	5,030	5,030

Robust standard errors in parentheses, errors clustered at household level. Year FE included. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

*Regression results from probit model in Table 6.1

Table 7

Variables	(1)	(2)	(3)	(4)
	Dependent Variable: $Pr(CooperativesParticipation = 1)$			
Profits/ha 94	2.06e-05***	2.07e-05***	2.05e-05***	2.14e-05***
	(3.40e-06)	(3.89e-06)	(3.75e-06)	(4.12e-06)
Household size		0.0201**	0.0211**	0.0310***
		(0.00988)	(0.00985)	(0.0104)
Poor 94			-0.119**	-0.140**
			(0.0584)	(0.0639)
Constant	-0.728***	-0.842***	-0.798***	-1.659***
	(0.0291)	(0.0662)	(0.0686)	(0.0955)
Observations	3,696	3,665	3,665	3,665
Year FE	No	No	No	Yes

Robust standard errors in parentheses, errors clustered at household level. *** p< 0.01, ** p< 0.05, * p< 0.1

Table 8

	Dependent Variable: Number of cooperatives in village			
Variables	(1)	(2)	(3)	(4)
Profits/ha 94	2.14e-06*	2.33e-06*	2.53e-06**	2.46e-06**
	(1.12e-06)	(1.25e-06)	(1.26e-06)	(1.21e-06)
Household size		-0.0180***	-0.0191***	-0.0138***
		(0.00412)	(0.00417)	(0.00381)
Poor 94			0.101***	0.0998***
			(0.0188)	(0.0187)
Constant	0.540***	0.650***	0.613***	0.222***
	(0.00890)	(0.0281)	(0.0272)	(0.0267)
Observations	3,696	3,665	3,665	3,665
R-squared	0.001	0.006	0.011	0.176
Year FE	No	No	No	Yes

Robust standard errors in parentheses, errors clustered at household level. *** $p< 0.01$, ** $p< 0.05$, * $p< 0.1$