Tenure Security and Household Welfare: Evidence from Ethiopia

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Abstract

Using the year 2005 land title certification program, this paper examines the impact of land tenure security on household welfare in rural Ethiopia. We have exploited the variation in the timing of certification between treated and control groups using the standard Difference-in-Difference (DID) approach. Estimates from binary and continuous treatment duration models point out the existence of a significant welfare improving effect from land tenure security. Compared to the control group, households who have got certified before the last agricultural season in the sample period, are found to have a higher welfare gain from the program. We have also decomposed the welfare effects of the program into different channels. Efficient allocation of labor (hired and community labor) are found to be the main mediators through which land title certification affect household welfare.

Key words: Tenure security, welfare, Mediators, Difference-in-Difference, Ethiopia.

JEL Codes: O120, Q150

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1 Introduction

Poverty reduction has been advocated as one of the most important program in developing countries like Ethiopia. Since the last two decades, as part of the Millennium Development Goals (MDGs), the government of Ethiopia has been implementing different polices to achieve a sustainable economic growth by reducing poverty. The country has experienced a double digit growth rate for the last decade and becoming one of the fastest growing economy in Africa. During 2003/04 to 2012/13 the economy has registered the average annual average GDP growth rate of 10.9%. The service sector were leading the sectoral growth rate by 12.4%. Agriculture and Industry sectors were also grow by 9.3% and 12.2% respectively. Similarly, in line with the MDG, there was also a massive reduction in poverty. Using the national poverty line of 3781 Ethiopian Birr (ETB), the proportion of the population who are living below the poverty line is reduced from 45.5% in 1995/96 to 27.8% in 2011/12 (MoFED, 2012; Zerihun, Kibret and Wakiaga, 2014). Such improvements in the economy is attributed to the implementation of different socioeconomic reforms. Among them, providing agricultural land title certification is most effected program through out Ethiopia.

A secured and easily transferable property right to land has been advocated as one of the most effective approaches for rural development and poverty reduction in developing countries. For agricultural land, tenure security can reduce uncertainties, thereby encouraging long term investment, maximize allocative efficiency via reallocation of factors of production, allow economic growth and diversification (Sadoulet, F and de Janvry, 2002; Deininger and Jin, 2006). It is also argued that having a land right can reduce boarder disputes and used as a collateral for credit in rural areas where financial markets are fragmented. Previous studies on this area have found a positive and significant effect of land title certification on long term investment in land (Besley, 1995; Deininger and Jin, 2006; Holden and Deininger, 2013), average productivity (Holden and Ghebru, 2008; Holden and Ghebru, 2011), establishment of land rental market (Deininger, Ali and Alemu, 2011), a reduction in border disputes (Deininger, Ali and Alemu, 2011) and household welfare (Holden and Ghebru, 2011). However, none of these studies take in to account the differential welfare effects of the program based on household's poverty status and try to decompose the effects in to different possible channels. Hence, this study aims to fill the existing loopholes that have been exist in the previous studies by examining the welfare effects of land tenure security in rural Ethiopia based on poverty status. The 2005 land title certification program is used as an exogenous experiment to exploit the variation between treated and control groups.

Estimated results from binary and continuous treatment models indicate that households who have got a land title certificate before February 2006 have a higher average welfare. The continuous treatment model also indicates that earlier certified households have a higher welfare compared to late certified households. We have also found a differential welfare effects of the program based on households poverty status. Land title certification improves the welfare of treated households who were poor in the first period, 2004. However, there is no significance difference in welfare between treated and control households who were non poor in the first period. The other interesting finding of this study is related to mediators. Efficient allocation of labor (hired and community labor) are the main channels trough which land title certification affect household welfare in rural households of Ethiopia.

Our study complements the existing literature in the following dimensions. First, to our knowledge, it is the first empirical evidence which aims to decompose the welfare effects of land tenure security in to different mediators. After examining the effect of land tenure security on household welfare, we decompose the effects of the program in to different potential mediators using the standard Difference in Difference methodology. Second, previous papers were concentrated on the average effect of tenure security for all rural households. They fail to examine the differential welfare effects of the program based on their poverty status.[1] Third, in addition to the standard binary treatment indicator, we have used a continuous treatment duration model to examine the effect of the program for the treated households. Finally, in contrast to previous studies which concentrate only village level treatment indicator, we have used household level treatment indicator and instrumental variable estimation.

The organization of the paper is structured as follows. Section two and three presents the evolution of land tenure policy in Ethiopia and conceptual framework respectively. The methodology and data source are presented in section four. Section five discuses the main findings and section six summarizes and concludes.

[1] For example, an increase in average productivity may not necessary improve the welfare of the poor unless it is associated with the land owned by the poor and the production effect out weights the price effect. Increase in agricultural productivity due to tenure security will have two opposite effect on the welfare of the rural households. In one hand, it will increase the amounts of output produced using a fixed factors of production. On the other hand, it will have a down ward pressure on the price of commodity produced. This is called price effect. Similarly, an increase in efficiency of land owned by the rich may not also improve welfare of the poor unless they hire land less poor workers on their farm.

2 Evolution of Land Tenure Policy in Ethiopia

Historical land policy regimes in Ethiopia can be classified into three different periods. The Imperial regime (Pre-1975), Derg regime (1975-1991) and Ethiopian People's Democratic Republic Front (1991 up to present). Under the Imperial regime, which was characterized by feudalistic system, land was owned by elites and small scale farmers were landless. The major form of ownership were the *rist (kinship)* and *gult* systems. The *rist* system, which was commonly practiced in the northern highlands of Ethiopia, is a type of corporate ownership system based on descent. All descendants, both male and female, were entitled *usufruct* right to use and share land. However, they were not allowed to sell, lease, mortgage or bequeath their share of land outside the descendant group. The other major form of tenure, which was mostly practiced in the southern parts of the country, was the *gult* system. It is an ownership right acquired from the monarch or provincial rulers who were empowered to to make land grant. *Gult* owners collect tributes and taxes from peasants either in cash or in kind in the form of labor service (Kebede, 2002). Apart from the *rist* and *gult* system, there were also other forms of land ownership granted to the nobilities, relations and the church.

The land policy during this period hardly addressed the needs of the majority of farmers in rural Ethiopia. Presence of high concentration of land in the hands of few (the church, nobility and high ranking military personnel), tenure insecurity in the tenant-landlord relationships and oppression of tenants initiated the strongest students' revolution in Ethiopian history. *"Land to the tiller"* became the popular slogan during the revolution. The movement expanded to the communities at large and the then military power overthrow Emperor Haile selassie in 1975 (Adnew and Abdi, 2005).

In 1975 the military government (Derg)[2] implemented a radical land reform to address the pressing demands of small farmers. Land owned by nobilities, feudal land lords, and the church were nationalized and redistributed to farmers through peasant associations.[3]Each household has a usufruct right to use land. Transferring land rights through inheritance was only allowed to the immediate family members and required permission from peasant association. However, land transaction in the form of land renting, selling, mortgage and share cropping were prohibited. Due to the population pressure, frequent land redistribution is implemented by taking land from most land rich households and giving it to the the landless. Such allocation, which is based on an egalitarian way, depends on household size and the

[2]Derg is a military government, which come to power in 1975, with a rigid Marxist - Leoninst ideology.

[3]Peasant association is a local level administrative organs mandated to handle land related matters such as redistribution, tax collection, and arbitration of disputes.

maximum farm size set to be 10 hectare[4]. Eligibility and access to land was contingent on physical presence on land, which prevents migration of rural land holders. Taking together, the land policy during the Derg regime was characterized by high level of tenure insecurity (Kebede, 2002; Adnew and Abdi, 2005; Holden and Ghebru, 2011; Bezabih, Mintewab, Mannberg and Siba, 2014).

In 1991, the military regime was overthrown by the Ethiopian People's Revolutionary Democratic Front (EPDRF). Though the new government introduce a free market economy, land remained a public property. In the 1995 constitution, Article 40 states: " The right to ownership of rural and urban land, as well as of all natural resources is exclusively vested in the state and the people of Ethiopia". Compared to the Derg regime, the new constitution has made only few improvement on tenure security. If land is needed for public purpose, land holders have the right to get compensation for any investment made on the land. The new government by large maintained the land policy of the Derg regime which prohibited land transactions. The constitution states that " Land is a common property of Nations, Nationalities and peoples of Ethiopia and shall not be subject to sale or other menses of exchange". Generally, the existing tenure insecurity in rural households were only partially resolved by the 1995 constitution (Adnew and Abdi, 2005; Bezabih, Mintewab, Mannberg and Siba, 2014).

To enhance tenure security and improve utilization of land, a new land law that allocates legislative power to the federal government and delegate implementations to regional states was developed in 1997. That is the Rural Land Administration and Use Proclamation was drafted and revised in 1997 and 2005 respectively by the Ministry of Agriculture and Rural Development. It intends to grant land holders to transfer their land rights to their family members, lease out plots to other farmers or investors without displacing the land administrative rules, and use land as a collateral (Adnew and Abdi, 2005; Bezabih, Mintewab, Mannberg and Siba, 2014). In 2002, the current government delegated greater legislative powers to regional states. More specifically, it was related to drafting regional land policies and establishing new regional structures for land administration. As a result, Tigray, Amhara, Oromia and Southern Nations and Nationalities (SNNP) have drafted their own regional land policies that include land registration and certification. Some regional governments, for example Amhara and Tigray, have also established Environmental Protection Land Use and Administration Authority (EPLAUA), which is responsible to manage land administration.

The Ethiopian land certification program has been one of the important reforms that the

[4]The feudal landlords were left with less than 10 hectare of land and excluded fro the local leadership positions

current government implemented. It was first introduced in Tigray in 1998 and followed by Amhara in 2003, and Oromia and SNNP regions in 2004. It is one of the largest land registration program in the world, where more than 20 million plots and 6 million households have certified their land holdings between 1998 and 2007 (Adnew and Abdi, 2005; Holden and Ghebru, 2011; Deininger, Ali and Alemu, 2011).[5] Compared to other African countries land certification program, it is the one of the most cheapest to implement. For example, Madagascar's program costs 150 USD, while it cost less than 1 USD per farm and 3.5 USD per household in Ethiopia (Deininger, Ali and Alemu, 2011; Jacoby and Minten, 2007).

The land title certificate, which is issued in the name of both husband and wife, contains a list of all plots measured and names of family members. The implementation of the program was conducted in the following five major steps. First, to increase awareness of farmers regarding land registration and certification, a meeting was conducted between Woreda administration and farmers at Kebele (Village) level. Second, Land Administration Committee (LAC), which is responsible for the implementation of the program, was directly elected in a democratic fashion. Then, a short term training about the program implementation was given to the elected LAC members. In the third step, demarcation of individual household plots was taken place jointly by LAC members, the household and its neighbor. During the fourth step, all registered information is filled in a form and the LAC passed any outstanding conflicts to a court. Then, the result of the land adjudication is presented for the public for a month long verification. Finally, the holding of the household is registered jointly by the head of the Woreda EPLAUA and the LAC chairperson (Deininger, Ali and Alemu, 2011; Bezabih, Mintewab, Mannberg and Siba, 2014).

3 Theoretical model

The conceptual framework, which is based on the standard agricultural production model, is developed by extending the works of Bardhan and Udry (1992), and de Janvrye Janvry, Emerick, Gonzalez-Navarro and Sadoulet (2013). Farm households in rural areas produce and often consume parts of their own production. Unlike the classical microeconomics theory, rural households act as both a consumer and producer. In the absence of market failures, the production and consumption decisions can be separated in two stages. First, the household maximizes profit by producing an optimal level of output. Then, given the maximum level of

[5]It is similar to the land title certification program in Vietnam (1993-2000) and Thiland (1980-2005) which awarded over 11 and 8.7 million titles respectively. It is also comparabele to the program in peru and Indonesis which covered around 2.7 and 1.8 titles respectively.

profit, the household maximizes utility. However, since the rural households in Ethiopia face imperfections in factor and output markets, their production and consumption decisions will be determined simultaneously. That is the production decision of the household depends on the preference and endowments of the household.

Assume a household maximize a twice differentiable quasi linear utility function,$U(C,l) = C + v(l)$, where C is consumption, l is leisure, and the utility of leisure is concave ($v' > 0,\ v'' < 0$). Using farm labor L_e and land A, households produce expected output Y_e according to $Y_e(L,A) = \gamma A^{\alpha} L_e^{\beta}$, where $0 < \alpha, \beta < 1$, and γ is a total factor productivity parameter. Farm labor, L_e, is the sum of on farm family(L^f) and hired (L^h) labor used in the production process. Similarly, the amount land used in the production process can also obtained either from own or rented from other sources. Suppose E^L andE^A are the households total endowment of labor and land respectively. The household allocate its fixed amount of labor endowment to leisure, working on own farm (L^f), and on wage labor off the farm activities(L^m). Further assume that p is the price of output, w be the wage rate for labor, and r as a price of one unit of land.

The household's problem is to maximize the following utility function subject to the budget and resource constraints.

$$\underset{c,l,L^f,L^h,L^m,A^f,A^h,A^m}{Max}\ U(C,l) = C + v(l) \tag{1}$$

subject to:

$$pc + wL^h + rA^h \leq p\gamma A^{\alpha} L_e^{\beta} + wL^m + rA^m \tag{2}$$

$$L = L^f + L^h \tag{3}$$

$$A = A^f + A^h \tag{4}$$

$$E^A = A^f + A^m, E^L = L^f + L^m + l \tag{5}$$

$$c, l, L^f, L^h, L^m, A^f, A^h, A^m \geq 0 \tag{6}$$

Equation (1) is the household utility function which depends on consumption(c) and leisure(l). Equation (2) is the conventional budget constraint, which states that the total cash expenditure on consumption, hired labor and rented land should not exceed the revenues generated from farm output, off farm labor(L^m) and rented out land. Equation (3)–(5) indicates the resource constraints. Farm labor input (L) is a sum of household (L^f) and hired labor (L^h) used on the farm production, where as farm land input (A) is obtained from household's cultivated land (A^f) and rent in land (A^h). Land endowment (E^A) is equal to household

cultivated land (A^f) plus rented out land (A^h), and household labor endowment (E^L) is allocated to household labor on farm (L^f), wage work (L^m) and leisure time (l).

According to the traditional land insecurity model, tenure insecurity is treated as a tax on production. That is, a secured property right on land increases expected output and household welfare.[6] More specifically, secured property right may increase agricultural productivity either trough long term investment on land or changing input allocation. By reducing the risk of loss, it encourage long-term investment in tree planting, conservation, manure, fertilizer, irrigation, etc (Holden and Ghebru, 2011 and Besley, 1995).

Under tenure insecurity, the expected farm output produced by the household can be rewritten as $Y_e(L, A) = (1-\tau)\gamma A^{\alpha} L_e^{\beta}$, where $\tau \in [0, 1]$ is the degree of tenure insecurity in property rights. Differentiating the first order condition of the household's problem with respect to τ gives the following prediction:

$$\frac{\partial L^f}{\partial \tau} = \frac{-L^f}{(1-\tau)(1-\beta)} < 0, \text{ and } \frac{\partial L^h}{\partial \tau} = \frac{-L^h}{(1-\tau)(1-\beta)} < 0,$$

Under the standard traditional land insecurity model, tenure insecurity on land reduces the amount of family and hired labor on farm. Hence, any property right on land increases the amount of land and farm labor which intern increases expected output and hence household welfare. By reducing the risk of eviction, a well defined property right on land also encourages household to invest on their land (in the form of fertilizer use, irrigation, tree planting, soil conservation) and achieve a higher productivity and household welfare. Moreover, it also help land owners to increase their willingness to rent out the land and generate additional income without losing their right to use land for insurance or old-age protection (Deininger, Ali and Alemu, 2011). Inefficient land owners and female headed households may also rent out their land and participate in different off farm activities without losing their land title. Hence, efficient farmers are able to consolidate and cultivate larger farm areas. Finally, it has also assumed to improve the welfare of rural households by saving money and different physical and financial resources that would be wasted following the border disputes.

[6]The basic assumption behind this argument is that households are always efficiently allocating labour between different uses (de Janvrye Janvry, Emerick, Gonzalez-Navarro and Sadoulet, 2013).

4 Data, Identification and Estimation Strategy

4.1 Data and Estimation approach

To examine the welfare effect of land tenure security, we have used two rounds survey data of rural households who are living in Amhara region East Gojjam zone. Around 650 randomly selected households are examined in year 2004 and 2007. The data was collected by Addis Ababa University, Department of Economics in collaboration with University of Gothenburg (Sweden), Ethiopian Development Research Institute (EDRI), and the World Bank. Since we have the data before and after the land certification program started, it is possible to employ a standard Difference-in-Difference methodology.[7] This study exploits the variation in the timing of land title certification among different households who are living in seven villages (Kebele) of East Gojjam zone.

Using the rural land tenure certification program as an exogenous intervention, the standard Difference-in-Difference (DID) is estimated to compare the welfare effects of the program between certified and non-certified households before and after the program. The following empirical model, which is based on the works of Wooldrige (2002), assumes that y_{ist} as a welfare of household i in state s at time t. The time variable,t, takes a value of t_1 if the period is before the land title certification and t_2 afterward. ω_{it} is an indicator of whether the household i has received a land title certificate for its land holdings at time t. More specifically, it takes the value of $\omega_{i,t=1}$ if the household gets certificate before February 2006, $\omega_{i,t=0}$ otherwise. Finally, the state of the world can be expressed as $s = 1$ when there is land title certification program and $s = 0$ otherwise. The conditional mean function for welfare outcomes of the household can be expressed as:

$$E[y_{1,st}|i, s, t] \tag{7}$$

$$E[y_{0,st}|i, s, t] \tag{8}$$

Equation (9) is the conditional mean outcome of the household who gets certified before February 2006, whereas Equation (10) indicates the conditional mean consumption per capita, which is used as a proxy for household welfare, for households who do not get a land title certificate. The object of interest is to estimate the average treatment effect of

[7] The descriptive statistics and map of the study area is presented in the Appendix.

land certification on the treated (ATT):

$$ATT \equiv \mathrm{E}(y_{1,st}|\omega_{it} = 1) - \mathrm{E}(y_{0st}|\omega_{it} = 1) \tag{9}$$

However, y_{0it} is unobserved for households who have received land certification at time t. Instead, we assume that the average outcomes for treated and non-treated would have followed parallel paths in the absence of land title certification and estimate the counter factual. That is,

$$\mathrm{E}(y_{0,it_2} - y_{0,it}|\omega_i = 1, x_{it}) = \mathrm{E}(y_{0,it+1} - y_{0,it}|\omega_i = 0, x_{it}) \tag{10}$$

where x_{it} captures the different control variables which affects the welfare of the household i at time t. Further, assume that the effect of land certification can be captured by the homogeneous treatment effect, say α_3. Hence, the estimated DID model for household i at time t can be expressed as:

$$y_{it} = \alpha_0 + \alpha_1 P_t + \alpha_2 T_i + \alpha_3 (P_i * T_i) + \alpha_4 X_{it} + u_{it} \tag{11}$$

where y_{it} is household's real per capita consumption expenditure, which is used as a measure of welfare of household i at time t. P_i is an indicator variable which takes a value of one if the time period is before the last agricultural season in the sample (February 2006) and zero otherwise. T_i is a treatment indicator which takes a value of one if the household is treated, zero otherwise, and X_{it} represents different control variables (for example, household size, farm size etc) which likely affect household welfare. The effect of the program between treated and control households is captured by a homogenous treatment effect, α_3.

4.2 Identification Strategy

In order to examine the welfare effect of the program, we have use both binary and continuous treatment indicators. The differential timing of land title certification is used to exploit the variation between treated and control groups. Under this identification strategy, treated households are those who have got certified before the last agricultural season, February 2006.[8] Whereas, households who do not have a certificate at all or those who got it after February 2006 are considered as a control group. Our main identification assumption is that households who have got a tenure security before February 2006 are assumed to have an incentive to adjust their economic decisions on land and labor market participation decisions which will in turn affect their welfare. On the other hand, any land right obtained after this period will not have any effect.

The original plan of Amhara regional state, which started land registration in 2003/04, was to implement the program in all woredas (districts) simultaneously. However, due to shortages in manpower and financial resources both at kebele (village) and woreda (district) levels, a sequential implementation of the program was designed. The following table illustrates the timing of land title certification in the study villages.

Table 1: Program Characterstics by Village (Kebele)

	Machakel	Machakel	Enemay	Enemay	Gozamin	Gozamin	Gozamin
Village (Kebele)	Amanuel	Debre Elias	Telma	Sekal Debir	Kebi	Wolkie	Addis Gulit
Area in hectares	4373	1790	1964	2560	630	2670	2172
Program introduced	Feb.2004	Feb.2004	Oct.2003	June 2005	May 2005	Sep.2006	Feb.2003
Completed registration	June 2004	Jul.2004	Aug.2006	Dec.2006	Dec.2005	NC	May 2005
Certificate distribution	Feb.2005	Feb.2005	Sep.2006	NS	Aug.2006	NS	June 2005

Note: NC and NS are represents Not completed and Not started at the time of the survey, respectively.
* Source: AAU/WB/Gothenberg Survey and Deininger et al. (2011)

In all villages, there is a delay between the date of announcement and issuance of land title certificate. With the exception of Wolkie, all villages have completed land registration before September 2006. On average, there is a five month delay between completion of registration

[8]Belg (from February to June) and Meher (from June to October) are the two main crop seasons in Ethiopia. In some highland areas, particularly in our study area, the belg and meher seasons merge into one extended agricultural growing period (from February to October) where both long-cycle grains (like sorghum and corn) and short-cycle grains (such as wheat, barley, and teff) can be grown (United States Department of Agriculture, 2008). Hence, February 2006 is the period when the last agricultural season in the sample period starts. Any land title certificate obtained before this period will assumed to have an impact on the household's economic decison.

and certificate distribution. This difference in the timing of certification among villages is not a threat to our identification strategy as long as it is uncorrelated with the pre-treatment outcome variable (de Janvrye Janvry, Emerick, Gonzalez-Navarro and Sadoulet, 2013). However, if timing of certification is correlated with the pre-program consumption per capita, the estimated average program effect will be biased.

To test this hypothesis, we have used the standard regression of pre-program consumption per capita, which is used as our welfare indicator on different timing of certification. Estimated results, depicted in Table 2 below, confirms the absence of a significant correlation between timing of certification and consumption per capita at the baseline. It can be used as an evidence that pre-program time trends in consumption were not correlated with the timing of certification.

Table 2: Effect of timing of certification on pre-treatment consumption per capita

	Model 1	Model 2	Model 3	Model 4
Treatment Duration	-11.568	-12.088		-7.592
	(-1.53)	(-1.32)		(-0.15)
One agricultural season			-48.178	66.909
			(-0.36)	(0.11)
Two agricultural season			-27.656	3.096
			(-0.12)	(0.01)
Village Fixed Effect	YES	YES	YES	YES
Constant	1179.507***	1180.802***	1208.288***	1113.020
	(30.17)	(26.01)	(10.09)	(1.81)
Observations	636	636	659	636

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Treatment duration, which is measured by the number of months elapsed from the period when the households got a land title certificate up until February 2006., does not have statistically significant effect on households real per capita consumption expenditure at the baseline. Similarly, there is no significant welfare effect from having a land title certificate either for one or two agricultural season. Moreover, we have also tested the internal validity of our identification by running a regression between the timing of certification on different observed characteristics of the household at the baseline.

Table 3: Effects of observed characteristics on the timing of certification on the baseline

	Model 1	Model 2	Model 3	Model 4
Real consumption per capita	-0.000	-0.000	-0.000	0.001
	(-1.15)	(-1.50)	(-0.71)	(0.34)
Farm size	0.065	0.174	0.463	1.272
	(0.29)	(0.47)	(0.71)	(1.96)
Head age	-0.007	-0.017	-0.022	-0.066
	(-0.67)	(-0.77)	(-0.93)	(-1.23)
Head Male	-0.842	-1.407	-1.525	0.525
	(-1.40)	(-1.09)	(-1.22)	(0.19)
Household size	-0.000	-0.016	-0.219	0.460
	(-0.00)	(-0.08)	(-0.78)	(1.17)
Number of dependant household members	-0.020	-0.030	0.065	-0.570
	(-0.15)	(-0.11)	(0.22)	(-0.90)
Head Married	0.060	0.356	0.397	3.084
	(0.10)	(0.30)	(0.33)	(0.93)
Head Education (Read and Write)	-0.351	-0.707	-0.685	-1.156
	(-1.15)	(-1.03)	(-0.84)	(-0.66)
Poor in 2004	-0.022	-0.213	-0.011	3.373
	(-0.06)	(-0.28)	(-0.01)	(1.07)
Village Fixed Effect	YES	YES	NO	NO
Constant	4.027**	8.326**	6.566*	-1.586
	(3.10)	(2.84)	(2.20)	(-0.21)
Observations	634	286	110	74

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Estimated results in Table 3 point out that the timing of certification is not affected by different observed characteristics of the household both across and with in the villages. The first two models indicates the effect of observed covariates on the timing of certification in the all and treated villages respectively. While, the last two columns present the effect with in the villages. In all cases, non of the controlled observed covariates affect the timing of certification on the baseline. This can be taken as an evidence against self selection based on observed characteristics.

In addition to the standard binary treatment identification, we examine the welfare effects of the program among treated individuals using a continuous treatment indicator. With in our sample, some treated households had got certified 12 months before the last agricultural season starts, while others had only got certified before a month. Since the impact of the program for the latter group is assumed to be smaller than the former one, the variation in treatment duration is used to examine the welfare effects of the program among treated households. [9]

The above identification strategy may be considered as conservative. That is, defining treatment at the time of certificate distribution instead of completion of registration process may underestimate the actual effect of the program. The implicit assumption is that registration process, which certainly lead to certification, has no effect and hence the expectation of a certificate will not affect the households economic decision on land and labor. However, as it is clearly depicted in Table 1 above, all villages had got information about the program and started the registration process. If our implicit assumption is violated, it would underestimate the actual effect of the program and hence the estimated value will indicate the lower bound of the true welfare effect of the program.

5 Results

This section presents the main findings of the study. First, the welfare effects of land tenure security is estimated using the standard binary treatment indicator both at village and household level. Second, continuous treatment duration is estimated to examine the average treatment effect of the program for the treated households. Finally, we decompose household welfare effects from tenure security into different mediators and run robustness check.

5.1 Binary Treatment Model

The standard binary DID model is used to examine the welfare impacts of the program between treated and control groups. This approach will give an unbiased estimate if the two groups have the same characteristics at the baseline.

[9] Duration of a treatment is defined as a number of months elapsed from the period when the households got a land title certificate up until February 2006. It ranges from one to 12 months.

The following table presents the baseline covariate balance test between treated and control groups.

Table 4: Test of Covariate Balance Across Control and Treatment Groups

	Control	Treatment	Difference	p-value
Real consumption per capita	1160.33	1227.29	-66.96	0.581
poverty status	0.71	0.69	0.02	0.696
Head Male	0.87	0.85	0.02	0.707
Age of the household head	48.36	46.87	1.49	0.461
Head Education (Read and Write)	0.38	0.39	-0.01	0.832
Land ownership	0.98	0.98	-0.01	0.783
Farm size	1.60	1.39	0.21	0.089
Head Married	0.86	0.87	-0.01	0.788
Household size	6.31	5.57	0.73*	0.019
Number dependant household members	2.78	2.52	0.25	0.208
Improved seed use	0.18	0.18	0.00	0.973
Hired labour	14.93	3.64	11.29	0.537
Family labour	113.24	82.93	30.31	0.081
Community labour	50.14	45.77	4.37	0.929
Off-farm labour participation	0.18	0.11	0.07	0.188
Fertilizer use	0.92	0.97	-0.05	0.385
Manure use	0.69	0.69	-0.00	0.972
Irrigation	0.10	0.07	0.03	0.534

Except household size, there is no statistically significant mean difference in observed covariates between treated and control groups at the baseline. The covariate balance test based on household's poverty status, depicted in Table 13 in the appendix, also confirms that the mean difference in all variables, including household size, between the two groups is not statically different from zero. Hence, it seems plausible to assume that in the absence of the treatment, the difference between treated and control groups would not have been systematically different from zero. Table 4 compares the welfare effects of the program between treated and control groups using both Instrumental Variable (IV) and binary standard treatment model.

Table 5: Welfare effects of the program using full sample

	Model 1 (IV)	Model 2 (DID)	Model 3 (DID)	Model 4 (DID)	Model 5 (DID)	Model 6 (DID)
Treatment	526.010**	65.927	6.993	40.830	55.658	-36.122
	(2.40)	(0.58)	(0.06)	(0.35)	(0.48)	(-0.32)
year=2007		164.477***	190.232***	165.330***	105.500	221.616***
		(3.10)	(3.55)	(3.12)	(1.45)	(2.98)
Treatment x year=2007		470.971**	465.179**	471.724**	479.470**	462.003**
		(2.33)	(2.32)	(2.33)	(2.36)	(2.30)
Household size			-81.709***			-89.523***
			(-7.76)			(-8.13)
Training				125.383*		210.283***
				(1.66)		(2.80)
Farm size					-49.131	22.797
					(-1.55)	(0.72)
Constant	1214.373***	1159.272***	1675.730***	1133.096***	1238.086***	1644.577***
	(48.25)	(31.22)	(20.45)	(30.44)	(16.57)	(17.34)
Number of Obs.	1247	1247	1247	1247	1247	1247
wald chi2	5.7	22	82	27	29	87
Prob > chi2		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

*H*ausman Test between IV and DID estimates: Chi2(1) = 1.62 and Prob > chi2 = (0.2028)
t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Model 1 presents the impact of the program using IV estimation. Village level treatment indicator [10]is used as an instrument for household level treatment indicator. Households who have got certified have an average of 526 Ethiopian Birr (ETB)[11] higher real per capita consumption expenditure, which is statistically different from zero at the conventional 5% level of significance. Similar result is obtained by employing the standard binary treatment effect model, presented in column 2. Having a property right on land before February 2006, increases the average real per capita consumption of households by 470 ETB. It can be interpreted as the causal effect of land tenure security certification, under the assumption that in the absence of land title certification, the differences between treated and control groups would not have been systematically different.

The Hausman test statistics is used to examine whether there is a systematic difference in the coefficient which measures the impact of the program between the IV and DID estimates.

[10]Under village level treatment indicator classifies households who are living in villages (kebeles) which undergo certificate distribution before the last agricultural season are considered to be treated, control otherwise

[11]Birr is the domestic currency in Ethiopia. One US Dollar was equivalent to 8 Ethiopian Birr during 2005.

The test statistics, presented in the bottom of table 4, indicates the absence of any significant difference between estimated results in the IV and DID approach. This can be used as an evidence for absence of selection problem in our identification strategy. Since we fail to reject the null hypothesis of the Hausman test statistics, which is the difference in coefficients in the two models are not systematic, the DID estimation technique is used for our analysis.

The impact of the program may not be valid if we fail to control factors which are likely correlated with household's participation decision to the program. For example, before the introduction of the program there was a public meeting about the relevance of having a land title certification which is likely to affect the households certification decision[12]. On top of this, it is very important to control both household size and farm size which were statistically different at 5 % and 10 % level of significance between treated and control groups on the baseline. However, controlling these potential confounding factors does not really change the welfare effects of the program.

Table 6: Welfare effects of the program for the households who were poor in 2004

	Model 1 (IV)	Model 2 (DID)	Model 3 (DID)	Model 4 (DID)	Model 5 (DID)	Model 6 (DID)
Treatment	508.725**	18.977	-10.056	1.608	22.969	-26.429
	(2.41)	(0.49)	(-0.26)	(0.04)	(0.59)	(-0.69)
year=2007		508.120***	520.591***	508.843***	530.660***	589.184***
		(9.55)	(9.50)	(9.56)	(9.88)	(9.65)
Treatment x year=2007		519.982**	509.323**	520.234**	516.338**	497.349**
		(2.39)	(2.31)	(2.39)	(2.37)	(2.25)
Household size			-42.294***			-49.053***
			(-4.04)			(-4.47)
Training				102.358*		137.649**
				(1.73)		(2.34)
Farm size					18.242	53.111***
					(1.17)	(3.17)
Constant	983.851***	783.520***	1063.293***	761.895***	753.670***	992.019***
	(46.37)	(70.25)	(14.98)	(46.78)	(26.64)	(14.62)
Number of Obs.	836	836	836	836	836	836
wald chi2	5.8	115	117	121	124	132
Prob > chi2		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

*H*ausman Test between IV and DID estimates: Chi2(1) = 0.03 and Prob > chi2 = (0.8567)
t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

[12]Participation on land tenure meeting was voluntary and all households, who are living in the village, were invited.

Examining the differential welfare effects of the program based on household's poverty status is one of the main contribution of this study. In order to do this, we split the sample into two. The first sample comprises only households who were poor in the first period, which helps us to analyze the program impact for poor households on the baseline. On the other hand, the welfare effects of the program on non-poor households is investigated by using households who were non-poor in 2004.

Table 7: Welfare effects of the program for the households who were non poor in 2004

	Model 1 (IV)	Model 2 (DID)	Model 3 (DID)	Model 4 (DID)	Model 5 (DID)	Model 6 (DID)
Treatment	475.780	72.719	14.951	26.799	49.767	-82.504
	(0.97)	(0.31)	(0.06)	(0.11)	(0.21)	(-0.32)
year=2007		-714.742***	-667.742***	-713.804***	-849.564***	-689.897***
		(-6.22)	(-5.70)	(-6.21)	(-4.72)	(-3.68)
Treatment x year=2007		458.121	473.635	463.795	472.121	489.634
		(1.19)	(1.26)	(1.20)	(1.21)	(1.29)
Household size			-76.308***			-88.649***
			(-4.28)			(-4.24)
Training				169.953		306.294*
				(1.03)		(1.81)
Farm size					-121.413	-28.318
					(-1.37)	(-0.31)
Constant	1695.465***	2093.604***	2516.849***	2059.020***	2277.106***	2565.768***
	(30.45)	(22.27)	(18.43)	(23.73)	(11.44)	(12.81)
Number of Obs.	411	411	411	411	411	411
wald chi2	.94	45	71	46	47	81
Prob > chi2		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

*H*ausman Test between IV and DID estimates: Chi2(1) = 0.20 and Prob > chi2 = (0.6517)
t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6 and 7 below present the welfare effect of land tenure security based on household's poverty status. Results from the above two tables indicates that land title certification only improves the welfare of treated households who were poor in 2004. Estimated results from the IV and DID models, presented in column (1) and (2), shows that treated poor households have around 509 and 520 ETB higher average real per capita consumption expenditure respectively. However, there is no significant program effect for non poor households. Similar to the full sample analysis, the Hausman test statistics fails to reject the null hypothesis of no systematic difference in coefficients in the two models. Our result seems to be robust after controlling household size, farm size and participation on the land title certification training.

5.2 Continuous Treatment Model

In addition to the standard binary treatment model, we have estimated the effect of the program among treated households using a continuous treatment indicator. Treatment duration, which is measured by the number of months elapsed from the time of certification to the last agricultural season in the sample period, is used as a continuous treatment indicator. It is assumed that, households who have got certified earlier have a higher per capita consumption expenditure. Table 8 reports the average welfare effect of one month treatment duration for the treated households.

Table 8: Effect of Treatment duration on household Welfare

	Model 1	Model 2	Model 3	Model 4
Treatment Duration	87.820**	90.568***	90.508***	102.229***
	(2.60)	(2.70)	(2.74)	(2.82)
Household size		-46.221		-88.477*
		(-1.01)		(-1.80)
Training			440.066**	549.157**
			(2.15)	(2.53)
Farm size				49.670
				(0.47)
Controls	NO	YES	YES	YES
Village Fixed Effect	YES	YES	YES	YES
Constant	1269.482***	1524.465***	1083.798***	1464.182***
	(11.60)	(5.38)	(8.04)	(4.80)
Number of Obs.	119	119	119	119

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Estimated results in Table 8, column (1) - (4), show that early certified households have a higher average welfare gain compared to late certified households. The first columns indicate the welfare effect of having a one month certificate without covariates. One month increment in treatment duration is associated with an average increase in household real per capita consumption by 87.82 ETB. The effect increases to 102 ETB if we control for household size, participation to the training and farm size. Controlling relevant confounding factors does not really change the main result. In line with economic theory, household size has found to have a significant and negative effect on household welfare. Whereas, participation to land title certification training is found to have a positive effect.

5.3 Robustness Check

In this section, we have presented different robustness tests which support the validity of the identification assumption of this study. In our identification strategy we have implicitly assumed that land tenure security will affect household welfare if and only if households get certified before the last agricultural season. However, our estimate could be a lower bound of the actual program effect if households who got certified after February 2006 change their behavior and benefited from the program. As a robustness check, we have used households who have got treated after February 2006 as placebo treated group and those who have not got certified at all as a control group. If we get any systematic difference in welfare effect of the placebo treatment between the two groups, the average treatment effect in the previous section will be biased and lower bound.

The estimated average treatment effect of the program, presented from Table 15 to 17 in the Appendix, found to be statistically insignificant. That is, there is no significant difference in the welfare effect from the land title certification between households who have got a land title certificate after the last agricultural season and those who did not have it. This can be taken as an evidence in favor of our identification assumption. Moreover, the internal validity test presented in Table 2 and the IV estimates can also be used as an alternative robustness check.

5.4 Decomposition of Welfare Effects into Mediators

This section presents the decomposition of the welfare effect of the program into the different mediators. Estimated results from binary and continuous treatment models indicate that households who have got a land title certificate before February 2006 have a higher welfare. Theoretical literature suggests that long term investment on land (Besley, 1995; Deininger and Jin, 2006; Holden and Deininger, 2013), efficient allocation of inputs (land and labor), and relaxing credit constraints are the potential channels through which land tenure security affects household welfare. Before conducting the decomposition analysis, it is really important to examine the effect of the program on these potential mediators in Ethiopia.

The following tables present the DID estimation for the effect of land tenure security on potential mediators mentioned above.

Table 9: DID program impact on Investment on Land

	Conservation	fertilizer	tree_dummy	irrgation
Treatment	-38.758***	0.053***	0.146***	-0.043***
	(0.715)	(0.005)	(0.006)	(0.010)
year=2007	-24.149***	-0.124***	0.142***	-0.027***
	(3.408)	(0.009)	(0.011)	(0.001)
Treatment x year=2007	71.097***	0.001	0.026***	0.075***
	(0.500)	(0.003)	(0.002)	(0.000)
Training	6.436***	0.072*	0.045	0.074
	(0.562)	(0.037)	(0.044)	(0.046)
Household size	-0.312	0.024***	0.031***	0.020***
	(1.494)	(0.002)	(0.007)	(0.001)
Farm size	1.941	0.017**	0.046***	-0.036***
	(2.430)	(0.009)	(0.008)	(0.001)
Constant	40.239***	0.725***	0.403***	0.015**
	(5.417)	(0.031)	(0.039)	(0.006)
Number of Obs.	1243	1186	1247	1247

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

In line with the theoretical literature, we have found a positive and significant program effect on long term investment on land. That is, compared to the control villages, households who have got a land title certificate before the last agricultural season of the survey period have exhibited a higher average investment on land. Except fertilizer use, on average, treated households have a higher investment on soil conservation, tree planting, and irrigation. Compared to the control group, on average, treated households have spend around 71 hours more on soil conservation which is found to be significant at a conventional 1% level of significance. Similarly, they have on average a probability of 2.6 and 7.5 percentage point to invest on their land in the form of tree planting and irrigation respectively.

The second possible channel through which land tenure security affect household welfare is through efficient allocation of inputs. Table 10 reports the effect of tenure security on land and labor allocation.

Table 10: DID program impact on Input Mix

	Family labour hr.	Hired labour hr.	Community labour hr.	off-farm	Rental Market
Treatment	149.723***	-12.268***	-2.258	-0.000	-0.037***
	(24.60)	(-8.20)	(-0.18)	(-0.66)	(-28.05)
year=2007	-63.086***	-6.426***	-124.186***	-0.709***	0.948***
	(-4.05)	(-13.92)	(-6.30)	(-575.26)	(279.32)
Treatment x year=2007	7.701***	10.052***	112.771***	0.002***	0.041***
	(3.48)	(33.88)	(310.54)	(19.56)	(62.02)
Training	-18.756***	13.158	9.632	-0.003	-0.001
	(-31.01)	(1.44)	(0.18)	(-0.90)	(-0.81)
Household size	14.824***	1.478***	3.739*	-0.001	0.004**
	(3.75)	(3.02)	(1.69)	(-1.01)	(2.00)
Farm size	47.612***	2.621***	5.914	-0.000	-0.009***
	(3.36)	(27.24)	(0.41)	(-0.16)	(-5.18)
Constant	-38.020	-1.362	15.031***	1.008***	0.030***
	(-0.80)	(-0.28)	(7.25)	(101.86)	(3.64)
Number of Obs.	1186	1186	1186	1247	878

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The estimated DID result shows that households who have got certified before the last agricultural season have use more family labor, hired female labor and community labor in their production process. That is, compared to the control group, on average treated households have used around 113 and 10 more hours in community and hired labor respectively. They have also have an average of 7 hours more family labor, 0.2 and 4.1 percentage point higher probability to participate in off-farm and rental market participation respectively.

The third possible channel through which property right on land affect welfare is by relaxing credit constraint exist in rural households. However, since using land as a collateral is not allowed in Ethiopia, this channel may not. The DID estimates from Table 9 and 10 clearly indicate that land title certification have a significant and positive effect on long term investment on land and efficient input allocation. Once we identified the potential mediators, it is possible to do the decomposition analysis. The following table indicate the welfare effects of the program by taking in to account investment and input allocation channels.

Table 11: Decomposing the Welfare Effects of the Program Using Household Level Treatment

	Model 1	Model 2	Model 3	Model 4	Model 5
Treatment	-25.202	-25.274	-30.747	-27.748	-26.689
	(-0.22)	(-0.22)	(-0.26)	(-0.24)	(-0.22)
year=2007	225.691***	225.662***	218.688***	215.505***	215.612***
	(3.01)	(3.00)	(2.68)	(2.64)	(2.63)
Treatment x year=2007	447.037**	449.958**	512.254**	26.985	120.853
	(2.19)	(2.02)	(2.31)	(0.08)	(0.32)
Training	206.698***	206.879***	183.195**	170.618**	171.721**
	(2.72)	(2.71)	(2.45)	(2.29)	(2.27)
Household size	-89.862***	-89.879***	-90.486***	-90.119***	-90.768***
	(-8.23)	(-8.22)	(-7.82)	(-7.81)	(-8.00)
Farm size	23.162	23.180	24.701	22.362	22.921
	(0.73)	(0.73)	(0.72)	(0.66)	(0.67)
Conservation	0.055	0.054			0.007
	(0.37)	(0.29)			(0.04)
Irrigation	25.564	26.419			36.276
	(0.43)	(0.44)			(0.62)
Treatment*Conservation		0.004			-6.688
		(0.02)			(-1.32)
Treatment*Irrigation		-19.779			-99.365
		(-0.05)			(-0.19)
Family Labour			0.019	0.017	0.016
			(0.52)	(0.48)	(0.46)
Off-farm Participation			-94.463	-84.536	-83.926
			(-1.31)	(-1.15)	(-1.14)
Hired Labour			0.272*	0.235**	0.236**
			(1.72)	(1.97)	(1.98)
Community Labour			-0.032	-0.035	-0.034
			(-1.16)	(-1.34)	(-1.29)
Treatment*Family labour				-0.668	-0.812
				(-0.27)	(-0.30)
Treatment*Off-farm				-388.086	-396.166
				(-1.00)	(-1.01)
Treatment*Hired labour				26.693***	26.798***
				(6.18)	(6.58)
Treatment*Community				12.312	14.034*
				(1.46)	(1.66)
Treatment*Rental Market				192.347	235.730
				(0.44)	(0.55)
Constant	1641.100***	1641.116***	1664.845***	1667.985***	1666.926***
	(17.03)	(17.01)	(16.27)	(16.32)	(16.07)
Number of Obs.	1243	1243	1184	1184	1184

The first two columns present the effect of the program after taking into account the different investment channels. Controlling the potential investment channels does change the effect of the program on households welfare. That is, we still observe a significant welfare difference between treated and control groups even after controlling the investment channels. The coefficient of the interaction effect of treatment and the investment channels found to be statistically significant. This can be taken as an evidence against the idea that long term investment on land can be taken as one of the channels through which land tenure security affect household welfare in Ethiopia. Column (3) and (4) report the welfare effects of the program by taking in to account labor and land allocation channels, whereas the last column combines both the investment and input allocation channel. While the DID estimate found to be statistically insignificant, its interaction with hired and community labor found to be statistically significant. This can be taken as an evidence which supports labor allocation as an important channel through which land title certification affects household welfare. Compared with the control group, on average, treated household's welfare increased by 26.8 and 14 ETB when they employe one more hired and community labor hour. An increased productivity following the use of hired and community labor is the main channel through which land title certification affect household welfare. On the other hand, there is no evidence in favor of the investment channel.

6 Summary

The largely theoretical literature on property right has suggested that land tenure security can be used as a potential tool for rural development and poverty reduction in developing countries. More specifically, having land rights, by reducing the risk of land eviction, encourage long-term investment on land in the form of tree planting, soil conservation, fertilizer and irrigation use, maximizes allocative efficiency through reallocation of factors of production, relaxing credit constraint, reduce border conflicts among neighborhoods, allow economic growth and diversification.

Despite an extensive theoretical literature, well-defined empirical evidence on tenure security and household welfare is limited. Moreover, there is no any empirical paper which aims to decompose the welfare effects of tenure security into different mediators. Hence, this study aims to examine the welfare effects of tenure security on rural households based on household poverty status in Ethiopia. We have used the year 2005 land title certification program to exploit the variation between treated and control groups using the standard Difference-in-Difference approach. Using both binary and continuous treatment model, this paper finds

a positive and significant effect of land tenure security on improvement of rural household's welfare in Ethiopia. Efficient allocation of labor (hired and community labor) are found to be the main mediators through which land title certification affect household welfare.

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7 Appendix

Figure 1: Map of the study Area

Table 12: Summary statistics of the main variables used in our analysis

	Observation	Mean	Std. Dev.	Minimum	Maximum
[1em] Nominal annual consumption expenditure	1247	8519.425	7042.771	578.1333	71800.82
Real Consumption Per capita	1247	1407.367	1150.604	365.0064	11966.8
Certified Household	1247	0.6102646	0	1	
Certified Household before February 2006	1247	.095429	.2939245	0	1
Poor households	1247	.6479551	.4777995	0	1
Education Head	1247	.3568565	.4792641	0	1
Treatment Duration	238	3.831933	4.805222	0	16
Household Size	1247	6.38733	2.348101	1	14
Number of Dependants	1247	2.801925	1.51982	0	9
Farm Size	1247	1.02247	.929844	0	6.7725
Land Ownership	1247	.9815557	.1346054	0	1
Taking Certification Training	1247	.2279835	.1333933	0	1
Age of Household Head	1247	49.12048	15.07244	3	97
Married Household Head	1247	.8532478	.3540007	0	1
Male Household Head	1247	.8572574 .3499505	0	1	
Fertilizer use	1247	.818765	.3853673	0	1
Manure use	1247	.818765	.3853673	0	1
Tree planting	1247	.7393745	.439152	0	1
Irrigation	1247	.1106656	.3787368	0	1
Number of hours spend on soil conservation	1247	29.91637	106.6395	0	1
Tree planting	1247	.7393745	.439152	0	1

Table 13: Test of covariate balance across control and treatment groups by poverty status

	Control	Treatment	Difference	p-vale
Non-poor households in the base line				
Consumption per capita	2093.60	2166.32	-72.72	0.803
Head male	0.82	0.84	-0.02	0.810
Head age	47.82	48.37	-0.55	0.884
Head education	0.41	0.32	0.09	0.444
Land ownership	0.98	1.00	-0.02	0.504
Farm size	1.51	1.32	0.19	0.343
Martial status	0.81	0.84	-0.03	0.765
Household size	5.55	4.79	0.76	0.199
Number of dependants	2.34	1.96	0.38	0.214
Fertilizer use	0.93	1.00	-0.07	0.628
Manure use	0.17	0.32	-0.14	0.175
Improved seed use	0.19	0.23	-0.04	0.631
Hired labour	31.50	4.95	26.56	0.663
Family labour	107.12	91.37	15.75	0.440
Community labour	42.16	68.42	-26.26	0.054
Off-farm participation	0.20	0.16	0.04	0.679
Irrigation	0.15	0.05	0.09	0.552
Poor households in the base line				
Consumption per capita	783.52	802.50	-18.98	0.611
Head male	0.89	0.86	0.03	0.527
Head age	48.58	46.19	2.39	0.323
Head education	0.37	0.43	-0.06	0.444
Land ownership	0.98	0.98	-0.00	0.849
Farm size	1.64	1.42	0.22	0.163
Martial status	0.87	0.88	-0.01	0.828
Household size	6.62	5.93	0.69	0.056
Number of dependants	2.96	2.79	0.17	0.476
Fertilizer use	0.92	0.95	-0.03	0.430
Manure use	0.69	0.76	-0.07	0.464
Improved seed use	0.19	0.12	0.07	0.325
Hired labour	8.27	3.05	5.22	0.082
Family labour	115.70	79.12	36.58	0.115
Community labour	53.34	35.52	17.81	0.797
Off-farm participation	0.18	0.10	0.08	0.183
Irrigation	0.08	0.07	0.01	0.809

Table 14: Instrument validity test: Falsification test

	(1) Consumption per capita	(2) Consumption per capita	(3) Consumption per capita
Household level treatment	299.4***		218.3**
	(3.25)		(2.04)
Village level treatment		176.5***	104.5
		(2.93)	(1.50)
_cons	1237.3***	1216.0***	1215.6***
	(43.48)	(38.00)	(38.09)
N	1247	1247	1247

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 15: Welfare effects of the program for the households for the full sample

	Model 1	Model 2	Model 3	Model 4	Model 5
Pseudo_Treatment	126.947*	132.172*	126.901*	137.073*	129.538*
	(1.67)	(1.76)	(1.67)	(1.74)	(1.67)
year=2007	161.323**	162.527**	163.074**	92.693	186.467**
	(2.22)	(2.24)	(2.24)	(1.10)	(2.18)
Pseudo_Treatment x year=2007	-21.260	24.649	-23.501	-25.331	23.474
	(-0.20)	(0.23)	(-0.22)	(-0.23)	(0.22)
Household size		-86.190***			-91.380***
		(-7.95)			(-8.11)
Training			67.671		149.949*
			(0.85)		(1.92)
Farm size				-57.990*	16.858
				(-1.68)	(0.50)
Constant	1103.930***	1645.864***	1089.785***	1192.479***	1621.434***
	(24.20)	(20.36)	(21.77)	(16.87)	(17.88)
Number of Obs.	1128	1128	1128	1128	1128

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 16: Roboustness Check: Welfare effects of the program for the households who were poor in 2004

	Model 1	Model 2	Model 3	Model 4	Model 5
Pseudo_Treatment	50.509**	66.853***	49.310**	46.211**	53.454**
	(2.22)	(2.66)	(2.18)	(1.98)	(2.14)
year=2007	425.212***	428.574***	426.409***	448.409***	502.986***
	(6.50)	(6.58)	(6.52)	(6.52)	(7.20)
Pseudo_Treatment x year=2007	146.735	165.982	145.538	148.819	172.755
	(1.40)	(1.57)	(1.39)	(1.43)	(1.64)
Household size		-52.061***			-58.101***
		(-4.79)			(-5.13)
Training			60.921		98.642*
			(1.01)		(1.69)
Farm size				19.261	59.852***
				(1.16)	(3.50)
Constant	762.771***	1100.444***	750.392***	733.019***	1027.118***
	(53.71)	(15.24)	(39.28)	(25.42)	(14.57)
Number of Obs.	759	759	759	759	759

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 17: Welfare effects of the program for the households who were non poor in 2004

	Model 1	Model 2	Model 3	Model 4	Model 5
Pseudo_Treatment	-60.878	-80.267	-56.405	-48.733	-67.216
	(-0.32)	(-0.43)	(-0.29)	(-0.25)	(-0.34)
year=2007	-701.073***	-692.537***	-696.600***	-854.598***	-739.206***
	(-3.79)	(-3.73)	(-3.74)	(-3.98)	(-3.34)
Pseudo_Treatment x year=2007	-12.695	52.348	-19.842	-12.125	41.671
	(-0.05)	(0.22)	(-0.08)	(-0.05)	(0.17)
Household size		-75.116***			-81.079***
		(-4.20)			(-3.80)
Training			100.815		226.482
			(0.55)		(1.20)
Farm size				-136.876	-51.172
				(-1.45)	(-0.53)
Constant	2124.751***	2551.300***	2101.947***	2325.411***	2608.954***
	(17.46)	(17.61)	(15.69)	(12.71)	(14.45)
Number of Obs.	369	369	369	369	369
wald chi2	45	71	46	47	78

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 18: Spillover effects of the program using full sample

	Model 1	Model 2	Model 3	Model 4	Model 5
Treatment	11.358	-19.771	5.905	5.980	-32.591
	(0.10)	(-0.18)	(0.05)	(0.05)	(-0.31)
year=2007	125.577**	145.084***	126.168**	61.279	174.489**
	(2.40)	(2.75)	(2.41)	(0.88)	(2.43)
Treatment x year=2007	190.065	223.094	189.232	200.818	218.799
	(1.13)	(1.33)	(1.12)	(1.20)	(1.31)
Household size		-84.178***			-89.714***
		(-7.94)			(-8.09)
Training			59.835		144.837*
			(0.78)		(1.91)
Farm size				-51.732	21.452
				(-1.60)	(0.67)
Constant	1156.706***	1695.435***	1145.313***	1240.796***	1668.427***
	(30.97)	(21.09)	(27.58)	(17.82)	(18.11)
Number of Obs.	1128	1128	1128	1128	1128
wald chi2	10	67	12	16	70

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$