Effects of agricultural land tenure security on women's labor participation in Ecuador

Nicolás Pazos Navarro

Abstract

The objective of this paper is to evaluate the effect of a rural land regularization program in Ecuador on women's participation in the labour market. This program provided a georeferenced cadastral map to rural households, which is fundamental for land titling. Notably, when the treated land was inhabited by a couple, the program explicitly acknowledged joint ownership, thereby affirming the rights of both partners. The main hypothesis is that, for certain households, the program will enhance women's land tenure security, thereby giving them a better outside option and increasing their bargaining power within the household. This may change intrahousehold work dynamics, as women might be inclined to allocate more of their time towards activities that provide them with private income. The study uses data collected for the program's impact evaluation, including both baseline and endline surveys. Using a combination of difference in difference and triple difference estimations, this study finds that providing women with land tenure security can affect the allocation of working time within the household, increasing women's leisure time, increasing their participation in work within the household's farm and shifting the household's productive decisions to be more diverse and risk-averse. In general, the study shines a light on the impact of land tenure security on increased bargaining power.

1. Introduction

For a long time, economics have mostly focused their analysis on households as unified economic entities. This is the case, for example, of the very influential unitary model of the household proposed by Becker (1981), which considers that households take decisions as if they had a unified utility function with identical preferences or that one member took all the decisions for the household, operating as a dictator. In this model, income is completely pooled. Advances in the field have questioned this view, recognizing that members of the household may differ in their preferences, having to bargain their way into maximizing their own utilities. Therefore, members with more bargaining power might change the household decisions in terms of production and consumption to meet their preferences. These models consider that individual resources might not be fully pooled in the household budget constraint. This shift to models that focus on intrahousehold dynamics has been motivated by empirical evidence, but also by an increasing interest in international politics for reducing gender gaps.

In this paper, I evaluate the effect of a program that provides joint land tenure security to rural household-farms in Ecuador on women's labor participation, measured as time used in different labor activities. Particularly, I am interested in how providing information on the jointly owned nature of productive land can induce households to reassign workload between the household head and their partner. I combine household survey data with a triple difference strategy to measure shifts on the woman's use of time for leisure activities, agricultural work within the household, and private income generating activities outside the household, relative to their partners. I then complement these results using a difference in difference strategy to quantify direct effects on women's time use, women's personally earned income from diverse activities, household's income and production. This analysis serves to evaluate the roll of an income effect. Then, I use the same strategy to test effects on variables related to the household's diversity of production and investment in education, as measurements of changes in the outcome of the household's decision-making processes. This analysis should help reveal the presence of changes in the household's utility function due to changes in the weights associated with the individual utilities. Lastly, I calculate the effects on the probability of breaking the partnership, as a way of testing changes in bargaining power and breaking points.

The results show that, although this type of intervention are insufficient to increase the households' income and productivity, they might play an important role in reducing the time use gender gap in agricultural households. In particular, the program shifted working time from the women to the men in the household, decreasing women's time spent at work. Additionally, providing women with land tenure security increased their time working at the household's farm, potentially increasing their participation in productive decision. In fact, we observe an increase in crop diversity in households in treated households, implying a change in

productive decisions. We also observe that couples from households that received the program were more likely to get separated, suggesting a decrease in the breaking point. Overall, the results seem to imply that the program manages to improve women's land security, increasing their bargaining power, and the weight of their preferences in the household's utility function.

Since the results of this study provide no evidence of income effects driving the observed changes in time use, it provides valuable empirical evidence supporting that changes in intrahousehold dynamics can occur through information channels. Simultaneously, this study provides evidence on the impacts on gender gap reduction of policies focused on informal land tenure security. This is particularly relevant, as the theoretical and empirical literature has long pointed at the lack of security over land tenure as one of the main drivers of this disparity in agricultural settings, as it hinders equals opportunities within the household (FAO, 2011; Quisumbing et al., 2014, Agarwal, 1997; Udry, 1996; Bose & Das, 2017). This study manages to tie these concepts with the predictions of intra-household bargaining models, suggesting that securing women's land tenure can lead to an increase in their bargaining power (McElroy & Horney, 1981; Manser & Brown, 1980). Importantly, this study provides evidence of this channel, and building up on a still very limited literature on the the importance of land tenure security to reduce the gender gap, and to increase women's welfare, particularly relevant in developing contexts.

The study is organized as follows. Section 2 includes a description of the SigTierras program in Ecuador. Section 3 discusses the conceptual framework. Section 4 presents the data. Section 5 discusses the empirical strategy. Section 6 shows and discusses the results, and Section 7 concludes.

2. The SigTierras program

This study analyzes the effects of a land formalization program in Ecuador called SigTierras. This program was implemented by the government of Ecuador as part of a major project to formalize rural land in the country, which still has a lot of land with no legal documentation. To regularize and register properties, this program used canton-level cadaster sweeps (Corral & Montiel, 2022). In the following lines, I will briefly present the program, together with relevant information for this study.

The program started in 2012 but was not actually implemented until 2016. As the cadaster sweep was performed at a canton-level, the program was also provided at this level, with 50 selected cantons. SigTierras had four main components to achieve massive land regularization at a canton level. First, they generate cadastral

mapping, previously unavailable. This was done through surveys and aerial pictures (orthophotography), used to generate digital maps of the parcels within the selected cantons. Second, SigTierras gave financial and technical assistance to the selected cantons to use data-management technology that would facilitate the use of the digital maps to manage property registers. The third and final step would be the regularization of the land titles. To do this, SigTierras provided legal assistance to parcel owners that required it to deal with unresolved land conflicts.

For this study, we are mainly interested in the first component of the SigTierras program. As mentioned, in this first component SigTierras created orthophoto maps of all the 50 participating cantons and used surveys to assign all parcels to their owners, after revision. These maps were not simply given to the authorities, but instead were published and presented to the local communities during highly advertised meetings held in schools and other public spaces. In these meetings, parcel owners that agreed with the way land was divided received an official map with their parcels and additional information. This first component of the study was very time intensive and took from 2012 to 2016 to be completed.

Importantly for this study, parcels that were occupied by married or legally cohabitating (common-law union) couples explicitly recognized joint ownership over the land. This recognition was explicit throughout the whole process, included in the map information and in the public meetings. Also, the program provided legal assistance to women to provide support in taking advantage of the property rights.

Moreover, even though the initial phase of the program was successful, with more than 160 thousand digital maps created, by the end of the program the regularization of legal ownership status was not met. In fact, only around 20% of the parcels necessary to achieve the goal of the program were formalized. However, my hypothesis is that the publication of the joint status of parcel ownership in the community meetings, next to the digital maps, were perceived to be enough of a treatment to observe changes in female tenure security, even in the absence of formal land titling. This becomes even more relevant as the digital maps are the only necessary document to start application for government programs, such as certain subsidiary schemes.

Participating of the meetings could have served to provide women, and their partners, with legal knowledge on their ownership status. Also, since these meetings were done in front of the other members of the community, the ownership status was made clear not only within the household, but also to everyone else.

In conclusion, even without actual land formalization, the program managed to provide women with knowledge about their joint ownership of the land, which was validated not only by the program, but by the whole community and by official documentation, in the form of a cadastral map. However, it is also important to note

that the lack of formal title in the majority of treated households implies that the program did not automatically provide the households with the documents necessary to obtain credit.

3. Conceptual Framework

As described by Browning et al (2014), economic literature tends to model households in three major ways, depending on how decision processes are made within the household. First, classic economic theory usually assumes unitary households' models, such as that used by Samuelson (1956). In this case, the household maximizes its total utility, which is an increasing function of its members' utilities. It also only considers the total household income – as a pooling of the individual incomes – as relevant to determining final consumption. Second, there are non-cooperative models, where individuals are completely selfish and maximize their utility only, without considering their partner's utility. In these models, optimal decisions are not necessarily Pareto efficient, meaning that by taking a different decision at least one household member would have been better off without making any other worse off. Third, there are cooperative models, where Pareto efficiency is necessarily achieved, after households decide how to allocate their resources. It is important to note that this case does not imply that all members of the households get the same resources, as there are still power dynamics within the household that determine how resources are distributed. This is related to the concept of bargaining power.

The model used as framework for this paper is a general collective household model based on that proposed by Browning et al (2014). Let us consider a household with 2 members, the man (*m*) and the woman (*w*), both maximizing their own utilities. Their utilities will depend on the consumption of public good Q and private good q, and both members care about their partners' consumption. We can write the members' utilities as:

$$u^m(\boldsymbol{Q}, \boldsymbol{q^m}, \boldsymbol{q^w})$$
$$u^w(\boldsymbol{Q}, \boldsymbol{q^w}, \boldsymbol{q^m})$$

Where $\boldsymbol{u^m}$ is the utility function of the man and $\boldsymbol{u^w}$ is the utility function of the woman, and both depend on the consumption of the same vector of (perfect) public goods $\boldsymbol{Q}$, a vector of the personal private goods $\boldsymbol{q^w}$, and a vector of the consumption of their partners private goods $\boldsymbol{q^m}$ in the case of the woman (for the case of the man, we can simply exchange $\boldsymbol{q^w}$ for $\boldsymbol{q^m}$).

Then, the household faces a maximization problem which considers both utility functions, weighted by the parameter μ. The equation can be written as follows:

The equation can be written as follows:

$$\max_{\boldsymbol{Q},\boldsymbol{q^w},\boldsymbol{q^m}} \mu u^w(\boldsymbol{Q},\boldsymbol{q^w},\boldsymbol{q^m}) + (1-\mu)u^m(\boldsymbol{Q},\boldsymbol{q^m},\boldsymbol{q^w})$$

$$s.t.\ \boldsymbol{P'Q} + \boldsymbol{p'}(\boldsymbol{q^a} + \boldsymbol{q^b}) \leq x$$

where $\boldsymbol{P}$ is a vector of prices for the public goods and $\boldsymbol{p}$ is a vector of prices of the public goods. In this simple case, we are considering $\boldsymbol{x}$ as total household income. It is important to consider that, as defined, only the total household income is relevant for defining the budget constraint. Technically, all private income and shared income can be pooled to form the total household income $\boldsymbol{x}$. The relevance of private income will be introduced later.

We can think of μ as the share of bargaining power for the woman, and $(1-\mu)$ as the share of bargaining power of the man. Browning et al (2014) define these weights as the Pareto weights, which guarantee the efficiency of the cooperative model. It is easy to think of these weights as shares, so that the more power one individual has, the more their utility is considered in the household's maximization problem relative to their partner. Note that it is not implied that when $\mu = 1$ the utility of the man becomes zero, as the man's utility also includes goods that will be consumed by the woman ($\boldsymbol{Q}$ and $\boldsymbol{q^w}$), and vice-versa. Instead, the implications relate mostly to the decision-making process.

We can then follow Browning et al (2014) and rewrite the household maximization problem as:

$$\max_{\boldsymbol{Q},\boldsymbol{q^w},\boldsymbol{q^m}} \mu(\boldsymbol{P},\boldsymbol{p},x,\boldsymbol{z})u^w(\boldsymbol{Q},\boldsymbol{q^w},\boldsymbol{q^m}) + u^m(\boldsymbol{Q},\boldsymbol{q^m},\boldsymbol{q^w})$$

By doing this, the model now incorporates the prices and incomes as factors that affect the weights; or the relative bargaining power. This simplifies the model, but also considers that prices are not included in the individual utility functions.

This model also incorporates vector $\mathbf{z}$ is a vector of distribution factors. The distribution factors are all those events that might affect the distribution through changes in the decision process. These factors could be related to the alternatives outside of marriage (outside options), ownership over productive goods, private income, and emotional bonds. It is important to note that, as explained earlier, the budget constraint has only been defined

in terms of total household income. Therefore, private income is only relevant in this model as it affects the total bargaining power.

We can briefly depart from the model proposed above to include the perspective of a bargaining model. In this model, the two individuals set a threat point that is equivalent to the utility provided by outside option, or the option that does not require cooperation. We can interpret the threat point as another take on the distribution factor (μ) observed in the previous model. In fact, an increase on the threat point should naturally translate to an increase in the bargaining power.

Based on this cooperative collective model, there are many factors affecting the equilibrium, either by affecting the preferences of the individuals, their budget constraints, or the decision process (distribution factor). In the case of the land regularization program, we can think of it as an income effect (affecting budget constraint), a distribution factor **z**, or both. First, it can affect the budget constraint, as gaining security over land could help reduce credit constraints for the household. Since the program provides joint land titles, we can think of this as an increase in the household's total income. However, it can also be regarded as a distribution factor if it ratifies women's ownership of the land, previously ignored. As such, it affects her outside options to the marriage/partnership, as she can now consider divorce/separation with no fear of losing her claim on the property. In the same vein, it can give her explicit rights over the land's production outputs, as she becomes a co-owner of the farm.

In terms of how the land security tenure enters this dynamic, there is some evidence of the role of an increased land tenure security for women on their participation in decision making. For example, Wiig (2013), Santos et al (2014) and Mishra and Sam (2016) find positive relationships between joint land ownerships and an increased decision-making power for women. There is also evidence that strengthening women's tenure security can increase access to credit (Asfaw & Maggio, 2018; Santos et al 2014), and increase adoption of natural resource management practices (Deininger et al., 2008a). Similarly, Deininger et al. (2008b) find that knowledge about a legal provision of land tenure increased the tree planting and soil conservation activities for households in Uganda. Other studies that have identified Lack of land tenure security as an important constraint for gender equality within households in agricultural settings include those by Bose and Das (2017) and Udry (1996). Nevertheless, none of these studies give any insights on how land security might affect time allocation differently.

Time allocation is a good measure of resource allocation, as both partners have the same amount of time to distribute across different activities, regardless of their personal characteristics. Additionally, leisure time can be considered as a pure private good that we can explicitly assign to a specific individual. Most studies that want

to analyze private consumption in laboratory settings use gender-specific items. This is not something we can vary with observational data, making the use of time the only actually private good observable.

Both the changes in the distribution factor and in the budget constraint (income shock) may happen simultaneously. Nevertheless, they are driven by different mechanisms, and might manifest in different intensities or independently of each other. For an income effect to materialize, the regularization program should have an actual effect on the household's budget. The most obvious way for this to occur is through changes in their credit constraints (i.e., property could be used as collateral). Additionally, higher land tenure reduces the risks of having land conflicts, therefore making investments on the land less risky. Investing in agricultural technology will in turn translate into higher land productivity and higher income for the household.

For the program to shift the distribution of resources, however, it must have a differentiated effect in terms of land tenure security for each member of the household. Particularly, it is the purpose of this study to analyze if it gave women more security on their land, as they might have not been able to claim ownership without the program, or simply not been aware of it. In any case, if the joint nature of land ownership was already clear before the program, we should not expect changes in the decision-making process. Also, this effect does not require for the program to have a measurable income effect on the household. In fact, it could be argued that under the absence of income effects, any changes in production should be a result of this alternative scenario, exclusively.

If the land regularization program has an effect on the decision process that is favorable for the women, then it should be increasing the bargaining power (expressed in our model as μ), and therefore increasing the woman's utility. Assuming women gain utility from consuming private goods, then their consumption of these goods should increase with respect to that of their partners. Even if there is a strong preference for public goods, it should still be the case that their relative consumption of private goods should increase, as reallocation should benefit the consumption of public goods by decreasing their partners private consumption, and not their own.

As such, women should increase their time allocated to leisure relative to their partners, as leisure time can be considered a private good. We should also expect increases in line with those typically found in the literature to be related to women's preferences, such as investment in children's education and increases in crop diversity (risk aversion). Furthermore, we should expect that, under a bargaining model perspective, the threat point of separation should be higher, and therefore the probability of getting divorced/separated should increase.

In summary, I expect to find that if the program manages to enhance women's land tenure security, it should give them a better outside option and increase their bargaining power within the household. This should change intrahousehold work dynamics. If work within the household (either agricultural work or domestic chores) is a mean of producing a public good and households are not fully cooperative and do not pool their income, women might be inclined to allocate more of their time towards activities that provide them with private income. However, regardless of the level of cooperation, I should also expect women to spend less time working when compared to their partners, implying a higher consumption of leisure time. Additionally, I should expect the household to spend more money on goods that are typically preferred by women such as childcare and more risk-averse investment decisions (diversified production).

It must be said that although this is a very general and accepted framework, there are many studies that challenge its results and intuitions of the collective model, mainly in the empirical literature. Some studies that disproof the collective model do it by challenging the assumption of Pareto efficiency (Udry, 1996; Ashraf, 2009; Iversen et al, 2011; Dasgupta & Mani, 2015). There is also vast evidence of lack of cooperation from public good games performed during lab-in-the-field experiments (Barr et al, 2019; Fombe et al, 2013; Lecouter and Jassogne, 2019).

4. Data

In the context of the SigTierras program, an impact evaluation design was implemented to measure the effects of the program on actual land titling and productivity. This evaluation included the selection of a treatment and control group at the canton level. In this study, I will use the data collected during this impact evaluation for the analysis.

It is important to mention that the selected cantons were not randomized. Instead, cantons (the second geopolitical subdivisions of Ecuador below provinces) had to require being part of the program, which implies there was self-selection. However, the total self-selected cantons included a total of 171 cantons. From these cantons, only 50 were selected to participate. Of these 50 cantons, 9 were selected for the treatment group, only for those cantons located in the Andes. The selection process excluded cantons for various reasons, including the timely completion of the application process, and the availability of aerial photographs. This last point is important, as some cantons were not selected because an important and continuous area of their land was covered by clouds during the selection process. From the cantons that could not receive the treatment because of meteorological reasons, the evaluators constructed a Propensity Score using variables from the National Census to select the 9 cantons that were the most similar to the 9 selected treatment cantons.

After this process, the evaluators had to choose households to participate in the study. To do so, they followed a randomization within the households that were reported to have at least one parcel with land tenure issues within the treatment group. The objective of this evaluation was to find effects on land formalization, so it only made sense to include those that actually needed to be formalized. They followed a similar procedure to select control group households, although they again based their selection on a propensity score matching technique, again using data from the census.

The final data includes a total of 2712 households: 1356 control households and 1356 treatment households. The baseline data was collected through a survey in 2014, and the follow-up survey was administered in 2018. Since the program was only finished in 2016, the follow-up survey corresponds to two years after its implementation. Both surveys consisted of the following modules: Sociodemographic characteristics, non-agricultural economic activity of household members, information on plots, agricultural production, migration and remittances, savings and loans, equipment, dwelling characteristics, household participation in social programs, and social and productive organizations.

These data offer important and detailed information on its household's members activities, such as use of time in work activities, divided in domestic chores, agricultural activities within the household, and other activities outside of the household. The data also includes detailed individual-level information on entrepreneurial activities, investments, loans, production decisions at the plot level (who is responsible of making decisions), production at the plot level, children education, and relationship status.

Similarly, these data do not only include households were both a man and a woman were found. Therefore, not all included households will provide us with examples for evaluating the effects of the program on intra-household dynamics. Nevertheless, 69% of the sample consist of households where the household head had a partner at baseline, although only 61% kept the same partner by the endline (considering some cases where the partner took the role of the household head). The 8% of households that broke after the program will provide data for the part of the analysis regarding breaking points. As such, our main analysis consists of the 1518 households that included the same partners in both the baseline and the endline.

Table 1 shows the summary statistics for some sociodemographic characteristics at baseline for the subsample of undivided households, for both the treatment and control groups. The last column shows the difference between the means of both groups, with the significance level. As can be observed, both groups are very similar in terms of most variables, with some exceptions. For example, the probability of couples in the treated group to be married is higher than for those in the control group. However, in both cases the couples in the sample

are likely to be married instead of cohabiting. Households in the sample typically are Spanish speaking, have around 5 members and couples have around 2 children. Another difference found between control and treatment households is that both women and men are older and less educated in the treatment group, compared to those in the control group. It is the case in both groups that men are more educated and older than their female partners. We also find no differences in the average years of education of the couple's children.

Table 1: Summary statistics for sociodemographic characteristics at baseline

	Control	**Treatment**	**Total**
Couple is married	0.707	0.789	-0.081***
	(0.455)	(.408)	
Household head speaks a native language	0.144	0.127	0.017
	(0.012)	(.012)	
Household Size	4.854	5.015	-0.161
	(2.002)	(2.334)	
Number of children	1.959	1.9048	0.055
	(1.726)	(1.739)	
Woman's age	43.544	46.572	-3.028***
	(14.882)	(15.193)	
Man's age	48.025	49.5641	-1.539*
	(15.535)	(15.329)	
Woman's years of education	5.561	4.563	0.998***
	(3.406)	(3.243)	
Man's years of education	6.081	5.287	0.794***
	(3.346)	(3.167)	
Average years of education of children	5.40	5.54	-0.153
	(3.519)	(3.170)	
Number of observations	793	725	

Note: Averages by group. Standard deviation in parenthesis. Difference unequal to zero if p-value significant at the 99 (***), 95 (**), or 90 (*) confidence level.

Regarding our variable of interest at the household level, we will focus on production and income variables. Table 2 presents the summary statistics for relevant household level variables related to production and productive decisions. The total number of productive hectares refers to the total land in the household dedicated to agricultural production. The total annual income was constructed by adding the annual incomes provided by the private income of all household members, income from sales of crops and livestock produced in the household's farm and external transfers. The value of harvested crops represents the total output of the farm's crop production in dollars, while the household's agricultural income includes only the crops that were sold and subtracts the associated input costs such as fertilizers and seeds. The household's productivity is measured as the total value of the harvested crops in dollars, divided by the total hectares. As shown, we do not observe any significant differences between control and treatment groups in these variables.

To measure the diversity of the household's agricultural production, I constructed the Simpson's Crop Diversity Index (SDI), based on the following equation (Simpson, 1949):

$$SDI = 1 - \sum_{i=1}^{N} a_i^2 / \left(\sum_{i=1}^{N} a_i \right)^2$$

where a_i is the market value of crop i (in US$) and N represents the total number of crops sowed by the household in a given agricultural cycle (see; Hirschman, 1964). Thus, this index takes higher values when there is more diversification, taking the value of zero if only one crop is being produced, and one at the limit when N goes to infinity.

Since there is evidence of women having higher preferences for the household's nutrition than men, the analysis includes a separate measure for diversification that considers the adequacy of the production for human diet. To account for this, I constructed the Agricultural Diversity Score (ADS), which accounts for the number of food groups produced by the household (Sibhatu & Qaim, 2018). The agricultural products were assigned to different food groups following Chegere and Stage (2020) and the 12 food groups proposed by FAO: cereals; white tubers and roots; legumes, nuts and seeds; vegetables; meat; eggs; fish and other seafood; fruits; milk and milk products; oils and fats; sweets; and spices, condiments and beverages. When a product belonged to more than one food group, then the two groups were assigned. This decision was made because having one product that covers two food categories should imply that two nutritional requirements are met. Therefore, household's giving priority to nutrition could include more of these products to satisfy their needs. Since there are 12 food groups, the ADS takes values between zero and twelve.

As observed in Table 2, there are no differences in the Simpson's diversity index between control and treatment groups at baseline, as both groups seem moderately diversified. This is related with the characteristics of our sample, which is compromised by very small agricultural households, and not big agricultural exploitations, as also shown by the small average number of hectares owned by the household. In terms of agricultural diversity, however, we do observe a significant difference where treated households have 0.7 more food groups on average than their control peers at baseline. However, it is worth noting that none of the groups are covering on average less than 4 of the 12 food groups on their production. Of course, these households are part of larger communities and can buy additional product in the markets to complement their diet.

Table 2: Summary statistics for household production characteristics at baseline

	Control	Treatment	Total
Total number of productive hectares	2.828	3.422	3.11
	(9.541)	(10.686)	
Total annual income	3029	3300	271
	(10654)	17061	
Value of harvested crops (USD)	1524	2249	-724
	(4729)	(13253)	
Household's agricultural income (USD)	1069	1862	-792
	(8877)	(16198)	
Household Productivity (USD/hect)	685	3382	-2697
	(25511)	(89265)	
Simpson's Diversity Index (SDI)	.408	.396	.012
	(0.288)	(0.275)	
Agricultural Diversity Score (ADS)	3.254	3.947	-0.693***
	(1.600)	(1.687)	
Number of observations	793	725	

Note: Averages by group. Standard deviation in parenthesis. Difference unequal to zero if p-value significant at the 99 (***), 95 (**), or 90 (*) confidence level.

Summary statistics for the time spent in each working activity at the baseline is available in Table 3. Here, instead of showing differences between treatment and control group, differences between women and men are displayed. As observed, women spend significantly less hours on wage agricultural work, wage non-agricultural work, self-employed agricultural work, and agricultural work at home (which includes both paid and unpaid work). However, they spend significantly more time doing unpaid labor, and spend more time in non-work-related activities.

Table 3: Summary statistics for weekly time use at baseline

	Woman	Man	Total
Agricultural work	1.335	7.190	-5.854***
	(6.350)	(15.923)	
Non-agricultural work	2.623	13.371	-10.747***
	(10.193)	(22.690)	
Self-employed agricultural work	5.105	19.725	-14.621***
	(12.522)	(22.363)	
Self-employed non-agricultural work	3.6357	4.122	-0.487
	(12.691)	(13.689)	
Unpaid labor	11.125	1.074	10.051***
	(16.995)	(6.108)	
Agricultural work at home (paid or unpaid)	14.847	20.137	-5.290***
	(19.040)	(22.390)	
Non-work-related activities	144.175	122.517	21.658***
	(21.494)	(19.241)	
Number of observations	1,518	1,518	

Note: Averages by group. Standard deviation in parenthesis. Difference unequal to zero if p-value significant at the 99 (***), 95 (**), or 90 (*) confidence level.

It is worth mentioning that this variable was constructed as the difference between the total of time available a week (168 hours) and the time spent in all other working activities, including paid or unpaid. As such, it represents an imperfect measurement of leisure time. It is possible that some household chores are included in

this variable. However, many household chores were already included in the "unpaid work" variable, as it includes activities such as cleaning, cooking and "taking care of other people", although it is possible that respondents are not considering all the possible households' chores under this narrow specification. Although we could expect differences in what this variable means between men and women, there is no reason to believe there is a systematic misreport in this variable for treated and control groups.

5. Empirical Strategy

To find the main effects for this study we will use a triple difference approach. To do so, I take advantage of the impact evaluation data and consider differences between treated and control households in the baseline and endline trials. To achieve the triple difference, I include differences between the man and the woman in the household. This means that we will be observing differences in individual variables between the woman and their partner, within the same households, before and after the treatment, for treated and control households. This methodology still relies on the assumption of common trends, but is more robust than a double difference estimation, as by implicitly including household fixed effects we are relaxing the common trend assumption.

As such, this research uses the triple difference strategy to find the differences in time allocation between partners (men and women) in treated and control households, both before and after the implementation of the program. Particularly, the analysis focuses on differences in terms of time used in household chores, intra-household agricultural work (public income) and work activities performed outside the household (private income).

To test some of the potential mechanisms, I perform a complementary analysis based on a difference-in-difference approach. This allows us to test for variables defined at a household level, that cannot be tested using the triple difference approach. Particularly, I examine relative changes in household's total income, farm production, farm productivity, investment in productive assets, investment in children education, and the probability of the partnership getting separated.

6. Results

6.1. Main results: The effects of land tenure on Time Use

In this sub-section, I present results for the effects of the program on women's time use. First, I will present results for the triple difference analysis. These results compare time invested in different work activities between women and men in the household. Therefore, these results provide information of the time use redistribution within the household. Second, I present the results for the difference in difference analysis. These results provide information on effects of the program on total time used by women in the different activities, regardless

of the effects on their partners. As such, this set of results does not provide evidence on reassignment of time within the household, but total changes in women time use, and should be regarded as complementary for the main analysis.

Table 4: Triple difference results for the effects of SigTierras on women's Time Use compared to their partners

	Hours a week spent in…						
	Wage agricultural work	**Wage non-agricultural work**	**Self-employed agricultural work**	**Self-employed non-agricultural work**	**Unpaid labor**	**Residual time**	**Agricultural work at household's farm (paid or unpaid)**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Treated*Post *Woman	**-5.859*** **	**3.130***	2.107	0.070	**2.830*** **	**3.996*** **	**5.239*** **
	(1.157)	(1.647)	(1.740)	(1.659)	(1.010)	(2.864)	(1.888)
Treated *Woman	2.110**	-1.881	2.346*	0.583	-3.067***	-4.129*	-0.713
	(0.865)	(1.278)	(1.316)	(0.963)	(0.920)	(2.161)	(1.504)
Treated* Post	4.125***	-3.981***	-2.193	0.948	0.522	-8.829***	-2.247
	(0.856)	(1.423)	(1.526)	(1.325)	(0.443)	(2.154)	(1.529)
Post *Woman	15.299***	7.651***	-0.386	-7.867***	-11.443***	-27.344***	-11.325***
	(0.883)	(1.169)	(1.218)	(1.107)	(0.731)	(2.073)	(1.345)
Woman	-6.861***	-9.849***	-15.741***	-0.765	11.516***	-7.979***	-4.950***
	(0.673)	(0.871)	(0.916)	(0.632)	(0.677)	(1.600)	(1.079)
Post	-8.405***	-5.864***	-1.078	9.646***	-0.264	10.845***	-1.295
	(0.633)	(1.016)	(1.081)	(0.907)	(0.292)	(1.569)	(1.081)
Treated	-3.727***	2.474**	-1.773	0.864	0.112	5.405***	-1.675
	(0.806)	(1.165)	(1.146)	(0.705)	(0.315)	(1.802)	(1.148)
Constant	8.970***	12.189***	20.573***	3.710***	1.020***	121.538***	20.937***
	(0.610)	(0.801)	(0.812)	(0.470)	(0.213)	(0.685)	(0.812)
N	6,063	6,063	6,063	6,063	6,063	6,063	6,063
Adjusted R2	0.081	0.064	0.156	0.067	0.167	0.149	0.108
F	80.694	43.318	162.843	44.980	75.017	169.567	175.528

note: *** p<0.01, ** p<0.05, * p<0.1

Table 4 presents the results for the triple differences on the time use of women, when compared to men. Particularly, columns 1 to 5 present the results for time spent in different working activities, column 6 presents the effect on the residual time (the difference between total hours a week and the time spent doing the enumerated activities), and column 7 presents the effects on the amount of time spend working in the household's farm, which includes wage work, self-employed work and unpaid agricultural work. Since the residual time excludes all reported working activities (including unpaid work at home), we can think of it as an imperfect measurement of leisure time.

As can be observed in column 1, treated women spend almost 6 hours a week less on wage agricultural work compared to men than their untreated peers. Similarly, column 2 show that the treatment increased the amount of time women spent in non-agricultural work when compared to their peers by around 3 hours a week. Columns 3 and 4 show no results for time spent in self-employed activities.

The last three columns show interesting significant positive effects on how time has been redistributed. Column 5 shows that women spent almost three hours more in unpaid labor than their male peers, column 6 show that women spent almost 4 hours more than their male partners in non-work-related activities, and Column 7 shows that woman spent more than 5 hours of additional in agricultural work in the household, when compared to their peers. As such, these three results imply a shift of the work for activities performed within the household.

To complement the analysis of these effects, **Table 5** presents results using difference in differences for the effects of participating of SigTierras on women's time use. Since the difference in difference approach does not include the effect on men, these results can be compared to those of the previous Table to differentiate changes in total time used by the woman from reallocation of working time within the household.

As can be seen in column 1, the SigTierras program significantly decreased the time women spent doing wage agricultural work by almost two hours, compared to the women in the control group. It is worth noting that these results are 3 times smaller than those observed for the triple difference specification, suggesting that not only women spent less time in wage agricultural work, but that they do so even more when compared to their partners. This implies a redistribution of workload within the household, where men now work more in this specific activity than before.

Similarly, column 2 shows that they spent almost an hour less in doing self-employed agricultural work, although these results are not significant. Given that our triple difference results suggested positive effects of the program on the time women spent in these activities, these results could be interpreted as men shifting out of non-agricultural work. This case also be observed in the results on wage agricultural work.

In terms of columns 5, 6 and 7, results are similar to those found in the triple difference analysis, showing an increase in time spent in unpaid labor, leisure activities and agricultural work at the household. However, it is interesting to observe how these results change in magnitude. Columns 5 and 6 are larger in the Difference in Difference. Even more striking, Column 7 shows results that are almost half of those found in the triple difference analysis. These differences reveal some reassignment of the leisure time and time spent in the family farm, and not simply an increase of household participation in the household's farm that could have resulted of an increase in the interest of the household to spend time in agricultural work.

Table 5: Difference-in-differences results for the effect of SigTierras on women's time use

	Hours a week spent in…						
	Wage agricultural work	**Wage non-agricultural work**	**Self-employed agricultural work**	**Self-employed non-agricultural work**	**Unpaid labor**	**Residual time**	**Agricultural work at household's farm (paid or unpaid)**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Treated	**-1.734****	-0.851	**-0.086***	1.018	**3.352*****	**5.167***	**2.993****
*Post	(0.779)	(0.829)	(0.835)	(0.997)	(0.907)	(1.887)	(1.107)
Post	6.894**	1.787	-1.464*	1.778	-11.707***	-16.499*	-12.620**
	(0.615)	(0.578)	(0.560)	(0.635)	(0.670)	(1.356)	(0.800)
Treated	-1.617**	0.593	0.573*	1.447	-2.955***	1.276*	-2.387**
	(0.315)	(0.526)	(0.646)	(0.655)	(0.864)	(1.192)	(0.972)
Constant	2.108**	2.340	4.831*	2.945	12.536***	143.240***	15.987**
	(0.283)	(0.342)	(0.424)	(0.423)	(0.643)	(0.763)	(0.711)
N	3,030	3,030	3,030	3,030	3,030	3,030	3,030
Adjusted R2	0.084	0.003	0.004	0.011	0.144	0.074	0.120
F	109.809	4.330	4.767	11.644	164.567	79.050	135.873

note: *** p<0.01, ** p<0.05, * p<0.1

These results show that the program had an important effect on how women used their time, suggesting that they spent more time on agricultural work at home, unpaid labor and a proxy for leisure time, but less time on paid agricultural work. As a result, it appears that women are shifting their time from agricultural work activities

outside the household to more work within the household. More importantly, these results suggest that the household is reassigning the time spent in different activities for each member of the household.

These results also reveal some information on the potential mechanisms driving the effects of the program on the reorganization of time use within the households. First, since households are assumed to be utility maximizing, the households' utility function must include women's and men's leisure time. As leisure time is not productive (income maximizing), it enters the utility function directly, as part of the preferences. Then, the observed results on leisure time imply that the program is either helping maximize a utility that existed prior to the program – for example, via an income effect –, or changing the utility function. To evaluate the income effect channel, the next subsection presents the effects of the program on some income variables.

6.2. Exploring the income channel

In this subsection, I will explore results related to potential effects on variables related to income. First, I show the results from the triple difference estimation on the effects of the program on personal income for women, both compared to men. Second, I present the results for the same variables using a difference in difference approach, meaning it only considers changes in women's individual income, regardless of their partners income. These results involve only income from sources that I can directly link to individual work. That is, it excludes income from the household's farm. Third, I present results on total household income. Compared to the previous two tables, these results include the pooled income from the household's members and the total income from the households' farm production.

Table 6 shows the effects on income and investment decisions for the women found using the triple difference estimation. Column 1 shows effects on total annual income from all individual sources, while Columns 2 and 3 divides income from agricultural work and non-agricultural work. Complementing these results, Column 4 presents effects on the amount of money invested in personal businesses, taking the value of 0 when no investment was made.

As observed, there are no significant effects on any of these variables. This should not come as a surprise, as there is no reason to believe that the increased land tenure security within the household should have a differentiated effect on the income of women and men generated outside of the household.

Although insignificant, we do observe some negative effects on annual income. Such a negative effect could be related with the less amount of time dedicated to working activities found on the previous regressions, which should inevitably lead to less income. A potential explanation for why women choose to work less and decrease

their share of total income compared to their partners after the program is that their increased bargaining power allows them to reach a higher utility through household decisions without the need of external income.

Table 6: Triple difference results for the effects of SigTierras on women's income and investment decisions, compared to their partners

	Total annual income	Total annual income from all agricultural work	Total annual income from all non-agricultural work	Amount invested in business
	(1)	(2)	(3)	(4)
Treated*Post	-331.415	40.394	-338.773	-98.851
*Woman	(337.281)	(158.623)	(291.300)	(77.019)
Treated	458.955*	95.339	341.716*	82.836
*Woman	(234.759)	(74.408)	(207.740)	(61.514)
Treated* Post	695.273**	259.458***	394.318	80.653
	(295.703)	(74.859)	(280.109)	(73.335)
Post *Woman	-739.073***	-52.580	-735.021***	56.378
	(263.088)	(80.208)	(243.556)	(66.834)
Woman	-840.116***	-172.734**	-620.342***	-100.190*
	(204.691)	(72.246)	(178.690)	(59.232)
Post	856.875***	-39.808	958.718***	-39.217
	(250.324)	(63.698)	(235.714)	(64.155)
Treated	-663.741***	-266.828***	-363.708*	-76.722
	(224.718)	(58.015)	(203.032)	(59.867)
Constant	1,115.619***	349.433***	704.153***	121.673**
	(194.407)	(55.267)	(174.512)	(58.959)
N	6,063	6,072	6,072	6,063
Adjusted R2	0.043	0.005	0.043	0.001
F	67.646	36.781	49.062	2.051

note: *** p<0.01, ** p<0.05, * p<0.1

Table 7 shows the effects of SigTierras on the same variables related to women's income, and investment in businesses, this time using the difference in difference approach. In contrast with what we found in the triple difference specification, this time results show an increase in total annual income, coming from agricultural work. These effects are not only significant, but also considerable in size, when compared to the average income. In contrast, there are no effects on income from non-agricultural work and on investments. Since we

did not observe any results in the triple difference specification, these results suggest that both men and women experience a boost in their income due to the program.

Table 7: Difference-in-differences results for the effect of SigTierras on women's income and investment decisions

	Total annual income	**Total annual income from all agricultural work**	**Total annual income from all non-agricultural work**	**Amount invested in business**
	(1)	**(2)**	**(3)**	**(4)**
Treated	**363.858****	**299.852****	55.545	-18.198
*Post	(162.228)	(139.848)	(79.966)	(23.536)
Post	117.802	-92.388*	223.696***	17.161
	(80.952)	(48.742)	(61.306)	(18.732)
Treated	-204.786***	-171.489***	-21.993	6.114
	(67.921)	(46.592)	(43.977)	(14.139)
Constant	275.503***	176.699***	83.811**	21.483***
	(64.067)	(46.530)	(38.414)	(5.685)
N	3,030	3,036	3,036	3,030
Adjusted R2	0.005	0.001	0.012	-0.001
F	16.256	14.856	15.279	0.358

note: *** p<0.01, ** p<0.05, * p<0.1

Table 8 presents the results for the difference in difference specification on the household's income, total production, agricultural income, and agricultural productivity. The table shows no significative results, implying that that the program did not affect the total productivity of the treated households. It is worth noting these results refer only to our main sample of households where the same couple was present in the baseline and endline surveys. In the appendix, Table A1 shows these same results using the entirety of the data. That is, including households where only a man was present in either of the rounds, only a woman was present in either of the rounds, or the person reported having a different partner. Results of this analysis are similar in nature to those for our subsample, showing no significative results.

As observed, these subsection shows there are virtually no effects on the households' income or household's farm productivity, which makes an income channel unlikely. Similarly, we do not observe that the program had effects in the relative income of women when compared to their partners. This supports previous results, as the redistribution of time use does not seem to respond to an intention to increase personal income.

Table 8: Difference-in-differences results for the effect of SigTierras on household's production and income
(Sample of undivided coupled households)

	Total Annual income (1)	Value of harvested crops (USD) (2)	Household's agricultural income (USD) (3)	Household Productivity (USD/hect) (4)
Treated	-38,322	-39,975	-39,336	-20,367
*Post	(39,426)	(39,878)	(39,415)	(21,167)
Post	40,077	40,605	40,252	27,959
	(39,409)	(39,865)	(39,399)	(19,643)
Treated	271	724	792	2,697
	(738)	(548)	(679)	(3,454)
Constant	3,029	1,524	1,070	685
	(378)	(187)	(315)	(913)
N	3,036	2,806	3,036	2,996
Adjusted R2	-0.000	-0.000	-0.000	0.000
F	1.674	1.555	1.649	1.518

note: *** p<0.01, ** p<0.05, * p<0.1

6.3. Evidence of changes in outcomes of the decision process

In this subsection, I analyze the effects of the program on observable decisions made within the household. Since these decisions are made at a household level, the results presented correspond to the difference in difference analysis.

Table 9 shows the results for these estimations. The variables included are the average years of education of the partner's children, which serves as a proxy of investment in education, the Simpson's diversity index (SDI) and The Agricultural Diversity Score (ADS). Additionally, column 4 of Table 9 shows the results for a dummy variable indicating if the household was broken when interviewed at the endline. For this estimation, I used a larger subsample of all households where the household head had a couple at baseline. As in the previous table, results here refer only to our sample of undivided households. Results for the full dataset can be found in Table A2 in the Appendix. Again, the results of these analysis are almost identical to those found in our subsample.

Table 9: Difference-in-differences results for the effect of SigTierras on household's decisions regarding education, productive diversification and partnership continuity

Sample:	**Only undivided coupled households**			**Coupled households at baseline**
	Average years of education of children	**Simpson's Diversity Index (SDI)**	**Agricultural Diversity Score (ADS)**	**Partnership broken at endline**
	(1)	**(2)**	**(3)**	**(4)**
Treated	0.198	**0.043***	-0.141	**0.029****
*Post	(0.217)	(0.024)	(0.116)	(0.014)
Post	-1.861***	-0.072***	-0.435***	0.086***
	(0.154)	(0.018)	(0.080)	(0.009)
Treated	0.153	-0.012	0.693***	0.000
	(0.186)	(0.017)	(0.085)	
Constant	5.395***	0.408***	3.255***	-0.000
	(0.134)	(0.012)	(0.057)	
N	2,543	2,238	3,029	3,472
Adjusted R2	0.094	0.008	0.059	0.054
F	92.986	6.851	60.948	.

note: *** p<0.01, ** p<0.05, * p<0.1

Results show no significative effects on the children's years of education, although the effect appears to be positive. Similarly, we observe no significative effects on the agricultural diversity score (ADS), which implies that treated households are not necessarily more concerned with having a dietary diverse production. However, we do find significative positive effects on the SDI of around 0.04 . This suggests that treated households are more concerned with having a diverse production, which could be related to a risk minimizing behavior. It is worth remembering that the SDI is a measurement of diversity that considers each different product as adding diversity to the plot, while the ADS is a score that classifies food in accordance to their nutritional value for humans. As such, including two different products that can be classified in the same nutritional category does not add diversity under this measurement. Therefore, finding results for SDI but not for the ADS reveals that households are diversifying their production for market purposes, and not thinking of meeting the dietary needs of the households.

The results in Table 9 also show that partners in a treated household are 3 percentage points more likely to end their relationship and have a member moving out of the household than those in the control group. This finding could serve as evidence that the program provided the partnership with a lower breaking point for their bargaining model. In other words, since women are now more publicly entitled to the land and are expected to continue owning it in the case of a breakup, the outside option from departing the partnership becomes more attractive.

It is important to be careful with the interpretation of this result, as there could be other potential mechanisms not intended by the program. For example, it is possible that the partner that previously felt more entitled to the land (typically, we would assume that is the man) feels threatened to share the land ownership and chooses to exclude their partner of this benefit by ending the relationship. However, 64% of the broken households in our sample are cases where the woman is the interviewed household head at the endline (while only 5% of them were the household heads at the baseline). Moreover, 75% of broken partnerships in our sample of treated households are headed by a woman. This means that in most cases it is the woman that remains in the household after the breakup, and not the other way around. Although this does not disprove the previous caveat, it does prove that women are the ones more likely to keep the land in the case of separation.

These results give at least some perspective on the potential effects of the program on household level decision making. Although we cannot establish the exact mechanisms through which the program is changing the household's utility function, from a bargaining model perspective we can think of an increment in the weight assigned to the women's utility in the household's combined utility function. This would explain why we observe more broken partnerships after the program. Similarly, this could explain a shift in the production diversity to meet more risk-averse preferences.

Technically, it could be the case that even if there is a change in the utility function, this is given by an increase in the weight assigned to the man's utility function. This could only be the case as long as the men's preferences gives a higher value on women's leisure time, more diverse and risk-averse production decisions and more time for the woman working at the household's farm. However, the program is shifting ownership to include women, which should in turn increase their bargaining power and not reduce it. Moreover, it is difficult to imagine that men would value their partners leisure time more than their own, and more than their partners themselves, which is what this hypothesis would require. Then, the most logical explanation is the one proposed by this study: Land tenure security increases bargaining power, which assigns more weight to their own preferences and therefore increases leisure time.

On a similar note, the positive effects on working time within the household's own farm also seem to imply a higher participation of woman on the productive aspects of the household. The fact that they are increasing with respect to their partners imply that women receiving the program are likely to increase their share of participation in the household's production.

7. Conclusions

This study focused on a program that provides women from agricultural households with security on their land tenure, in the context of Ecuador, to analyze the effects of such a program on the intrahousehold work dynamics, with a particular focus on the reassignment of working time. This study uses a bargaining model framework to hypothesize that providing women with security on their land should improve their bargaining power, shifting the household's decisions in a direction that weights women preferences more heavily than in the absence of such rights. The results show that that the program induced changes in how working time was distributed between partners within the households.

Particularly, the program shifted women work participation from the agricultural wage and self-employed work into work within the household's farm, which could be suggesting a higher participation in the household's productive decisions. More importantly, the program shifted some of the leisure time from men to women. These results, combined with those on a higher-diversified risk-minimizing production, and an absence of income effects, indicate a shift in the household's decision-making process, that might be favorable for the women's preferences. These results align with our hypothesis and suggest an increase in women's bargaining power. This can be thought of as an increase in the weight that the household's combined utility function assigns to women's preferences. Also supporting this view, the study finds that the program increased the probability of women ending their relationships, which aligns with the hypothesis of a higher return to outside options, and an increase in bargaining power.

An important limitation of this study is that it is unable to present direct evidence on the mechanism driving the results. The study proposes that the program's provision of land tenure recognition increases the land tenure security and the bargaining power of women, which in turn shifts the household's decisions in their favor. However, the surveys include no direct measurements for bargaining power, land tenure security or preferences. Instead, these concepts are implied indirectly, by observing end results and relying on a well-established model. Future studies could tackle this limitation by including measurements of empowerment, bargaining power, or preferences. Such a study would require incorporating experimental techniques to measure these concepts.

This being said, the results of this study are still informative, both for the literature and policy makers. To the author's knowledge, there are no other studies directly linking land tenure recognition to household dynamics and resource allocation. As such, it represents a first step in understanding how intra-household dynamics operate in the presence of tenure public information. In terms of policy implications, the results of this study suggest that providing information on shared land tenure, even when it does not lead to the formalization of land titles, can provide women with higher bargaining power, and play a role in reducing gender gaps. This is particularly relevant in developing contexts where land formalization is expensive and hard to implement, which opens the question for social land recognition as a low-cost alternative to achieve gender parity.

The research agenda for this study will include exploring the different channels and providing more evidence on the assumptions' validity. In particular, I will incorporate a more detailed exploration of the parallel assumptions trend by using external data on the treated areas that could define participation and trends. This data will include average rainfall and cloud coverage, as well as average farm size. In terms of the mechanisms, I plan on focusing on exploring two sets of variables that will give this research a better understanding of the mechanisms. The first one is the effects on income. As it is for now, these variables require more refinement and a deeper exploration of its consequences for the model. The second one is the conditions for breaking up the partnership. The current theoretical framework does not provide a formal inclusion of the concept of outside option. Future instalments of this study should include and discuss this concept in more detail. Finally, I will explore on the mechanisms that explain why women would prefer to spend more time working in the household after gaining more land security by reviewing the literature.

References

Agarwal, B. (1997). "Bargaining" and gender relations: within and beyond the household. Feminist Economics, 3(1), 1-51. doi: 10.1080/135457097338799

Ashraf, N. (2009). Spousal control and intra-household decisionmaking: An experimental study in the Philippines. American Economic Review, 99(4), 1245–1277. https://doi.org/10.1257/aer.99.4.1245

Barr, A., Dekker, M., Janssens, W., Kebede, B., & Kramer, B.(2019). Cooperation in polygynous households. American Economic Journal: Applied Economics, 11(2), 266–283. https://doi.org/10.1257/app.20170438

Becker, G. S. (1981). A treatise on the family. Cambridge, MA: Harvard University Press.

Bose, N., & Das, S. (2017). Women's inheritance rights, household allocation, and gender bias. American Economic Review, 107(5),150-153. doi: 10.1257/aer.p20171128

Browning et al (2014). The collective model of household consumption: A nonparametric characterization. Cambridge University Press.

Corral, L. R. & Montiel-Olea, C. E. (2022). "Effects of land administration: evaluation of Ecuador's rural land administration program, SigTierras [Unpublished manuscript]". Washington, DC: Inter-American Development Bank.

Dasgupta, U.,&Mani, S. (2015). Only mine or all ours: Do stronger entitlements affect altruistic choices in the household? World Development, 67, 363–375. https://doi.org/10.1016/j.worlddev.2014.10.021

Deininger, K., Ali, D. A., Holden, S., &Zevenbergen, J. (2008a). Rural land certification in Ethiopia: process, initial impact, and implications for other African countries. World Development, 36(10), 1786-1812. doi: 10.1016/j.worlddev.2007.09.012

Deininger, K., Ayalew, D., & Yamano, T. (2008b). Legal knowledge and economic development: the case of land rights in Uganda. Land Economics, 4(4), 593-619.

Fombe, L. F., Sama-Lang, I. F., Fonjong, L., &Mbah-Fongkimeh, A. (2013). Securing tenure for sustainable livelihoods: A case of women land ownership in anglophone Cameroon. Ethics and Economics, 10(2), 73–86.

Food and Agriculture Organization of the United Nations (FAO, 2011). "The state of food and agriculture. Women in Agriculture. Closing the gender gap for development". Rome, Italy: FAO. Retrieved from: http://www.fao.org/3/i2050e/i2050e.pdf

Iversen, V., Jackson, C., Kebede, B., & Munro, A. (2011). Do spouses realise cooperative gains? Experimental evidence from rural Uganda. World Development, 39(4), 569–578. https://doi.org/10.1016/j.worlddev.2010.09.011

Lecoutere, E., & Jassogne, L. (2019). Fairness and efficiency in smallholder farming: The relation with intrahousehold decision-making. Journal of Development Studies, 55(1), 57–82. https://doi.org/10.1080/00220388.2017.1400014

Manser, M., & Brown, M. (1980). Marriage and household decision-making: a bargaining analysis. International Economic Review, 21(1), 31–44. doi: 10.2307/2526238

McElroy, M., & Horney, M.J. (1981). Nash-bargained household decisions: toward a generalization of the theory of demand. International Economic Review, 22, 333-349. doi: 10.2307/2526280

Mishra, K., & Sam, A. G. (2016). Does women's land ownership promote their empowerment? Empirical evidence from Nepal. World Development, 78, 360-371. doi: 10.1016/j.worlddev.2015.10.003

Quisumbing, A., Meinzen-Dick, R., Raney, T., Croppenstedt, A., Behrman, J., & Peterman, A. (2014). Gender in agriculture: closing the knowledge gap. Springer. doi: 10.1007/978-94-017-8616-4

Samuelson, P.A.(1956). Social indifference curves. The Quarterly Journal of Economics, 70(1), 1-22.

Santos, F., Fletschner, D., Savath, V., &Peterman, A.(2014). Can government-allocated land contribute to food security? Intrahousehold analysis of West Bengal's microplot allocation program.World Development, 64, 860-872. doi: 10.1016/j.worlddev.2014.07.017

Udry, C.(1996). Gender, agricultural production, and the theory of the household.Journal of Political Economy, 104(5), 1010–1046. https://doi.org/10.1086/262050

Wiig, H.(2013). Joint titling in rural Peru: Impact on women's participation in household decision-making.World Development, 52,104-119. doi: 10.1016/j.worlddev.2013.06.005

Appendix

Table A1: Difference-in-differences results for the effect of SigTierras on household's production and income (Whole sample)

	Total Annual income (1)	Value of harvested crops (USD) (2)	Household's agricultural income (USD) (3)	Household Productivity (USD/hect) (4)
Treated	-23,476	-25,131	-24,386	-14,107
*Post	(25,395)	(25,900)	(25,388)	(13,933)
Time	25,986	26,526	26,100	20,365
	(25,346)	(25,851)	(25,340)	(12,880)
Treated	511	1,098	1,021	2,184
	(654)	(633)	(625)	(2,185)
Constant	2,681	1,511	1,028	815
	(269)	(176)	(229)	(741)
N	5,014	4,602	5,014	4,902
Adjusted R2	-0.000	-0.000	-0.000	0.000
F	1.855	2.220	2.274	2.046

note: *** p<0.01, ** p<0.05, * p<0.1

Table A2: Difference-in-differences results for the effect of SigTierras on household's decisions regarding education and productive diversification (Whole Sample)

	Average years of education of children (1)	Simpson's Diversity Index (SDI) (2)	Agricultural Diversity Score (ADS) (3)
Treated	0.222	0.044**	-0.106
*Post	(0.182)	(0.019)	(0.091)
Time	-2.028***	-0.070***	-0.523***

	(0.132)	(0.014)	(0.064)
Treated	0.093	-0.003	0.668***
	(0.154)	(0.013)	(0.065)
Constant	5.628***	0.401***	3.207***
	(0.114)	(0.010)	(0.045)
N	3,702	3,643	4,974
Adjusted R2	0.106	0.008	0.065
F	154.180	11.126	113.192

note: *** p<0.01, ** p<0.05, * p<0.1